

# Digital assistance in higher education – requirements for the development of a digital study assistant

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**Abstract.** Digitalization in higher education sets a trend of digital support in students' and teachers' daily working routine. New ways of accessing teaching materials, simplifying semester planning or structuring learning materials are opened up by technologies such as digital study assistants (DSA). The DSA represents a new and innovative technology in higher education and is still in development. For this reason, it is unclear which exact processes and tasks this application should take over. In software development, it is essential to define the requirements precisely to carry out the subsequent development steps and implementation correctly. These requirements must be derived from the needs of the stakeholders to ensure acceptance and willingness for sustainable use. Therefore, a student survey was conducted via semi-structured qualitative interviews, to identify important requirements for a DSA. Based on our research results, we provide indications for the development and further research of digital study assistance systems.

**Keywords:** digital study assistant, higher education, digitalization, digital education

## 1 Introduction

Nowadays, digital technologies determine everyday life and working routines of students [1]. The Digitalization in the context of higher education allows the implementation of a decentralized, action-oriented teaching and learning approach [2]. Many technical solutions are available which support the digitalization in higher education institutions, and those technologies are proven to exert decisive impact on teaching type [3]. Here, e-learning takes on an important role, as do learning management systems (LMS), which are required as a backbone for the digital infrastructure of e-learning units in higher education [2]. Another example of a new digital technology is a digital study assistance system. A digital study assistant (DSA) is an individual, digital and data-driven assistant software to support students efficiently and effectively in achieving their educational goals. This can be accomplished by connecting previously unrelated data and information in the study assistant. Students should be encouraged to define and consistently pursue their own educational goals and be assisted by a data-supported environment. The assistant to be developed should be in a position to give situation-appropriate hints, memories and recommendations and to enable comparisons with individual, factual and social reference norms and other standards [4]. However, during a search for existing digital study assistants at universities, it became apparent that there are very few academic institutions that use such systems in addition to their own LMS. For this reason, our research aims to provide initial insights and a basis for further research in this area. Therefore, we expect that a qualitative and explorative approach will be useful to gain insights into important requirements for a digital study assistant.

The current development of an individualized, digital and data-supported study assistant addresses existing challenges: support students in pursuing their own goals and to accompany them through lots of innumerable study offers in an advisory, effective and efficient way [6, 7]. Through the involvement of students in the development of a study assistant the target group gets the opportunity to become part of the digitalization in higher education by critically shaping the development and design of digital services.

These challenges require the cooperation of different disciplines and institutions in order to achieve a successful outcome and to combine different points of view into one overall understanding. For instance, access to the data stored in the campus management system or in learning management systems must be guaranteed. In this context, the responsible persons must provide the necessary data. Students are also obliged to give their consent in accordance with the data privacy regulations, which is a fundamental requirement for digitalization [8]. Here the willingness to disclose personal data can be increased by presenting the terms of use of the collected data and by demonstrating the benefits of a DSA [9].

In order for a technical system, such as a digital study assistant, to be used sustainably, it is essential that it is accepted by the user group [10]. As Abbad et al. already pointed out, a solid understanding of user acceptance processes and knowledge about how to convince students to engage with new technologies is necessary for a successful implementation and adoption of a system [11]. This is

where our survey comes in. The results from an explorative student survey ensure that the functions regarded as important are taken into account in further development. The student survey takes place at a university that currently uses several different systems and websites for various functions and content. In this initial situation, there are two particularly important tools that students often use on a daily basis. On the one hand a system for the administration and registration of exams and on the other hand a system for the organization of studies with, for example, access to teaching materials, module registrations or course information. However, these systems have an inadequate mobile view and are mainly available via a browser with desktop view, which means using a PC or laptop. The aim of the study is therefore to ask users about important core elements and features of the DSA and thus create the foundation for a user-oriented and widely accepted product in the context of higher education. Accordingly, the research questions are: *What do students require from a digital study assistant? How and where is this kind of support desired?* The aim of this study is not a complete literature research in the context of DSA, but an explorative survey of end-users (students) in order to obtain an initial overview of desired functions. For this reason, only the students are regarded as the target group and other important stakeholders such as lecturers, experts, executives and so on are included in follow-up research. From our research developers can extract requirements for a DSA, which they should consider when developing such systems. Researchers, on the other hand, can use our explorative approach as a point of reference to conduct further detailed and confirmatory studies on digital study assistance systems.

