Design Principles for a Study Planning Assistant in Higher Education

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Digital study assistants (DSA) aim to support the challenging tasks of searching for relevant information and organizing this data for individual study planning. Although such systems are characterized by complex process flows, their user experience (UX) has rarely been examined adequately. This research comprehensively analyzes the UX of such a system at the University of Bamberg, which includes short-term planning for one semester as well as the distinctive feature of long-term planning beyond one semester. Via remote usability testing including an online questionnaire and involving 26 participants, this study explores students' interactions with the system and evaluates the impact of the system design on the UX, identifying strengths and weaknesses. The study has revealed that participants faced major challenges related to complex processes resulting from the lack of functional and terminological differentiation between short- and long-term study planning for users. In addition, certain features, including extended search options, were hidden and could not be found immediately. Derived from these findings, we present nine design principles to guide the development of effective DSA and similar support systems.

CCS Concepts: • **Information systems → Decision support systems**; *Web applications*; Personalization; **Retrieval tasks and goals**; • **Applied computing → Education**; • **Human-centered computing → User centered design**; **User studies**; **Usability testing**.

Additional Key Words and Phrases: study planning assistant, information-intensive decision tasks, usability study, design principles

ACM Reference Format:
Lena Bartel, Michaela Ochs, Tobias Hirmer, and Andreas Henrich. 2024. Design Principles for a Study Planning Assistant in Higher Education. In *Proceedings of the 2024 ACM SIGIR Conference on Human Information Interaction and Retrieval (CHIIR '24), March 10–14, 2024, Sheffield, United Kingdom.* ACM, New York, NY, USA, 18 pages. https://doi.org/10.1145/3627508.3638327

1 MOTIVATION

Study planning is a typical information-intensive task which is often a burden for students [21]. Here, the accessibility of relevant information is frequently hindered by its distribution across historically grown systems. One way to cope with these challenges of information seeking and use is to provide students unified, task-oriented access to the relevant information through digital study assistants (DSA). To shift the focus of support of such systems to the study planning aspect this research is examining, we will refer to these assistants as *digital study planning assistant (DSPA)* [26].

Although there is a rising interest in the research of DSA [12], there is a lack of comprehensive evaluation to identify general guidelines on what aspects should be considered in the design and implementation of such support systems. This research aims to identify such guidelines by evaluating a currently developed assistant at the University of Bamberg. Central to the evaluation of the DSPA is the effectiveness of students' retrieval of study planning related resources such

Manuscript submitted to ACM

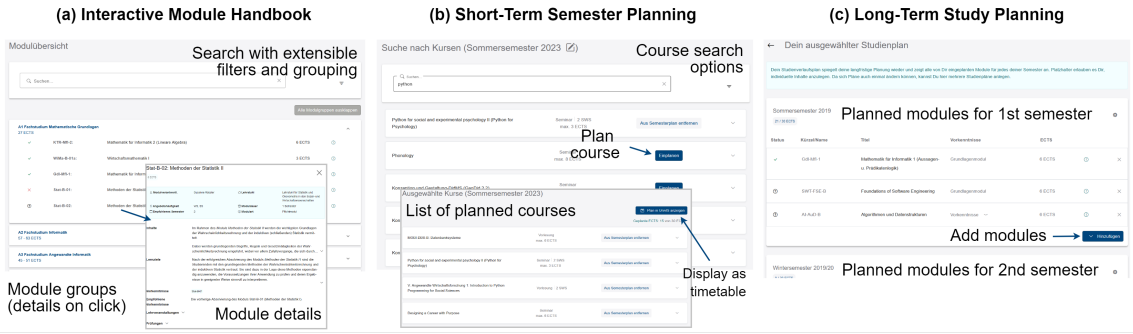

Fig. 1. Three components – (a) Interactive Module Handbook, (b) Short-Term Semester Planning and (c) Long-Term Study Planning – of the DSPA were tested in the user tests.

as module or course information and their intuitive interaction with these items within the context of the assistant. Accordingly, we aim to examine the following research questions related to the DSPA within the context of similar interactive student support systems: Which functions were found to support students in their study planning process? How is the DSPA perceived by students? Which design patterns should be considered when developing a DSPA or similar interactive support systems?

Therefore, we will briefly introduce the developed system in the second section and describe the methodology used in the subsequent section. The fourth section presents the results of the user tests, structured around information seeking as well as organization within the scope of study planning. The following discussion of these results in the fifth section presents nine general guidelines for the design and development of a digital study assistant or analogous assistance systems in higher education.

2 RELATED WORK AND CONTEXT

Since there is a rising interest in the research field on DSA, there are several projects aiming to support students in their study planning process. A short overview of such projects is given by Ochs et al. [26]. As previously mentioned, comprehensive evaluation of the developed systems has rarely been completed within the projects. Although Judel et al. [11] have conducted a similar user test in smaller size on their student assistant system with promising results in the assessment scores, for instance, they have not derived possible design patterns for other similar projects.

A distinctive characteristic of our DSPA is that it integrates relevant data sources such as the course management system (UnivIS) (semi-) automatically to reduce complexity and centralize the provision of necessary information for students. Compared to other DSA projects, our DSPA has a focus on long-term planning, i. e. planning for more than one semester. Here, the central idea is to integrate multiple data sources needed to make an informed decision – such as module descriptions, constraints related to study program structure, and previous students' study paths.

In the following, a short overview of the current functionality of the DSPA is given. A more comprehensive overview of the DSPA and its state at the time of the user tests is described by Ochs et al. [26]. As a first component, the *Dashboard* visualizes important key metrics of a student's studies, i. e. credit points or study success, and contains their meta information, i. e. start semester or degree program. Since the dashboard was still under development at the time of the user tests, its evaluation was postponed.

