A Multi-Perspective Research for the Investigation of Software Requirements for a Digital Study Assistant

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A MULTI-PERSPECTIVE RESEARCH FOR THE INVESTIGATION OF SOFTWARE REQUIREMENTS FOR A DIGITAL STUDY ASSISTANT

Research Paper

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Abstract

Digitalization in higher education is setting a trend. According to the latest NMC Horizon Report, virtual assistants are among the six most important future technologies in context of higher education. Digital study assistants (DSA) can shape the future of teaching and learning by open up new opportunities for students, organizational units and teachers. When introducing such technologies, it is essential to ensure that content and functions are designed in a user-oriented manner for sustainable use. It's therefore necessary to investigate expectations, success factors and barriers, as they are crucial for the acceptance and long-term use of new technologies. The SIDDATA project is currently developing a DSA and is striving to take these factors into account during development. Therefore, requirement analyses were conducted with various stakeholders. With regard to the multidimensional perspective in software development, three consecutive studies were accomplished with students (end user) and organizational units from different universities.

Keywords: digital study assistant, requirement analysis, software development.

1 Introduction

The digitalization of analog processes has advanced in recent decades to become an ubiquitous component of social life. The way people communicate, exchange information, develop and understand disciplinary knowledge has changed due to the development and availability of digital technologies (Ihme and Senkbeil, 2017). The degree of digitalization is also steadily advancing in the field of university teaching. This has a demonstrable impact on the agility of higher education that promote the availability of technical solutions. New developments are changing the nature of teaching, the organisation and structuring of studies and the relationship between universities and students (Schwab, 2016). Many technical solutions are available which support the digitalization in higher education institutions, and those technologies are proven to exert decisive impact on teaching types (Bennet et al., 2015). 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 (Kergel et al., 2018).

Another example of a new digital technology is a digital study assistance system. A digital study assistance system, also known as 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. Unrelated data is to be understood here as data that is largely available (e.g. on the homepages of university institutions, examination regulations or data from the LMS), but has not yet
been linked together. Such an digital assistant will be developed in the SIDDATA project and should give situation-appropriate hints, reminders and recommendations. The current development of the DSA addresses existing challenges: support students in pursuing their own goals (e.g. semester abroad or professional specialization) and to accompany them through lots of innumerable study offers in an advisory, effective and efficient way (Ahmed and Ghareb, 2018; Strauß and Schoder, 2002). The interdisciplinary project is funded by the German Federal Ministry of Education and Research. Within the funding period, several prototypes will be developed iteratively in order to implement new research findings in the current version of the DSA.

For the corresponding software development, requirement analyses of the different stakeholder groups are needed. Regarding to the systems development lifecycle model (SDLC) SIDDATA is now in phase two "requirement analysis". According to Elliott et al. (2004, p. 87) "the system development life cycle was created in the 1960s to develop large-scale functional business systems in an age of large business conglomerates". The framework for the SDLC provides a sequence of activities to be followed by system designers and developers. It consists of a series of steps or phases in which each phase of the SDLC uses the results of the previous ones. For this reason, it is important to survey expectations, success factors and barriers in the second phase in order to incorporate the requirements and wishes of the stakeholders into the development.

Relevant stakeholders in this context are especially the students as end users, organizational units of universities and lecturers. In this case the main focus of the surveys are students and organizational units. The survey of lecturers is still in progress and these results will be processed in a further additional paper. The inclusion of employees from organizational units in connection with students seems to make more sense at this point for the following reasons. First, in order to respond appropriately to the students' concerns in particular, it is useful to ask the contact persons of the university for student affairs. The involvement of university staff in the development of new technologies and software is important because they deal with students in their daily work routine and know many of the students wishes and needs. Second, not only students but also organizational staff can benefit from an assistant and be supported in their work. The big advantage that organizational departments can draw from the DSA is that it saves them time. With every question that the DSA answers or every information that the DSA provides from their field of activity, they save time resources that can be used elsewhere. With regard to students, it is essential that this main user group accepts technical systems, like a DSA, to ensure sustainable use (Abbad et al., 2009). 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 (Dellermann et al., 2017). The requirements must be determined together with the concerned stakeholders for a common understanding and to include different perspectives (Damm et al., 2010). For this reason an explorative online survey was conducted with students, followed by interviews with employees from various organizational units of the university and finally, students were surveyed again in a smaller workshop group.