In the next chapter theoretical basics are demonstrated and current developments in the context of assistance systems are shown. The method is then presented in the third chapter. The results of the survey are then demonstrated and interpreted in chapter four. Finally, practical implications are given in the discussion and an outlook for further and constructive research is shown.

## **2 Digitalization and Digital Assistance in Higher Education**

### **2.1 Digitalization in Higher Education**

The rapid digitalization across many different fields has great relevance and poses huge opportunities for the society [12]. This wave of digitalization is led primarily by social, mobile, analytic and cloud (SMAC) technologies and drives innovation within society and the economy [13]. SMAC technologies are opportunities available to develop sustainable systems and create a technology-driven competitive advantage [14]. Technological transformations like these can bring fundamental changes that significantly alter a relationship between an organization and its customers, in this case between universities and students [15]. With the digital revolution, the term digitalization is increasingly being defined as a strategic priority by the government resulting in more and larger initiatives to promote digital transformation in science, business and society [13]. It is regarded as a major change in society and business and is often described as an ongoing process [16, 17]. The ways people communicate, obtain information, develop and comprehend disciplinary knowledge have been

transformed through the developments and availability of digital technologies [18]. These circumstances have a particular impact on academic education and the availability of technical solutions that support digitalization and promote the agility of higher education. Those technologies are proven to have a decisive impact on the type of teaching, organizing and structuring the studies [3]. Digital assistance systems are an example of such technologies.

So, it can be said that digitalization is an important and contemporary issue in academic education and cannot be neglected in the context of new, innovative technologies like for example a digital study assistant [1]. Our society faces a digital transformation that is reaching universities with great impact. In order to prepare students for the changes of the “digital world”, one of the tasks is to involve them systematically and in a structured way. This requires technical guidelines at a strategic level for structured action by universities to adapt to these changes [19]. Changing learning conditions in the age of digitalization must be perceived and new technical innovations should be implemented in order to interact dynamically and flexibly [20]. For this reason, the consideration of the requirements for new technologies from the student's point of view is essential. The student survey raises important requirements of a digital assistant in order to highlight relevant points for the development. New technologies in higher education require a certain level of user acceptance in order to be able to sustainably establish itself on the market and above all to guarantee long-term added value for students and teachers [21]. Any barriers that can be avoided preventively before and during the development of an assistant contribute to achieving this goal. Regarding to that, to accomplish maximum benefit of technologies in universities, overcoming diverse barriers is necessary.

In the following, various existing assistant systems will be examined and the current development of such systems will be highlighted. In particular, the digital study assistant will be discussed, as this technology forms the basis of the survey.

## **2.2 Digital Assistance**

An immense technological development thrust is currently taking place in information technology, which is uncovering completely new usage potentials [22]. The omnipresence of new technologies puts companies under a lot of pressure to break out of their familiar and traditional workflows and allow change. New approaches from research for further education, new business models and ways of supporting the implementation of innovations are demanded from practice [13]. This demand is met by assistance systems or, in this context, so-called cyber-physical systems (CPS), which open up previously unused possibilities in a wide variety of application areas [22]. CPS refers to the interaction of physical systems with integrated software and global data networks with interactive and distributed application systems, in other words "intelligent" technologies with linked Internet applications [23]. Areas of application are above all medicine, traffic, housing or industrial production. Central capabilities of digital assistance systems in the current state of research are environmental perception, reactive behavior, attention control and situation interpretation [4]. The vision is that assistance systems provide adaptive, situational

and individualized support by capturing user input and context. The number and functionality of assistance systems is constantly increasing [4]. A prime example is the automotive industry in particular, which uses such systems to increase safety, efficiency and comfort [23]. In order to be able to react flexibly to changing products and volatile requirements and at the same time exploit cost-efficient potential for improvement, data can assist human work in future production scenarios to create such work systems [24].