Figure 1 displays the three remaining components, which were evaluated in the user tests:

- The *Interactive Module Handbook* (Figure 1a) incorporates the module handbook as a list of nested module groups which contain modules, and enhances it with the ability to search, filter, and group modules.
- In the *Semester Planning* component (Figure 1b), students can search for courses for the current semester and add them to their list of planned courses. In addition, these courses can be accessed as a timetable in the course management system.
- *Study Planning* (Figure 1c) allows students to plan modules for upcoming semesters. Each semester is represented by a card that students may add modules to.

What underlies the design of the current prototype is a distinction between modules and courses. In German higher education a module refers to a thematically and temporally separated learning unit that can consist of one or more courses [17]. Therefore, due to availability, courses are primarily planned for the current semester, whereas modules can be planned for more semesters in advance. In the current prototype, the semester planning component is designed for *course* retrieval and short-term organization, the module handbook and study planning component are constructed to work with *modules* for long-term planning.

3 METHOD

In order to develop a system that is helpful for students, the aim was to have the DSPA tested by a representative group of at least 20 students in order to ensure both a sufficient minimum number for meaningful metrics and to enable group analyses. Although five participants are commonly considered to be sufficient to discover 80% of issues [19, 25, 31], more participants are promising to provide more reliable insights into the frequency and severity of issues encountered.

We reached out to students, who had expressed their interest in participating in a user test of the DSPA in the context of a university-wide study planning-related survey the previous year, contacting them via e-mail. 21 of these students took part in the user testing. In addition, we invited 5 further students who had not participated in the survey within the context of further research questions aside the scope of this paper. As a result, a total of $n = 26$ students participated in our study.

Only students from faculties whose module handbooks could be integrated into the system at that point in time due to technical limitations were invited and thus, primarily computer science and social and economic science students took part in the study. The participants' age range lies between 20 and 46, with a majority falling between 21 and 26 years old. Approximately two-thirds of the students were female, which may be related to the predominantly female student population at the University of Bamberg. With regards to the faculty, most students were computer science students, followed by social and economic science students. The distribution of bachelor and master students was approximately equal. However, since 69% of the bachelor students were in their fourth or higher semester and approximately 77% of the master students were in their third or higher semester, a majority of the students was advanced in their studies.

In order to capture the user interaction and experience with the system, we employed *Remote Usability Testing (RUT)* [1, 2]. Accordingly, the interviews were conducted remotely via Microsoft Teams in order to give students more flexibility in participating within their semester break – which aligns with their typical study planning periods. For the purpose of allowing real-time interaction with the participants, a synchronous RUT approach was chosen over a asynchronous approach [1]. For the usability testing, we chose the *concurrent think aloud method* [30] to assess the system's structure and functionality, allowing participants to utter their thoughts and any challenges encountered

while performing tasks [7], which allows for deeper insights [24]. For the purpose of analyzing the students' clicking behavior and specifically investigating possible problems in the interaction, we recorded the tests in video format.

For complementary testing of the system's usability, we employed an online questionnaire based upon common scales, i. e. *System Usability Scale (SUS)* [4] and *User Experience Questionnaire (UEQ)* [29]. SUS is commonly used for quantitative usability assessment, while we chose UEQ due to its more holistic approach, capturing not only aspects related to usability, but also to user experience (UX). Apart from these scales, *Net Promoter Score (NPS)* [13] was included at the end of the interview to assess the students' satisfaction and loyalty with the system, asking how likely they would be to recommend the tool to a fellow student.

The interviews were semi-structured, with the interview guidelines structured according to Krug [14] as follows: After a brief welcome and pre-session interview that gathered demographic information, expectations, and previous use of study planning-related resources, students could explore the homepage of the DSPA in an exploratory warm-up session. Subsequently, participants were given a scenario and 4 real-world tasks to complete using the *think aloud method*. These tasks covered the system structure, module overview, semester planning, and study planning. Before concluding the interviews, a post-session interview was conducted for post-use reflection on both positive and negative aspects. Krug's approach [14] was complemented and specified by aspects relevant for UX assessment and an online survey was added to the post-session. Following this interview structure, the average interview duration was approximately 54 minutes, excluding the online survey.

The results of the usability test were evaluated in a mixed method approach. The qualitative aspects – the usability testing as well as the open questions from the pre- and post-session – were transcribed according to Dresing et al. [6]. Next, the transcripts were iteratively structured via *qualitative content analysis*, using Kuckartz's deductive-inductive approach [16] and the *MAXQDA* software[1] to identify students' expectations, interactions with the system, and reaction to the system, including any encountered difficulties. The categories of the qualitative content analysis were divided into visual and conceptual findings according to the system structure (cf. Figure 1). The analysis was validated via intracoder agreement according to Kuckartz [15] based on a re-examination of the code system. The same coder inspected and checked the code system after a period of time, and any divergent assignments were revised. We also conducted quantitative analysis – mostly descriptive statistics – of the respective parts of the usability testing as well as the questionnaire responses using the aforementioned scales. These usability scores and findings have been computed and organized using this mixed method approach and will be described in more detail in the next section.

4 RESULTS

Before presenting the overall results, this section shortly describes the tasks and percentage of fulfillment. At the time of the study, students were preparing to start the next semester. This scenario was adopted in the study by asking the participants to use the assistant to plan their further studies. In order to evaluate the current version of the DSPA and to gain initial UX ratings, participants were given 4 open tasks:

(1) At first, participants were asked to think aloud about their understanding of the components of the system as they were navigating through them for the first time.
(2) Next, participants should select a module they would like to complete in the next semester and read about the module's learning objectives.