The aim of the study is therefore to survey expectations, success factors and barriers from stakeholders that are likely to have an influence on the successful introduction and sustainable use of the DSA. To create a consistent understanding, we define the construct expectation as a stakeholder's belief regarding the desired performance of the system related to their potential future use (Szajna and Scamell, 1993). A success factor is understood as the condition that must be met to ensure the success of the system (Poon and Wagner, 2000). In this context the last research object barrier is understood as an obstacle to use from the stakeholder's perspective. In order to address the different research objects, the following research questions were considered:

- **F1) Which are the most important expectations from the perspective of relevant stakeholders?**
- **F2) Which are the most important success factors from the perspective of relevant stakeholders?**
- **F3) Which are the most important barriers from the perspective of relevant stakeholders?**

From this research, developers can extract requirements for a DSA, which they should take into account when developing such a system. Researchers, on the other hand, can use this exploratory
approach as a reference point to conduct further detailed and confirmatory studies on digital study assistance systems.

2 Theoretical foundation

2.1 Digital study assistants as part of digital transformation

The rapid digitalization across many different fields has great relevance and poses huge opportunities for the society (Dellermann et al., 2017). As Rouse already pointed out, technological changes are closely related to transformation (Rouse, 2005). The term digital transformation (DT) conquers the modern world and describes the use of new digital technologies to enable major improvements (Fitzgerald et al., 2013). These technologies are not new itself, it is more about the combinations and evolving possibilities which create a new innovation. DT is regarded as a major change in society and business (Schwab, 2016) and is often described as an ongoing process (Morakanyane et al., 2017). Many technical solutions are available which support DT and cause agility in higher education institutions. Those technologies are proven to have a decisive impact on the type of teaching (Bennett et al., 2015). DT is an important and contemporary issue in academic education and cannot be neglected in the context of a digital study assistant (Gottburgsen and Wilige, 2018).

Changing learning conditions in the age of digitalization must be perceived and implemented in order to interact dynamically and flexibly (Ahel and Lingenau, 2020). New technologies in higher education require a certain level of user acceptance in order to be able to sustainably survive on the market and above all to guarantee long-term added value for students and other stakeholders (Mukerjee, 2014). Any barriers that can be avoided preventively before and during the development of an assistant contribute to achieving this goal. Likewise, important success factors, as far as they concern the digital study assistant, can be included in the development. In addition to digitalization and the technical changes that have accompanied it, the internationalization of study structures, the increasing permeability of the education system and the pluralization of ways of life have shaped the academic landscape (Zervakis and Mooraj, 2014). The management of internationalization and diversity is becoming increasingly important because the number of students is much bigger and more heterogeneous today than in the past (Allemann-Ghionda, 2014). This makes it more difficult for universities and teachers to reach students individually. Traditional approaches must be reconsidered and replaced or supplemented by new ideas. It is therefore important that practitioners are supported by the academic community in the development of new business models and the implementation of innovation (Hold et al., 2017).