People can be supported in their work with selective information by digital assistance systems. These can be detailed instructions or simple hints. In return, companies benefit from assistance systems because they optimize the work of their employees, reduce errors and enable flexible personnel deployment. The continuing development and the increasing importance and influence of information and communication technologies has no longer only prevailed in the business sector, but also affects higher education institutions in particular [25]. This refers especially to cognitive assistance systems with regard to the provision of information and communication. These serve above all to provide application-oriented information in work and learning processes [4]. As a result, great potential for the increased use of digital assistants is recognized in the area of academic education. However, university institutions are lagging behind the rapid progress of well-equipped research laboratories in the industrial sector, so that in the context of higher education there is still no universally applicable definition of a study assistant [4]. In addition, the functionalities and structure of digital assistants can vary greatly depending on the needs of universities. In this context, more and more projects for higher education are being managed and promoted. Two examples are SIDDATA and SASy. For instance, the SIDDATA project is going to develop a data-based assistant, as part of the “Innovation Potentials of Digital Higher Education” funding line, provided by the Federal Ministry of Education and Research [26]. The project will investigate whether and how students can be supported efficiently and effectively in achieving individual educational goals by combining previously unrelated data and information in an individual digital study assistant. Students can use the assistant flexibly and determine individually which factors and data sources should be taken into account. The data that can be used include data from learning management systems, course materials and resources of other universities and institutions, as well as data on individual learning and work behavior. The other project, SASy, is supported and promoted by the Ministry of Science, Research and the Arts in Baden-Württemberg, and also pursues the basic idea of enabling an individually optimized process of study [27].

In general, the use of digital teaching is slowly finding its way into academic education, because students expect more flexibility in their formal education nowadays [28]. Prensky has already stated that these “new” students of today are ‘digital natives’ because most of them have grown up with digital technologies, and are surrounded by and immersed in technologies in their daily activities [29]. However, without massive government support, virtual universities and the spread of eLearning offerings, in most cases, cannot survive and never reach the desired level of sustainability [30]. In research, digital study assistance systems in higher education are mostly uncharted territory, and the lack of literature and studies in this context

reveals a research gap [5]. For this reason, our research starts at this point and provides first important insights through a survey of requirements for digital study assistants.

### 3 Method

There are several stages in a software development process that should be considered and gone through for a successful implementation of the software. ‘The Software Development Life Cycle’ (SDLC) is a vivid and widespread model for this. The SDLC includes the phases planning and requirement analysis, design and development, implementation, testing, integration and maintenance [31]. In this paper we focus only on the requirements analysis and neglect the subsequent phases. The determination of requirements for a software is covered in the SDLC as the first important phase of development and is indispensable [31]. Therefore, we asked for individual requirements of the target group regarding the necessary and useful components of a digital study assistant (DSA). In further progression of the development of the DSA, these requirements are to be taken into account in order to ensure the highest possible acceptance and thus the highest possible use by the students. Based on the research focus component of Sarker et al. we chose "what" and "how" questions to formulate the problem and took on a nominal view [32]. Our survey has a purely explorative character, as it is the declared goal to generate as much input as possible in the form of student requirements and expectations for the further development of the DSA.

To answer our research question a total of 24 interviews were conducted with students. We have chosen this method because it is fundamental with an explorative procedure to ask opinions and expectations of the test participants freely and as unbiased as possible. Our sample consisted of 11 female and 13 male students. Of these, 21 were students with a focus on economics, 1 on law and 2 on fine arts. All students have been studying at a university for at least two years. The sample was recruited at the same location where the digital study assistant will be developed, tested and finally introduced. We conducted all interviews in German, as this is the native language of the interviewees. This ensured that all questions could be understood and answered. As already mentioned before, the main goal was to gather requirements for a digital study assistant from a student’s point of view. For this purpose, we developed an interview guideline in German, which we have presented here in Table 1 translated in English.

**Table 1.** Interview guideline for the survey

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<b>Demographic data</b>	Study course:
	Semester:
	Gender:

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**Work routine**

Question 1	What does your student work routine look like?
Note	Also in lecture-free time

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### Tasks & Processes

Question 2	What are typical student tasks/processes in your everyday study life?
Examples	Not only lectures, but also preparation and follow-up, organization etc.)
Note	Special cases and lecture-free time

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### Students' requirements for a DSA

Question 3 preparation	Imagine a software that supports you in your student work routine:
Question 3a	For which tasks/processes can you imagine such help?
Question 3b	And what should this support look like?
Examples	Organizing courses, time management, structuring course materials, etc.