[1] https://www.maxqda.com/

(3) Then, participants were asked to create a semester plan for the next semester that includes all the courses of the module they have searched for in the previous task. The plan should be displayed as a weekly overview.
(4) Finally, participants should think about their long-term study plan and schedule at least three modules in different semesters.

These tasks were completed to varying degrees of success. While all participants completed Task 1, only 70 % fully completed Task 3. Four participants added only one lecture or tutorial and not all courses belonging to a module. Additionally, three participants deviated into long-term planning and did not display the courses in a weekly overview. Tasks 2 and 4 could be solved by almost all, i. e. 96% of the students. However, some difficulties occurred, so not all participants were able to complete the task fully. As an example, a participant could not find the desired module in Task 2 due to settings in the extended module search. In completing Task 4, further challenges were also encountered such as one participant returning to short-term planning and adding courses to the semester schedule instead of creating a long-term study plan. Nevertheless, the majority of the tasks could be completed successfully by almost all participants. Only the semester planning task performed slightly less well than the other tasks.

Overall, the idea and the concept of a DSPA, as shown in Figure 1, received great feedback. Providing an overview of all semesters for long-term study planning was mentioned to be particularly helpful by students. Participants also liked the selection and clear presentation of information for selecting modules for short- and long-term planning (in particular the module details, cf. Figure 1 (a)). Compared to previous study planning resources such as the module handbook as a PDF document and the university's internal course management system UnivIS, users indicated that they liked the design and layout of the DSPA more.[2] Participants further appreciated the clear and consistent layout of the DSPA, and they also valued that the DSPA centralizes study planning information and functions. These features enable students to better structure their study plans and help them make faster and more informed decisions. They can improve their study planning through better organization of information and a new long-term planning functionality.

Apart from these positive findings expressed by users, the study also revealed areas for improvement. The usability test analysis showed a large number of findings, which were rated using the *Severity Rating Scale* according to Nielsen [23]. In this paper, we present the most critical aspects according to this scale, as summarized in Table 1. Additionally, the study discovered various other minor findings, which are not discussed in this article due to its focus. Identified bugs were fixed immediately after testing. Results were obtained pertaining to all areas of the DSPA, as well as results relevant to only one of the components, including (a) Interactive Module Handbook, (b) Short-Term Semester Planning, or (c) Long-Term Study Planning. Thus, the results that are independent of the components are presented first, followed by the results that are specific to the components.

4.1 Component-Independent Findings

Component-independent usability findings recurred in more than one component or were conceptually related to several areas of the DSPA such as the following five findings that apply to the entire system (cf. Table 1: F1.1-F1.5).

F1.1 Unclear terminology. While integrating several functions within an application, it is crucial to differentiate system areas both linguistically and functionally. Some users have reported difficulties in comprehending the meaning and demarcation of terms, and in some instances, also the associated concepts – a phenomenon which might be related to the terminological ambiguity. This lack of clarity was evident in the understanding of "semester planning" (short-term) and "study planning" (long-term), as one participant puts it: "*[...] one thing*

[2]This comparison is based on existing systems and the status quo of study planning at the University of Bamberg, as described by Ochs et al. [27].

F1.1	**Unclear Terminology:** E.g. short-term semester planning vs. long-term study planning; course vs. module
F1.2	**Complex Process Flows:** E.g. differences between the functions of short-term and long-term planning
F1.3	**Poor Icon Design:** E.g. functions cannot be found due to the associated icons being too small
F1.4	**Missing Instructions:** E.g. effects due to the activation of the long-term study plan
F1.5	**Missing Undo and Redo Buttons:** E.g. navigation to the previous viewed module
F2.1	**Module Search:** Module is not found with input of module identifier
F2.2	**Extended Module Search:** Too many different filter options and combinations of module search
F3.1	**Course Search:** All courses of a module (e.g. lectures, tutorials) cannot be found directly
F3.2	**Semester Plan:** Weekly view (timetable) of the selected courses is not directly available in the system
F4.1	**Long-Term Conceptual:** Creation of more than one long-term study plan is not comprehensible
F4.2	**Long-Term Study Plan:** Display of study progress is missing

Table 1. Findings on difficulties in the use of different parts of the DSPA rated as severe according to Nielsen [23]. F1.1-F1.5: component-independent, F2.1-F2.2: interactive module handbook, F3.1-F3.2: semester planning, F4.1-F4.2: study planning

that I remembered as not so good was [hovers over 'semester planning' and 'study planning'] to some extent I didn't know how to distinguish semester planning and study planning."[3] With regards to the term of "semester planning", in particular, students preferred the term of "timetable" – indicating a certain familiarity from school. The terminology and associated functions of both areas were unclear to 62 % of the participants. There was further confusion regarding the terms "module" and "course". Users completing the tasks expressed uncertainty about whether they referred to the same thing. What has also become evident is that the use of terms from the module handbooks might not always be the most intuitive to the students. Instead of "organizational unit", for example, students preferred "chair" or "professorship". In order to enhance accessibility of the application for students, it is crucial to utilize terminology that is familiar to them within the system.

F1.2 Complex process flows. Due to the system's unclear terminology, the process flows were considered to be hard to understand. Users lost track of how to complete certain tasks because the steps were not clear or intuitive to them. This issue primarily concerns the differentiation between semester and study planning, where users experienced confusion regarding which planning functions corresponded to each area. For example, a participant tried to add courses to the study plan using the course search, although only modules can be added to the long-term plan. In general, some users have assumed that there is a dependency between the short- and long-term planning in the system, so that courses of modules they have planned in the study plan would also appear in their semester plan, although this could not be implemented so far. In addition, in the current DSPA of the University of Bamberg, it is possible to create several long-term study plans. Even though users can create

[3]Students' quotes have been translated from German analogously.