In recent years, the development of digital assistance systems in particular has gained enormous importance in the field of business informatics. The NMC Horizon Report from 2014 and 2019 lists virtual assistants as one of six important future technologies in the context of higher education (Alexander et al., 2019; Johnson et al., 2014). The progressive development, as well as the increasing importance and influence of information and communication technologies has no longer been confined to the economic sphere, but also affects universities in particular. 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 (Apt et al., 2018). The aim of the DSA is to support students in their actions through a situation analysis and to give them recommendations for achieving a predefined goal. Central capabilities of digital assistance systems at the current state of research are environmental perception, reactive behavior, attention control and situation interpretation. In the future, assistance systems should offer adaptive, situational and individualized support by means of sensory detection of the user and context (Apt et al., 2018). A DSA could, for example, react to requests from learners and support students in their everyday study routine. Such a system could support staff in advising and informing students, teachers with specific didactic and organizational tasks and support students in the self-organization of their studies in the form of a “reflection partner” (Schmohl and Schäffer, 2019).
The interdisciplinary SIDDATA project investigates how students can be supported in achieving individual educational goals. For this purpose, the digital study assistant is initially implemented and evaluated at three universities. Students should be encouraged to define and consistently pursue their own educational goals, and to be supported by a data-driven environment. The DSA is intended to combine several levels of analysis in which different factors influence academic studies. For the collection and evaluation of these conditions and design factors different methods of data acquisition and analysis have to be used. One example of a planned function of the DSA is to facilitate communication among students. Experience reports from study abroad or finding a learning partner should be supported in this way. Another example is the function for subject-related interests. This involves course recommendations at one's own university based on documented course data or the provision of open educational resources (OER) from other universities in order to take individual interests into account. The success of such digital assistance systems depends on several crucial factors. In addition to the relevance of high user acceptance for new technologies (Hirsch-Kreinsen et al., 2015), the implementation of new systems requires technical guidelines at the strategic level for a structured approach by universities to adapt to these changes (Leal Filho et al., 2020). The consideration of expectations, success factors and barriers to new technologies from the perspective of different concerned stakeholders is essential. Therefore, the survey of employees from organizational departments as data suppliers and students as the relevant user group will address these important aspects in order to identify crucial points for the development of a DSA.

2.2 Requirement analysis in the systems development life cycle

Since the early 1950s, the conglomeration of models and methods for structuring and developing complex systems has been summarized under the collective term of systems engineering (Alpar et al., 2019). However, a common consensus did not emerge until the 1960s, after poor software quality often led to system failures with sometimes enormous costs and consequences. Since then, this period has been known as the software crisis (Schulz-Schaeffer, 1996). It became clear that the developed software solutions had not kept pace with the complexity of new hardware. The computer scientist Edsger W. Dijkstra (1972, p. 861) describes the causes as follows: "As long as there were no machines, programming was not an existing problem; when we had a few weak computers, programming became a minor problem, and now that we have gigantic computers, programming is an equally gigantic problem."

Nowadays, software developers are facing an environment that is becoming more complex, dynamic, global and competitive due to the digital transformation (Dühring, 2020). The availability of new technologies leads to higher requirements for software development. Dynamic market changes are causing established and successful business models to be reconsidered and adapted (Herbsleb and Moitra, 2001). The "goal-oriented provision and systematic use of principles, methods and tools for the work-sharing, engineering-based development and application of comprehensive software systems" is the task of the software development research area, which has gained enormously in importance over the last decades (Herbsleb and Moitra, 2001, p. 16). In the past, various approaches to software development have been developed, which have strengths as well as weaknesses (Ecker and Wesinger, 2005; Wolff, 1994). The choice of method for certain types of projects must be based on various technical, organizational, project and team-related considerations (Suryanarayana et al., 2015). Depending on the objective, the development process can be linear or iterative. Procedure models of software development specify which steps are executed in which order in the entire software life cycle. The necessary development stages for the generation of a software product from planning to deployment and subsequent maintenance are summarized under the term systems development life cycle (Ruparelia, 2010). The classical sequential phase model is divided into the following six stages: (1) planning, (2) requirement analysis, (3) design, (4) implementation, (5) testing and (6) evolution. For each of these phases, expectations of results have to be defined a priori. A new phase can only start after the previous phase has been completed (Everett and McLeod, 2015).
With reference to the CHAOS study of the Standish Group (2015), it becomes clear that only 29% of IT projects are successful, which means that 71% fail partially or completely (Hastie and Wojewoda, 2015). The so-called software process improvement (SPI) aims to improve the effectiveness of the software development process (Khan and Keung, 2016). The requirement analysis in the context of the SDLC is of great importance, because it aims to completely capture the customer requirements and to ensure their implementation in all phases of the SDLC (Rani, 2017). Shortcomings in this phase can lead to non-fulfillment of customer requirements, which can significantly reduce product acceptance. The success of an implementation of such programs can be sustainably influenced by respecting (critical) success factors and removing barriers. If decision makers know which factors are most important for success, they can set priorities and thus improve the project results (Linberg, 1999). Factors that lead to the rejection of technologies do not directly reflect the opposite of the factors that lead to adoption, so a separate approach to barriers, success factors and expectations is necessary (Diestel and Ogonek, 2016).