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This guide contains a query on demographic data. Here we limited ourselves to the course of studies, the semester of studies and the gender. The main part of the short guide consisted of 3 core questions, which were sub-grouped for explanation (see Table 1). First, we asked about the students' everyday work routine, while the second question focused on explicit student tasks/processes. Question 3 then dealt with the requirements of a digital study assistant. Here the question was subdivided into part a and b. So in 3a, in which of the processes mentioned in question 2 could a DSA support and in 3b how this support could look like?

All interviews were recorded and transcribed to allow further research of this data. Then the interviews were analyzed by a data-driven qualitative, content analysis using a summative approach [33]. We divided the process of analysis into four phases. During the transcription process we, two researchers, became familiar with the data, a rough word count and a classification was created to identify the processes/routines as well as the desired requirements of the DSA. First, the answers were organized by questions (1 to 3b) and the paraphrased (phase 1). Then, the paraphrases were generalized to a level of suitable abstraction into core sentences (phase 2). In the third phase the first reduction was made by cutting semantically identical core sentence and those which are not felt to add substantially to the content. Finally, as the second reduction, the core sentences were combined with similar or identical ones and thus classified in categories (phase 4). Then a focus group of four other researchers discussed the frame of the study (participants, questions, transcriptions), and then categorized the data again to check the plausibility. Discussions afterwards revealed that all disputes were either ambiguous word interpretation or misunderstandings of speaker in transcription.

## 4 Results

### 4.1 Presentation of the overall findings

In this chapter a general overview of the results of this survey is given. To illustrate this, Table 2 shows examples of some core sentences and their numbers from which the categories were derived. These are listed according to the corresponding question categories and here again according to the importance, e.g. the number, of the collected core sentences.

**Table 2.** Overall findings

<b>Questions</b>	<b>Core Sentences (exemplary presentation)</b>	<b>Total number of mentioned Core Sentences</b>	<b>Categories (After 1<sup>st</sup> and 2<sup>nd</sup> reduction)</b>
<b>Work Routine Question 1</b>	Attend lectures, attend exercises, attend seminars	33	Attend a university course
	Prepare university courses, post-processing university courses	17	Preparation and post processing
	Learn for an exam, practice exercise tasks	12	Learning
	Procure learning materials, organizing learning materials	5	Learning material
	Create a timetable / calendar, Planning of semesters and modules	3	Planning / scheduling
	Work in groups	3	Group work
	Write homework and exercises, writing final papers and term papers	3	Rated submissions
<b>Tasks &amp; Processes Question 2</b>	Procure learning materials, organizing learning materials	17	Learning material
	Attend lectures, attend exercises, attend seminars	16	Attend a university course
	Prepare university courses, post-processing university	14	Preparation and post



	courses		processing
	Learn for an exam, practice exercise tasks	14	Learning
	Create a timetable / calendar, Planning of semesters and modules	7	Planning / scheduling
	Work in groups	6	Group work
	Social interchange between students	1	Interchange
<b>Students' requirements for a DSA</b>	Create a timetable / calendar, Planning of semesters and modules	22	Planning / scheduling
Question 3	Active reminder, push messages, push notifications	14	Push notifications
	Want the DSA as an App	12	App
	Social interchange, data interchange between students	9	Interchange
	Learn feature, exercise function, Query system for learning content	8	Learning assistance
	Provide documents from lectures, provide external information to a study topic	7	Educational resources
	Combine with other university systems, all for one solution	6	Integration of other systems
	Tutorial (1), clarity (1), location map (1), similarity recommendations (1), Cloud function (1)	5	Other

Table 2 first shows that the students surveyed obviously make little distinction between question 1 (work routine) and question 2 (tasks & processes) with regard to the categories identified, since most of them are the same. However, since these two questions are merely intended to encourage students to reflect on themselves and thus provide them with a basis for answering question 3, this aspect is not particularly important. The top 3 of the most frequently mentioned categories in question 1 are 'attend a university course' with a total of 33 core sentences, followed by 'preparation

and post processing' with 17 core sentences and 'learning' with 12 core sentences. In question 2, the top 3 categories are 'learning material' with 17 core sentences followed by 'attend a university course' with 16 core sentences. 'Preparation and post processing' and 'learning' share 3<sup>rd</sup> place with 14 core sentences each. In question 3, the top 3 categories are 'planning / scheduling' followed by 'push notifications' and 'App'.