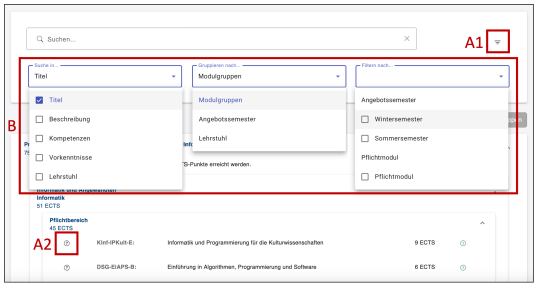

Fig. 2. A – Locating certain functions was challenging due to their unexpected or too small placement (F1.3). B – Too many different filter options and combinations of module search (F2.2)

several plans, we assumed that users will usually use only one study plan actively. Therefore, it is possible for users to activate a selected study plan and make it available directly via the navigation item 'Active Study Plan'. This function is based on a previous study of planning assistants' requirements, where students expressed a desire for several study plans to experiment with different study progressions [10]. However, during the usability tests it was found that this implementation was confusing and the need was not confirmed by the participants. It was unclear to users why several long-term plans should be created and what activating a study plan would do. Instead, students stated that it was sufficient to make changes to a single plan in order to keep track of them.

F1.3 Poor icon design. Certain functions and options were challenging for users to locate due to their unexpected or hidden placement. The issue was observed in all three evaluated components of the DSPA and is related to the design aspects of the user interface. For example, locating the search filter icon on the right side of the search bar (cf. Figure 2: A1) posed difficulty while searching for modules and courses because of its small size. Moreover, users perceived the module state icon as either too small or not easy to find (cf. Figure 2: A2). Even after direct questioning of users regarding the change of module state in the system, the function remained undiscovered by some users. As a result, some participants could not access the module state feature that classifies a module as taken, passed, or failed. In the DSPA, icons provide access to advanced system functions through a simple click, enhancing overall system usability. Thus, icons should be easily visible and located where users expect to find them.

F1.4 Missing instructions. Users reported a lack of guidance and information regarding the system's interconnections and functionality. While the module overview (a) was clear and self-explanatory for the majority of users, there were difficulties in recognizing the processes involved in the core components (b) and (c), as shown in Figure 1. Explanations provided in the form of information texts or hints were generally read and noted by users. Information about missing module requirements or successful course scheduling in the semester plan was positively emphasized. However, on the one hand, additional explanations and hints were often requested to make various aspects of the planning process more understandable such as clarifying the consequences of activating the long-term study plan. On the other hand, the design of the application should be developed in such a way that the assistant is self-explanatory for the user.

F1.5 Missing undo and redo buttons. Navigation between different sections of the system was challenging for some participants. For example, in the current system, it was not possible to return directly to the previously viewed module in the module details. Whenever users clicked on a module listed under the category of 'previous

knowledge', the module's detailed view directly transitioned to the corresponding module. Clicking the web browser's back button did not have the intended result of returning to the previous module. Therefore, the user had to use the module search function to find the module again.

4.2 Component-Specific Findings

After presenting the relevant findings for the whole system, two specific difficulties are presented for each system area. These results were discovered specifically in one component of the DSPA and are more detailed than the previously referenced findings. At first, the (a) *Interactive Module Handbook* (Table 1: F2.1-F2.2) is examined.

F2.1 Module is not found with input of university identifiers. Students primarily searched for modules using university identifiers such as module abbreviations. However, in no case could the desired module be found with the module abbreviation. Users were frustrated, as indicated by a participant's comment after entering the module abbreviation: "*Well, I assume that if I enter the abbreviation of the module in the search field, it will work.*" Since the module search is designed to find the required modules quickly and easily, this is a critical aspect for study assistants.

F2.2 Too many different filter options and combinations. More than one-third of users find the multiple filtering, grouping, and combination options of the extended module search overwhelming (cf. Figure 2: B), even though previously asked students had raised this need [10]. For example, there exist two variations in displaying modules based on the semester they are offered in, which are not easily comprehensible. In the current version of the DSPA, the modules can be (1) grouped according to the semester they are offered, and (2) filtered by semester when searching. According to the user tests, one option would suffice and simplify the extended module search. The usability of the extended search function is strongly affected by the fact that users were often confused by the various options.

After introducing the severe issues for the Interactive Module Handbook, the need for improvements regarding (b) *Short-Term Semester Planning* are presented in the following (Table 1: F3.1-F3.2).

F3.1 All courses of a module cannot be found directly in the course search. In order to ensure that courses are not forgotten or overlooked, all courses of a module need to be found. According to our research, 42 % of participants were unable to locate all courses of a module using the course search in the DSPA. That limitation is inherent in the fact that the course search function only operates within the title of the course. The course titles were directly imported from UnivIS, which means the presence of module identifiers in the titles cannot be guaranteed. This lack of module affiliation in the course title restricts the search and makes it difficult to find related courses belonging to a module. Figure 3 – C1 illustrates that entering the module abbreviation such as "AI-AUD" will not display all courses. It is necessary to specify the module name (beginning of the module name: "algorithmen") to display the tutorials accurately (cf. Figure 3: C2). The course search should present all courses for a given module, searchable by entering either the abbreviation or full module name. This allows users to vary their search inputs and easily select the most appropriate course for their needs.