3 A multi-perspective research design

After presenting some information about the study assistant in the context of digital transformation, as well as the theoretical embedding in the SDLC model and the procedure, the chosen research design is explained below. Requirement engineering is one of the most elementary steps in the process of software development (Saiedian and Dale, 2000). Without clear requirements and specifications, developers have no idea what to build and users do not know what to expect from the new software. Moreover, in this case there is no way to check whether the developed system really meets the needs of the users. The failure of a project at a very early stage of development is often due to the fact that the developer does not understand or does not know the requirements of the users and their environment (Saiedian and Dale, 2000). The following surveys are the basis for the next (third) phase of the SDLC, the software design. Functions, features, additional wishes and suggestions of the stakeholder groups regarding the study assistant will be considered and implemented in this subsequent step.

The development of software involves several interest groups, as it is a multidisciplinary collaboration (Awotunde et al., 2020). During the second phase of the SDLC, not only technical issues should be dealt with, but also cultural or, above all, organizational aspects of the working environment. For this reason, it makes sense to include different interests and roles in the requirement analysis. Therefore, the organizational units of the university as well as the students were interviewed. This allows a multidimensional perspective on crucial requirements for the development of the digital study assistant. Nevertheless, the performance of software application development is based on the collaboration of stakeholders from different disciplines (Awotunde et al., 2020). This means that software development involves different people and departments with their respective knowledge and expertise. In order to develop a user-oriented and needs-based digital study assistant, the students' wishes and requirements must be ascertained and incorporated into the development, as they are the most important stakeholder group. The university's organizational units form another important stakeholder group. In some other surveys, such as the survey of Kelkar (2018) the sampling strategy consisted in dealing with as many different organizational roles as possible. This ensured that the full range of university’s offerings, including educational experiences, could be captured and included. Employees from organizational units deal with the students' concerns and interact with them on a daily basis. For this reason, their experiences and expectations are also very useful and important for the development of such a system.

In total, three surveys were conducted. First, an online survey was sent to students from three different universities. A total of 572 students took part in the survey, answering four substantive questions and providing some sociometric data. This survey was developed and released soon after the start of the project, so that requirements, expectations and barriers to a digital study assistant were recorded at a very early stage. As a consequence there was no presentable prototype or a similar objective to
show. Therefore, a study assistant was unfamiliar and abstract to many students, so it was expected that there would be limited imagination in terms of functionalities. For this reason, not only free-text answers but also predefined answer options were used in the online survey to provide guidance to the students. At a later stage, the organizational units of the Osnabruèck University were surveyed through semi-structured interviews. In this case the first prototype could already be shown and more detailed questions could be asked. The interviews lasted 45 minutes on average and 14 employees of the Osnabruèck University were interviewed. Also in this case experiences, requirements and barriers regarding a DSA were asked. In addition, another 11 students were interviewed in a third study within a workshop at the Osnabruèck University. In this case only free text answers were chosen because the students had a specific idea of the DSA by showing the current prototype. Consequently, an even higher comparability between the results and statements of all respondents could be achieved.

4 Study 1 - student online survey

4.1 Description and method

The first survey was conducted online in spring 2019 with students from three universities in Germany within the SIDDATA project. A total of 572 students took part in this survey, consisting of 310 female and 196 male participants. The remaining number of participants described themselves as diverse, nonbinary or did not provide any information. The age distribution shows that about 65% of the respondents were between 18 and 24 years old and almost 21% were between 25 and 34 years old. The remaining students were 35 years and older. Students from various disciplines took part in the survey. The most frequently mentioned subjects were: Pedagogies (108), Economics (56), Engineering (54) and Social Sciences (54). The resulting values often deviate from the overall sample, because the students sometimes skipped questions or finished the questionnaire early. The online questionnaire consisted of a total of four questions, which were thematically aligned with the use of a DSA. The survey started with a description and basic information about the DSA. This introduction was followed by questions about expectations, success factors and barriers. The items relating to expectations and barriers were openly designed and offered the opportunity for free text answers. Success factors were first subdivided into the individual items functionalities and characteristics. The students were able to select the most important functions from 19 predefined statements (e.g. the DSA helps me organize my curriculum), whereby multiple answers were possible. In the case of the characteristics, however, the students should rank differently predefined characteristics (e.g. simple usability, gamification elements) in terms of importance. The scale here ranged from 1 unimportant to 10 very important. It should be mentioned that the sample size was not constant over the whole survey, because items were partly skipped or the survey was aborted before completion. The legend of table 1 shows the number of participants for the respective question (item) asked.