## 4.2 Findings related to the research question

The following section will comment on the results in relation to question 3 of the survey. The associated categories are defined and linked to the results. The first and most mentioned requirement of students is 'planning / scheduling'.

**Planning / scheduling.** All administrative activities before and during the semester concerning study planning, which courses are taken in which semester and the breaking down of a timetable fall into this category. Structure and organization are essential for a successful course of study, so that support for such planning elements was rated as particularly supportive and significant by the students. A total of 22 core sentences were formed in relation to question 3, which could be assigned to this first category. This means that students are looking for help, especially in organizational activities, as this category was by far the most frequently formed. The second most important requirement in the ranking of the core sentences is the category 'push notifications'.

**Push notifications.** This refers to hints, notifications and reminders that are actively requested by the user from the system. This function is used, for example, to send reminders of registered appointments or to inform students about the cancellation or relocation of a lecture. In this context, important, recurring actions such as the transfer of semester fees every six months could also be automatically sent by the assistant in the form of a reminder. These actions do not have to be actively requested by the user, but could be activated e.g. by a presetting or administration of the responsible administration instance. A number of 14 core sentences were given within question 3 on the category 'push notifications'. The concern to miss important information or changes is great with the students, so they want a system that keeps them up to date. The category that follows very closely as 3<sup>rd</sup> requirement is 'App'.

**App.** In relation to this category, a good mobile view is expressed as an important requirement very often. The desire for permanent availability of data and information in the form of an App for smartphones is very large among students. It has often been pointed out that the current status of the mobile view of the necessary systems is insufficient and unsatisfactory at the university surveyed, so that this category represents a major requirement. The category was named 12 times in total, so that it follows very closely the previous category 'push notifications'. The digital dependency of young people becomes particularly clear here, since they are used to being constantly informed about everything and to being able to retrieve any information at any time due to their good networking and the prevalent role of technology [34].

**Interchange.** The category ‘interchange’ mainly refers to two core sentences and requirements, on the one hand the social exchange among students and on the other hand the exchange of data. In general, social exchange is about sharing experiences and opinions. Students want more interaction with fellow students in order to facilitate group work and to be able to exchange information better, since they often sit in a large lecture auditorium with many people they do not know. With regard to data exchange, students imagine a kind of exchange platform where they can share and obtain summaries, their own work documents or learning content. The following categories are all very close to each other, but the interchange category came 4<sup>th</sup> with 9 entries and made it clear that social exchange and good networking among students is very important. A study assistant should consider this requirement in any case, so that anonymity does not have to be a matter for students to worry about.

**Learning assistance.** For this category 8 core sentences were mentioned from the students. In relation to this category, the interviews have shown that students want support in form of exercise functions or test and query functions when it comes to learning. These should help to learn by heart, support the learning process by e.g. to-do lists, which can be processed or also the input of partial goals with time limits, which have to be adhered to. In principle, one's own learning should no longer run unstructured, across different subjects. Much more students want a clear framework in the learning process, which shows progresses in the form of work that has already been done and work that is still missing.

**Educational resources.** Another requirement is the category ‘educational resources’, which is mentioned in 7 core sentences. Educational resources mean the availability of free educational resources like open educational resources (OERs) and internal university teaching materials. Here, the students want the DSA to provide educational resources as an active function. These educational resources are primarily seen as an additional source of information in addition to the lectures, in order to better understand and comprehend contents. Especially in the follow-up and learning of teaching contents, further or supplementary literature is more often needed.

**Integration of other systems.** The survey revealed that students, with a total of 6 core sentences, find the university's various systems confusing and poorly organized. They expect an assistant to integrate all existing platforms and bundle all necessary information to sustainably use this tool. Otherwise it is just another platform offering new ways to get information together. This could only further discourage students from using it.

**Other.** The last category ‘other’ covers a total of 5 aspects which could not be assigned to the other categories and which do not justify a separate category due to their unique mention in the survey. These 5 requirements for the DSA include a tutorial or a guide for the tool, a link to the location plan of the university buildings with the lectures taking place there, a cloud solution for own documents, good clarity in the interface design and the possibility to get recommendations based on similarity profiles.

## 5 Discussion

In this article, we used a qualitative survey to examine the requirements of a digital study assistant from the student's point of view. Our findings present a variety of work routines, tasks & processes as well as the students' requirements for a digital study assistant. It is of great importance for research, practice and software development to identify requirements for a digital study assistant and understand their role from a student's point of view. For this reason, this publication aims to provide first insights of desired requirements from the target groups point of view. This can be seen as a groundwork for the creation and development of a digital study assistant.