F3.2 A weekly view (timetable) of the selected courses is not directly available in the system. The current system forwards users to a weekly schedule of selected courses in the (previous) course management system, which frustrated participants. As we have discovered previously, the current course management system is a major source of dissatisfaction for the students [27], which might have affected their reaction. Furthermore, the

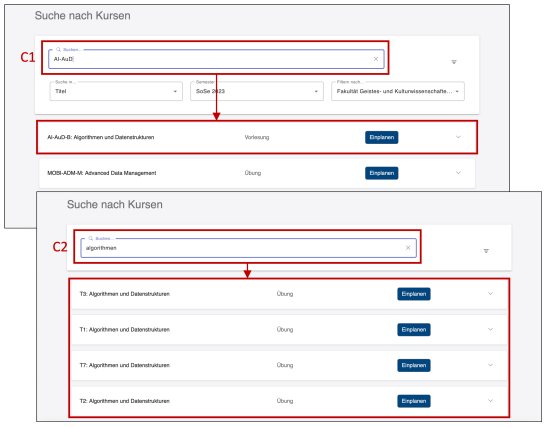

Fig. 3. C – Not all courses of a module can be found with one search entry (F3.1)

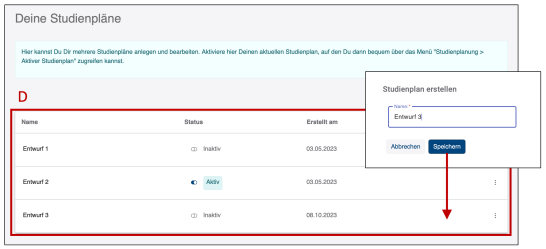

Fig. 4. D – Creation of more than one long-term study plan is not comprehensible (F4.1)

redirection to the previous system raises concerns with the users regarding the centralization of the systems. What has become apparent during the user tests is that a weekly overview is not currently available in the DSPA as a native function, but students strongly anticipate its implementation.

In the last step, the findings of (c) *Long-Term Study Planning* are described (Table 1: F4.1-F4.2).

F4.1 Creation of more than one long-term study plan is not comprehensible. As mentioned previously, users did not understand the reasoning behind the implementation of several long-term study plans. In the current version of DSPA, several study plans can be created and given a name (cf. Figure 4: D), so students can work with several versions in case their plans should change. In the user tests, students expressed that a single study plan is adequate for their long-term preparation. Nevertheless, participants also noted that the possibility of duplicating a study plan seemed reasonable and useful. This enables students to experiment with minor modifications without altering the primary plan. It should be noted that this concept has not been tested, only suggested by users. Furthermore, participants expressed that the study plan should be created directly within the system and not added by the user, as the long-term plan is a fundamental component of the DSPA.

F4.2 Display of the study progress is missing. In the long-term study plan, the display for target academic credit points can be customized and edited per semester by the user (cf. Figure 5: E1). However, it only calculates the sum of credit points for the modules planned per semester, not for the entire study program. This makes it

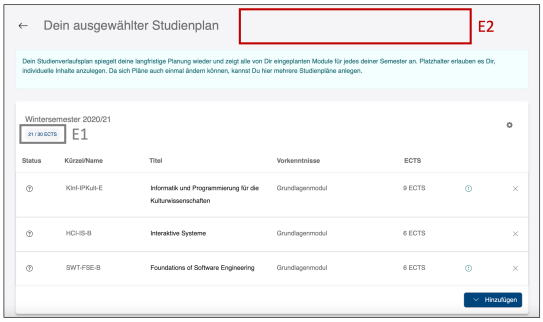

Fig. 5. E1 – Customization of target credit points per semester. E2 – Display of the study progress is missing (F4.2)

difficult for users to keep track of the edited credit points per semester. Figure 5 – E2 illustrates the location where students would have expected to see an indication of their personal study progress.

Overall, the user test revealed several difficulties. After completing the tasks based on which these findings were explored, participants were asked to complete the online questionnaire based on usability scales. These quantitative results are described in the following.

4.3 Usability and User Experience Evaluation

After conducting user testing, we evaluated the DSPA using various scales. In order to evaluate the usability of the system, the rating of the SUS is presented first. This is followed by the UEQ evaluation, which employs several dimensions, and finally, the NPS will be interpreted.

In terms of its usability, the DSPA achieved a SUS score of 83.2, which indicates a good (near excellent) rating for usability according to Bangor et al. [3]. There was considerable variability among the participants. The range of user ratings included a minimum score of 52.5 and maximum score of 97.5. The majority of participants (61.5 %) give a score of 85 or higher, which means that the majority of users rated the usability as excellent. However, 11.5 % of participants rated SUS items in a way that resulted in a SUS score of less than 70. These participants are about to finalize their bachelor's degree, i. e. they are in their sixth semester at least. While the individual statements of the SUS have no diagnostic value in themselves and do not refer to specific characteristics of a system, the SUS score can be interpreted more deeply. Based on a grade scale, a 'B' can be assigned, and indicating an acceptable usability rating according to the categorization of Brooke [5]. Overall, the usability is considered satisfactory despite numerous challenges identified in the context of the SUS.

Unlike SUS, UEQ allows for a quantitative analysis of the UX in individual dimensions. Due to the questionnaire's structure, the six dimensions of the UX can be evaluated separately and ranked on a scale from −3 to +3 [18, 29]. However, it should be noted that in practical use, calculating an average over a group of individuals with varying response tendencies often yields values that fall within a limited range of +2 and −2 [5]. Figure 6 provides an overview of the means and variances of the dimensions.[4] It is evident that five of the six dimensions achieved very good results. Attractiveness received the highest mean score of 1.91, while stimulation had the lowest mean score among the positive dimensions with 1.54. Similar to the SUS and the open-ended question of what was particularly liked after the user test, the DSPA was rated as easy to learn and clear in the UEQ. Nevertheless, the DSPA achieved lower scores for

[4]adapted from the UEQ-Tool: https://www.ueq-online.org, last accessed on 2023-10-17