Since, as already mentioned, different survey items were used in this study, the evaluation methods also differ according to format and objective. For the evaluation of the free text responses regarding expectations and barriers a content analytical evaluation based on the qualitative content analysis (QCA) by Mayring (2014) was applied. The answers were first reviewed and listed in tabular form in order to compare them. In a second step, core sentences were formed from the quotes of the survey in order to be able to capture the essential content of the answers concisely (Corbin and Strauss, 1990; Mayring, 2015). In a third step, so-called buzzwords were assigned to the core sentences, which in turn were combined into categories in a fourth step. The various categories were formed iteratively with the aim of establishing some clearly distinguishable expectations and barriers. In a so-called focus group six researchers from the field of business studies and information systems, have dealt with the categorization of expectations and barriers in order to gain intersubjectivity and therefore contribute to meaningful results through their expert knowledge (Przyborski and Riegler, 2010; Ruddat, 2012). The two closed items were evaluated using SPSS. With regard to the functionalities the total number of entries was accumulated. For the ranking of the DSA characteristics from 1 to 10, the mean value was calculated.
4.2 Study 1 results

The result overview in table 1 from the first study shows the 5 most frequently named categories of students in terms of expectations, success factors and barriers in relation to a DSA. The categories with the most core sentences, the highest mean value of prioritization or the highest number of multiple answers in relation to functions are displayed in the first line and from there the other categories in descending order. It should be emphasized that in this case success factors are divided into functionalities and characteristics as already mentioned in the methodology. In the following, the categories are briefly explained, whereby categories that appear several times are only presented once.

<table>
<thead>
<tr>
<th>Expectations</th>
<th>Functionalities</th>
<th>Success factors</th>
<th>Characteristics</th>
<th>Barriers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Category</strong></td>
<td><strong>No.</strong></td>
<td><strong>Category</strong></td>
<td><strong>No.</strong></td>
<td><strong>Category</strong></td>
</tr>
<tr>
<td>Study structure / planning</td>
<td>53*</td>
<td>Exam experiences</td>
<td>464**</td>
<td>Usability</td>
</tr>
<tr>
<td>Usability</td>
<td>50*</td>
<td>OER-tool</td>
<td>458**</td>
<td>OER repository</td>
</tr>
<tr>
<td>Data security / privacy</td>
<td>42*</td>
<td>Optimize study plan</td>
<td>417**</td>
<td>Interdisciplinary competencies</td>
</tr>
<tr>
<td>Situational adequate advice</td>
<td>34*</td>
<td>Study course knowledge</td>
<td>394**</td>
<td>Linked to calendar and LMS</td>
</tr>
<tr>
<td>Functions</td>
<td>31*</td>
<td>Organize curriculum</td>
<td>394**</td>
<td>Subject orientation, no gamification</td>
</tr>
</tbody>
</table>

* Clustered categories from free text answers of 352 (expectations) / 375 (barriers) students.
** Multiple answers possible of predefined functions from a total of 572 surveyed students.
*** Mean value of a prioritization scale 1 to 10 (predefined priorities) from a total of 570 surveyed students.

Table 1. Expectations, success factors and barriers of a DSA from students via online survey.