Our results have various peculiarities which we will explain in more detail below and try to find possible explanations for them. First of all, it is noticeable that the categories for 'work routine' and 'tasks & processes' do not differ, except for the category 'rated submissions' regarding question 1 and 'interchange' concerning question 2. A possible reason for this would be that students do not explicitly differentiate between 'work routine' and 'tasks & processes', since the concepts are not perceived in a clear-cut way. For this reason, some aspects of students in question 2 were probably not mentioned or not mentioned again, as they had already answered question 1 in this way. Even if the ranking of the results regarding the 2 questions is different, a strong overlapping of the contents suggests that in future research a distinction between 'work routine' and 'tasks & processes' is not really necessary. Regarding the research questions, the results of question 3 show clear preferences regarding the requirements for a digital study assistant. In the following, we will examine the top 3 categories in more detail and look at them from the perspective of the development of a DSA. The most important function for an assistant with 22 core sentences is covered by the category 'planning / scheduling'. This is in contrast to the collected values for the category 'planning / scheduling' in question 1 (3 core sentences) and 2 (7 core sentences). A potential reason for this discrepancy is that students need more support in planning tasks, but do not regard them as a primary task of study. For the development of a DSA it is therefore advisable to implement a module and semester planning function or a timetable planner. The second most important category with 14 core sentences is 'push notifications'. In contrast to 'planning / scheduling', the category 'push notifications' is not a pure function, but rather an option for active information transfer. The students themselves decide whether they want to make use of the opportunity and to what extent. In principle, the use of any functions is voluntary, but in any case they are present and perceptible in the assistant, whereas the function 'push notifications' is only shown when the student's consent to their use is received. The use potentials should cover various areas, such as exam dates, room changes and self-selected events. One reason for this requirement was given by the surveyed students with the fact that both the quantity of information and the distribution of information across various university platforms has increased rapidly in recent years. 'App' is the third most important category with 12 core sentences. Also the category 'App' is not only a function, but was regarded by some students as a basic requirement to use the digital study assistant at all. This is due in particular to the fact that, according to the students, the use of mobile end

devices (smartphones) has increased significantly. One reason for this is the ease of use and the permanent availability of information. For this reason, Apps should be increasingly used in the university context and be given special attention for the development of a digital study assistant. In this context, however, it is necessary to consider which technical equipment and systems are already available at the respective university, as these can vary greatly. Some universities may already have well-functioning apps and mobile views, so that the desire for Apps seems to be obsolete for students.

This work should provide a basis for further research approaches in the field of DSA. Supplementary research would be a useful extension of our work and would contribute to a deeper understanding of the topic. In our paper we also consider important quality criteria. Inter-subjectivity can be assumed by reviewing the methodology applied with the help of a focus group. This means that the facts at hand are equally recognizable and comprehensible for all viewers. In addition, the entire process is adequately documented and explained, so that a high degree of transparency is provided. One limitation is the small sample that does not promise general validity. Since our intention was to first collect explorative requirements from students, this does not contradict this study. A further limitation is the lack of differentiation between questions 1 and 2, so that distortions of the results may occur. The students obviously did not distinguish between the terms. However, questions 1 and 2 in this case were only preparatory for core question 3, from which we derived all implications. Questions 1 and 2 thus move into the background and do not change the primary objective of this study.

Further surveys are already planned in order to gain a deeper understanding of the requirements for a digital study assistant. For example, various organizational units of the university, as well as lecturers will be surveyed in order to examine the subject matter of DSA as comprehensively as possible. In addition, students will be surveyed a second time, but this time in a quantitative way, to confirm and enrich the results of this study. Furthermore, after completion of the respective prototypes, various surveys for the evaluation of the study assistant by user panels are planned. In total there will be 3 prototypes which will be tested e.g. by usability tests, interviews or experiments. Also, subsequent research will be linked to 'The Software Development Life Cycle' (SDLC) and findings will be provided for the further phases. The analysis of requirements will be followed by a concrete concept up to implementation and integration. Another further logical step could be to compare the presented requirements with features of existing DSA systems identified by a preliminary market analysis.

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