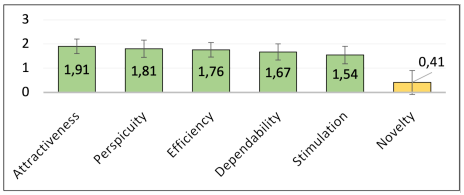

Fig. 6. UEQ Scales for the DSPA (Mean and Variance) – Positive ratings for Attractiveness, Perspicuity, Efficiency, Dependability and Stimulation, while Novelty received a neutral rating

complexity compared to other findings based on the usability test results as expressed in F1.2. Apart from its complexity, DSPA scores lowest on the novelty dimension. However, with a mean score of 0.41, novelty is considered neutral rather than negative. Specifically, DSPA was rated as more conventional than inventive and more dull than creative. Possible reasons for the lower rating of novelty for assistance systems in higher education are discussed in the next chapter. Furthermore, the UEQ scales can be classified into pragmatic quality (perspicuity, efficiency, dependability) and hedonic quality (stimulation, originality). While pragmatic quality describes task-related quality aspects, hedonic quality describes non-task-related quality aspects. Overall, the UEQ shows very good results with pragmatic quality receiving values nearing 2 and hedonic quality obtaining a value of 0.98. Thus, it appears that non-task-related quality needs improvement.

The previous metrics – SUS and UEQ – are more effective for UX research than NPS. However, the NPS has become a widely accepted standard due to its simplicity in data collection and interpretation, even by individuals outside the UX community. The NPS is an attitude-based metric that reflects the probability of users recommending a system to others on a scale of 0 to 10. After testing, the DSPA has achieved a NPS of 53 %. This rating reflects the percentage of users who are likely to recommend the system compared to those who are more critical of its use. Among the users, 65 % are promoters, 23 % are neutral, and 12 % are critics. According to [28], an NPS greater than 50 is an excellent rating, indicating that the recommendation rate of the DSPA is excellent.

In summary, the idea of an interactive, centralized application for short- and long-term study planning was well received: An interactive module handbook, a planning overview of all semesters with customizable target credits per semester and the integration of course schedules into semester planning. In addition, the NPS was rated as excellent and the SUS as good. The UEQ also shows very good results, with both attractiveness and pragmatic quality scoring close to 2. Nevertheless, the user tests have shown that a lot of improvements need to be considered in the further development of the system in order to make its use efficient and of added value for the students. Major usability-problems, such as unclear terminology between semester planning and study planning or overly complex process flows, were identified. In the following chapter, the outcomes will be thoroughly considered and discussed in different contexts.

5 DISCUSSION

While some of these findings have to be interpreted within the context of university-specific conditions or the broader university context, other insights may be of value to similar student support systems – and beyond. Therefore, this chapter first raises attention to possible context specificity or generalizability regarding the results and then presents nine more general guidelines that could prove to be beneficial for similar systems. Lastly, it addresses the limitations regarding the results of this study.

5.1 Context Dependency and Generalizability

In order to discuss the potential applicability and generalizability of the findings, this subsection's discussion distinguishes between aspects that may relate to specific conditions of the University of Bamberg, aspects relating to university context and aspects interesting for related projects and systems.

5.1.1 Aspects that may relate to specific conditions of the University of Bamberg. Each university has specific characteristics depending on its history and organizational structure, including the university, for which the evaluated DSPA was developed.

As described in Finding F1.1, some participants do not understand the distinction between modules and courses. This may be due to the fact that the classification of modules and courses is less present in some faculties. While for example, at the faculty of Computer Science, modules usually contain several formats of the same course, i. e. lecture and tutorial, several distinguished courses within one module are not common as they are in other faculties. However, since the DSPA is planned to assist all of the university's students, it was designed to allow for both course-oriented as well as module-oriented search.

In addition, the university has not yet provided a system for students that includes long-term study planning capabilities. Until now, students have primarily used UnivIS to plan their next semester, while planning for more than one semester mostly was done on paper or using specific software (e.g. notes app) as we have found in the context of the qualitative study of Ochs et al. [27]. It may be possible that students assumed the DSPA is simply an improvement to UnivIS and therefore may not have been able to directly classify long-term vs. short-term study planning.

Furthermore, not all students do plan for the long term at all. If a planned module cannot be taken, students still have to plan a new one. Thus, some students only plan their schedules from one semester to the next due to the scarcity of places in seminars or projects.

With regards to finding F1.4, i. e. incomplete instructions, it should be noted that the initial prototype is still under development. While a few areas may benefit from further guidance (per finding F1.4), the system aims to be self-contained and intuitive for users. Therefore, the focus should be on an intuitive design of the assistance system. Here, a follow-up test can determine at what point additional hints are useful.

An interesting aspect related to the ease of learning is the UEQ results, which present the DSPA as easy and clear to learn, while the system achieved poorer scores for complexity. This ambiguity might occur due to the perceived structured and simple design of the study assistant that is contrary to the complexity of the process flows described in F1.2, which are not apparent at first glance.

Last, the University of Bamberg has a historically grown diversity of systems which was first described by Henrich et al. [9]. Since students at the university criticize the sources and systems themselves such as the course management system UnivIS [27], it is not surprising that the forwarding to this system also is met with disapproval in the user tests. However, a certain heterogeneity in system diversity is not an exception at German universities [8]. Therefore, it is also important to consider how previous systems are rated by students at other universities and determine whether it is advantageous to avoid interfacing with them.