The category study structure / planning with 53 core sentences is the most important expectation for students in context of a DSA. The main focus here is to support administrative and organizational activities e.g. the design and planning of the students’ personal studies, the choice of courses and individual focus in the study program. An example of a core sentence for the study structure / planning category is: learning plan creation and reminder of how many days you have left for the exam. With 50 core sentences, usability is in second place in terms of expectations. In addition, usability was also ranked first in terms of characteristics among the success factors with a prioritization of almost 7 (10 means highest priority) and was also perceived as the biggest obstacle among the barriers with 100 core sentences. This shows the enormous relevance of usability for the students. Usability refers to the ease of use and user guidance of the software. Accordingly, the handling of the assistant should not be too complex, but intuitive and self-explanatory. Data security / privacy is in third place with 42 core sentences of the expectations for a DSA and with 81 core sentences the second most important barrier is poor data security / privacy. Data privacy is defined as a high level of transparency in the use of data and the transfer of sensitive, personal data. Data security should be seen as a supplement to the lack of data privacy. This includes the purely technical aspect of ensuring that personal data in particular, but also other types of data, are adequately protected against unauthorized access by third parties. Example core sentence: Anonymized data collection and no transfer to third parties or use of the data for purposes outside the known functions. The category situational adequate advice is in fourth place with 34 core sentences, ahead of functions with 31 core sentences. Situational adequate advice includes individual hints and recommendations given by the assistant on the basis of a student's input. These recommendations refer, for example, to courses, literature, OERs or information events. The category functions, on the other hand, refers to very specific function requests of students. For
example, there should be a function for the analysis of the personal learning level, a voice control via an associated app or a link to organizational units, such as the examination office, and provide relevant content.

With regard to the success factors students were able to indicate their preferences by multiple answers. In first place with 464 votes is the provision of exam experiences of fellow students. An OER-tool, which informs students about available learning materials and generally give them information about OERs, was voted with 458 responses. The three following functionalities optimize study plan, study course knowledge and organize curriculum are closely related to the category study structure / planning mentioned above. The assistant should optimize the personal study plan, be familiar with the individual subjects of each student and support students in organizing their own curriculum. The second position among the success factors in this study referred to the characteristics of a study assistant from the perspective of students. A high degree of usability is ranked first here (mean value 6.91). This is followed by an OER repository (search engine) with a mean value of 6.06, interdisciplinary skills (mean value 5.89), a link to the private calendar and timetable integrated into the university's LMS (linked to calendar and LMS, mean value 5.87), and finally a clear subject orientation without gamification elements with a mean value of 5.87 as well. Besides the barriers already mentioned, the category no added value visible is in third place among the most important barriers with 64 core sentences. These include superfluous or redundant functions as well as a lack of knowledge about a digital study assistant, which makes it difficult to imagine a personal added value. High effort of use is also named as an important obstacle for long-term use and is ranked fourth with 51 core sentences. This category refers to inconveniences such as constantly logging in and setting up the system. The time component plays a central role here as well. It seems that students want an intuitive system that requires little effort in terms of adaptation and time. The barrier unattractive user interface with 42 core sentences is also linked to this assumption. The user interface should be attractively designed and well structured to ensure simple operability.

5 Study 2 - organizational units interviews

5.1 Description and method

In order to ensure a goal-oriented and sustainable development of a digital study assistant, another target group, in this case employees of organizational departments of Osnabrueck University, were interviewed with a primary emphasis on expectations, success factors and barriers. Analogous to this survey, interviews were also conducted independently with university organizational units at other project locations. These results should be taken into account in the further development of the DSA in order to develop software that is as tailor-made as possible and thus ensure the most sustainable use by the students. Based on the research component of Sarker et al. (2013) questions were selected to formulate the problem “what” and “how” and took a nominal view. This survey has an highly explorative character, since the aim is to generate as much input as possible in the form of free formulated answers for the further development of the DSA. A total of 14 interviews (N=14) with employees from organizational departments of Osnabrueck University were conducted between February and April in 2020. Of these, 8 were female and 6 male. Among the organizational departments, for example, the Central Student Advisory Service, the Career Service Center, the International Office or the Language Center were surveyed. In addition, employees from technical service institutions such as the IT Service or those responsible for digital teaching and campus management were also included in the sample. All interviews were conducted in German, as this is the native language of the respondents. This ensured that all questions could be understood and answered. The interviews lasted 45 minutes on average.

First a prototype of the study assistant was shown, so that the essential questions could be answered in detail and all interviewees had the same understanding of a DSA. This prototype shows first functionalities and a distinct user interface, so that the presentation of a DSA is less abstract. After
that, the semi-structured interview started with questions about the requirements for use of the DSA. With regard to expectations, for example, specific questions were asked about usage potential. With regard to success factors, the interview included questions about aspects for successful implementation and necessary organizational framework conditions. In the last topic area, barriers, questions were posed about obstacles to the introduction and use of a DSA. The research objectives, mentioned above, cannot be viewed in a completely differentiated manner and there are some overlaps in the statements. All interviews were recorded and transcribed to allow further research of this data. Then interviews were analyzed by a data-driven qualitative, content analysis using a summative approach (Mayring, 2014). The process of analysis was divided into four phases. During the transcription a rough word count and a classification was created to identify the expectations, success factors as well as the barriers in the development of a DSA. First, the answers were organized by questions (1 to 3) and then paraphrased (phase 1) (Mayring, 2015). This is followed by an initial abstraction by means of a generalization, in order to enable a step-by-step reduction and subsumption of sub-categories on a scientific level (Mayring, 2015). The paraphrases were generalized to a level of suitable abstraction into core sentences (phase 2). Subcategories are inductively formed from the given statements in order to be able to include as much content as possible in the analysis. In the third phase the first reduction was made by cutting semantically identical core sentences and those which are not felt to add substantially to the content. Finally, as second reduction, the core sentences were combined with similar or identical ones and thus classified in categories (phase 4). In doing so, it is ensured that the categories are represented as precisely, disjunctively and comprehensively as possible (Raithel et al., 2012). The entire evaluation of the interviews was carried out independently by four scientists. Subsequently, the overall results were discussed and finally determined. This ensures that the intersubjectivity of the results can be considered as given.

5.2 Study 2 results

As an illustration, table 2 shows the top 5 categories and the number of respondents who contributed one or more core sentences on the corresponding category.

<table>
<thead>
<tr>
<th>Expectations</th>
<th>No.</th>
<th>Success factors</th>
<th>No.</th>
<th>Barriers</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range of services</td>
<td>8</td>
<td>Usability</td>
<td>5</td>
<td>Insufficient data maintenance / management</td>
<td>8</td>
</tr>
<tr>
<td>Study structure / planning</td>
<td>8</td>
<td>Data maintenance / management</td>
<td>4</td>
<td>Insufficient situational adequate advice</td>
<td>6</td>
</tr>
<tr>
<td>Situational adequate advice</td>
<td>7</td>
<td>Project marketing</td>
<td>4</td>
<td>Poor data security / privacy</td>
<td>4</td>
</tr>
<tr>
<td>Information</td>
<td>5</td>
<td>Integration of other systems</td>
<td>3</td>
<td>Unattractive user interface</td>
<td>3</td>
</tr>
<tr>
<td>Functions</td>
<td>5</td>
<td>User interface</td>
<td>3</td>
<td>Useless functions</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 2. Expectations, success factors and barriers of a DSA from organizational units.

It is important to note that in most cases there are multiple responses, but each core sentence was only counted once for each category and person. This allows to show exactly how many interviewees of the entire sample can be assigned to a category. The columns “category” shows the categories formed, which were derived from the core sentences. The columns “number” (No.) therefore corresponds to the proportion of interviewees out of the total sample, e.g. 5 means 5 interviewees out of a total of 14 respondents (N=14).