5.1.2 Aspects relating to university context. With regards to the quantitative results, the DSPA was rated more conventional than inventive and more usual than novel, as indicated by the UEQ rating. This result could possibly be connected to the existing innovation gap and the need to catch up in the area of digitization and support systems at higher education institutions. This observation is also evident in a recent related study in which a DSA was also

evaluated using the UEQ, and the hedonic quality, which includes the dimensions of stimulation and novelty, performed less well than other dimensions [11].

It should be noted that students in higher education may rate the system as more conventional regarding the DSPA within the context of state-of-the-art application design. This could indicate that students' expectations and evaluation criteria regarding the usability and novelty of higher education assistance systems are influenced by their background and industry-specific standards. This may explain why novelty was rated less highly than other aspects. The observation highlights the need to consider the requirements and expectations of students in educational institutions and to design future developments of assistance systems in close coordination with the needs and in the context of the higher education community.

Furthermore, during the evaluation, numerous suggestions for functions could be collected that might be applicable to related systems within the university setting. Students would like to receive module recommendations for the next semester based on previously taken modules and considering the specific examination regulations. Therefore, the system should generate course and module suggestions for semester and study plans. Another request was to notify students of schedule conflicts between courses. This will ensure that students are informed of any conflicts and can take necessary steps, such as adjusting their course schedule or rescheduling. Finally, many participants wanted to be able to share the long-term study plan with other students.

5.1.3 Aspects interesting for related projects and systems. In the context of digital study assistance systems, it is imperative to help students in their study planning efforts while ensuring usability in order to avoid imposing additional cognitive effort on students. Based on the large number of findings, it was possible to identify guidelines that may be relevant for the development of DSA which are presented in the following section. Design principles are important to ensure that the application is usable, engaging, and effective in supporting students' study planning.

For the derivation of these design principles, we used affinity diagrams [20] which helped structuring the qualitative study results. This approach facilitated the consolidation and abstraction of findings, as well as determining those findings that have a common underlying issue. Here, special attention was given to the results that acted as major obstacles for usability as they were deemed crucial in affecting the effectiveness and overall performance of the DSPA. Furthermore, positive aspects and user difficulties were contrasted to identify the core elements of a DSA that contribute to the aim of supporting students.

5.2 Design Guidelines

After structuring the findings in this manner, nine design principles could be derived which are shown in Figure 7 and described in the following. Six principles are specific to the DSA context, while three are similar to well-known heuristics, such as Nielsen's usability heuristics [22]. However, the description of the identified principles has been applied to the study context, i.e. they are focused on study support systems and are more targeted than the established heuristics. All nine principles can serve as guidelines for the development and design of such a DSPA and may also be helpful to similar, information-intensive student support systems:

(1) **Use of university identifiers:** Among students, the use of university abbreviations is widespread. Hence, terms and icons should be chosen from the university context. Search functionalities included in the system are important for finding modules and courses quickly and should be able to handle specific university identifiers, such as module abbreviations. In order to achieve added value compared to previous tools, a successful and fast retrieval of information within the assistant is indispensable.

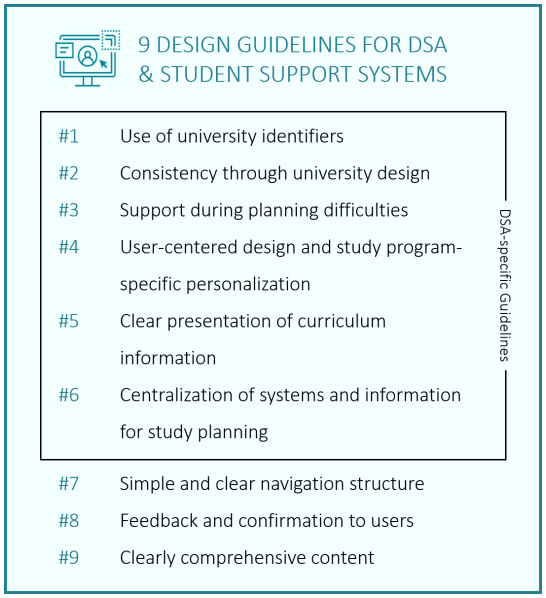

Fig. 7. Design Guidelines for DSA and related systems

(2) **Consistency through university design:** The application's design and layout should be based on the institution's standard color scheme. Consistent colors, fonts, button styles and user interface layouts shall be used throughout. The use of consistent design elements helps users understand and interact with the application. An overarching minimalist design and consistent arrangement of curriculum elements are particularly appreciated by students.

(3) **Support during planning difficulties:** The primary goal of a DSPA is to support study planning. Therefore, design and functionalities should contribute to the avoidance of planning errors. Design aspects, such as highlighting the current semester or making passed modules less prominent, can help students avoid errors in their planning. Clearly recognizable warnings and hints in case of planning obstacles should be integrated. Furthermore, students associate a DSPA on the one hand with the functionalities of module recommendations (long-term planning) and on the other hand with the support of collision avoidance in the case of temporal overlaps of courses (short-term planning). These should be taken into account during development.

(4) **User-centered design and study program-specific personalization:** The assistant should prioritize the individual student's needs, goals, and challenges. A high degree of customizability is essential for individual and personalized study organization. Students appreciate a system that is specific to their study program and tailored to them, which takes particular account of the planned number of semesters and credit points (overview of the work to be done and the work completed) and offers scope for individual planning aspects. Flexibility and freedom to make changes must be incorporated for all planning functionalities. Students would also like to have the option to easily and quickly reverse changes in semester and study planning.

(5) **Clear presentation of curriculum information:** To facilitate user guidance through study-relevant content, important information and features should be visually highlighted. The use of different sizes, colors and contrasts helps to draw attention to relevant elements. However, it is important not to overwhelm the user with the

design. Therefore, in the context of DSA, it is recommended to use timetables and weekly schedules for clarity of information. Students want to be able to quickly check which courses they have chosen and which courses are available for further selection. Therefore, important information such as course names (including module affiliation), course times, and rooms should be displayed directly.

(6) **Centralization of systems and information for study planning:** Care should be taken to advance the centralization of an educational institution's systems and information sources. A DSPA should not add a new system to a decentralized system landscape, but should unify study planning information and functions in the long term. Where necessary, students support the use of links to existing information sources and contacts to keep an overview.

(7) **Simple and clear navigation structure:** The assistant should offer a clear and intuitive structure and integrate the student's own study program, enabling users to easily navigate through the application's components and functionalities. A well-structured application hierarchy consisting of university-relevant planning components and corresponding well-positioned navigation elements is crucial. A recommendation for structuring the concepts relevant to study planning could be summarized as follows: A) For the purpose of gathering information about compulsory and elective modules, a *module overview* component interactively displays the student's module handbook. This provides the student with an overview of the modules to be completed. B) *Short-term planning* includes planning for the current semester at course level. A particularly valued component here is an integrated weekly schedule as an overview of the selected courses. C) *Long-term planning* covers the planning of modules over several semesters and offers students a supportive planning tool for the individual course of their studies.

(8) **Feedback and confirmation to users:** In the interaction between user and DSPA, feedback on changes and updates to the semester and study plan is necessary. Students want to receive clear feedback that their entries have been understood, that changes have been saved, or that updates to the course times have been made.

(9) **Clearly comprehensive content:** Students want to understand the system quickly. Clear instructions and explanations help users to use the application effectively. Therefore, sufficient explanatory texts and instructions should be presented in understandable language and without unnecessary complexity. Since a digital study assistant is a novel application for the majority of students, instructions and tips on how to use the study planning assistant should also be provided. A tool guide for first-time use or a help bar (context-sensitive help) is recommended.

In addition, **accessibility** should be considered during development to allow all students appropriate access to the system. This includes the use of accessible fonts, sufficient contrast, and other accessible design practices. This aspect was only addressed sporadically in the study results, so we do not consider it a separate principle, yet it underlies any modern effective and user-oriented design.

5.3 Limitations

One limitation of this study relates to the participant selection. Specifically, the sample primarily consisted of students who had progressed beyond the early stages of their studies. Only 4 of the 26 participants were in their first to third semester of their bachelor's degrees. Thus, the results may not be representative of all beginning students, who may have different needs and requirements for such a system, but may be harder to recruit for such a study. Nevertheless, the DSPA is designed for students in higher semesters as well as for students in the beginning phase. The study recruited participants exclusively from two university faculties, potentially limiting the incorporation of diverse academic

requirements and preferences. This limitation could undermine the generalizability of our findings beyond the sampled faculties.

Another limitation is related to the participants' knowledge before taking part in the user tests. Due to the invitation e-mail, they knew that they are testing and providing their feedback for a system that is currently developed at their university. The results and the scores, in particular, may have been impacted by the participants' possible intent to encourage further development of such a system.

It is also important to note that the design principles were derived by testing only *one* assistance system – limited to the planning focus. In the pre-session of the study, students were asked about their expectations for such a system. Besides the planning functions, they also wished to be able to integrate personal appointments and utilize an integrated chatbot for answering questions pertaining to their studies. Such features that go beyond the planning aspects were not included in the evaluated system.

Overall, despite the limitations, the described principles serve as a guide to create an effective, user-friendly and engaging assistant to support students. In addition, it is important to continuously improve the application based on user feedback. As a next step, it is crucial to validate the guidelines. Hence, it is essential to apply and test the principles on other DSA during development. Further research is necessary to ascertain the applicability and efficacy of the described principles for assistance systems.

6 CONCLUSION

Students face various challenges when planning their studies. As demonstrated, DS(P)As have potential to address these challenges and simplify some of the complex decision-making processes. The presented DSPA centralizes various information and offers students a new tool for short- and long-term planning of their studies. Nevertheless, university-specific constraints such as APIs, data quality, and data provision also limit the project.

The outcomes of this research not only show which design and functions are welcomed by the students, but they also give insights into how the students perceive the system. Within this context, we could reveal positive aspects as well as possible improvements in the assistance system such as the lack of module abbreviations processing in searches which hinders effective retrieval. To provide students with genuine added value, the currently developed system will be improved, in particular, by better integrating the new concept of long-term study planning. While our study as well as the improvements within the DSPA were discussed against the specific background of the University of Bamberg, the students' expectations as well as the derivation of the nine design principles are valuable for related projects and other university (information system) contexts. These principles can be used as a foundation for further research that aims to improve the effectiveness, usability as well as ease of use of DSA and similar student support systems. Nevertheless, we recommend a meta-analysis to verify whether the same principles can be derived for other DSA.

As for future work, we plan to integrate the suggested improvements and student needs in our further system development. Major aspects in this functional extension are related to further personalization of the system such as allowing for individual module and course recommendations. Also, the options of filtering and grouping that have previously been elicited have to be re-examined and reduced to those that are relevant in students' planning processes. A crucial aspect of this system extension is extensive iterative testing involving students from various faculties. In order to increase the test pool, we recommend inviting more first-year students to participate. It is further advised that usability scales such as SUS or NPS are reused during iterative development phases, which allows for continuous comparison and substantial improvement.

ACKNOWLEDGMENTS

This research was conducted as part of the projects "Developing Digital Cultures for Teaching (DiKuLe)" and "Learning from Learners (VoLL-KI)" and was financed by "Stiftung Innovation in der Hochschullehre (Foundation for Innovation in Higher Education)" as well as "Künstliche Intelligenz in der Hochschulbildung (Artificial Intelligence in Higher Education)"

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