With 8 core sentences, range of services was the most frequently mentioned statement for subject question one (expectations) from the perspective of the organizational units. This category contains offers and services of university associated units such as faculties (seminars, events), library, international office or the Career Center presented by the DSA. The organizational units of the
university expect the DSA to increase the visibility of their service portfolio among students. The next category **study structure / planning** shares first place within expectations with 8 core sentences. This point covers the design and planning of the students' personal studies for example the choice of courses and individual focus in the study program. The following category is ranked third in expectations with 7 core sentences, as well as second in barriers with 6 core sentences. **Situational adequate advice** is intended to help students individually and precisely by providing information on, for example, semester planning or courses. Recommendations and advice appropriate to the situation are actively given to the student by the system, without direct request from the student, on the basis of information previously released by the student. Conversely, insufficient situational adequate advice means that these recommendations do not meet the students' needs, be it through wrong, trivial, too few or too many (poorly filtered) advice. **Information** as a category is defined as a generic information on easy to answer, frequently asked questions (comparison FAQ). This category represents information that is neither appropriate to the situation nor individual. Instead, only general information is provided. With 5 core sentences, information is number four of expectations. **Functions** is a collective term for all subordinate functions within the DSA, such as a feedback function. It should be noted that other named categories, which by their nature can also be regarded as functions, such as situational adequate advice, are not included here because they pursue superior and fundamental objectives of the DSA. With 5 core sentences, functions has the same rank as information regarding the expectations of the organizational units. But also among the barriers, the category **useless functions** with 2 core sentences comes in fifth place.

Considering the success factors, the category **usability** with 5 core sentences is the most important aspect. It describes the simple and intuitive use by the end user. Survey participants seem to assume that simple and uncomplicated operability is of utmost importance for a successful implementation of the DSA. The following category **data maintenance / management** is understood to mean the maintenance and providing of data by organizational units, external third parties and lecturers. Expressed as a barrier, insufficient data maintenance / management indicates that data entry is complicated and time-consuming. With 8 core sentences out of 14, the category insufficient data maintenance / management takes the first place of the barriers. In addition, the positive side of the category data maintenance / management is in second place among the success factors with 4 core sentences. This high-level double designation leads to the assumption that this category plays a key role for a successful implementation. **Project marketing** describes all processes involved in making the digital study assistant known, e.g. flyers, announcements or promotion videos. Project marketing is also on the second rank of success factors with 4 core sentences. In project marketing, the respondents see an important factor in the introduction and use of a DSA. **Integration of other systems** means the interconnection of university third party systems with the DSA, whether the DSA integrates such a system or other systems include the DSA. An example would be that the DSA should not be available as a standalone version, but as a plug-in to an already established LMS system. Integration with systems occurs with 3 core sentences exclusively for the success factors. The interviewees consider it important for the success of the DSA that it integrates already existing study relevant systems such as the LMS or an overview of grades into its own system. The last category of success factors is **user interface**. This refers to the graphical design of the DSA. The student uses the user interface to enter data or navigate through the DSA. User interface occurs with 3 core sentences for both the success factors and the barriers (unattractive user interface). Respondents consider an attractive design (for the user group) and a clear, well-structured user interface to be a key success factor. Conversely, a poor, unclear design is perceived as a barrier. Finally, only the category **poor data security / privacy** remains to be named among the barriers with 4 core sentences. Here, the interviewees see possible security concerns, as well as the lack of choice in what kind of data is shared with the DSA, as the main barrier.
6 Study 3 - student workshop survey

6.1 Description and method

The third survey was conducted with a workshop group of students. Here, 11 students of the Osnabrueck University took part in this survey, 8 were male and 3 female. All students were enrolled in the Bachelor of Economics program and were between their third and fifth semester. The workshop survey consisted of three open questions about expectations, success factors and barriers to the DSA and lasted about 10 minutes on average.

This survey is considered particularly important because, unlike the survey of the organizational units, the first survey of students did not include a prototype and thus no illustrative material on which the students' recommendations could be based. Therefore, although the indications from the first survey are important to show fields of action for the development of a DSA. However, the students in study 1 lacked a specific idea of what the DSA could look like. This fact shall now be taken into account with this survey. During the online workshop the students were first presented a short info text, which briefly outlined the intentions and goals of the DSA. Afterwards, the workshop group was shown an official image film with wishes from students and statements from developers regarding the DSA. In a last step, the workshop group was shown the prototype of the DSA in an online live presentation. The most important functions and features of the current prototype were shown and the students could ask questions to the developers in this context. After the students had been fully informed about the DSA, a link to the online survey was sent out. Next, the students had the opportunity to answer the questionnaire individually. The evaluation of the answers was done analogous to the evaluation of the free text answers of the online survey from chapter 3. First the answers were paraphrased, reduced to core sentences and finally formed to categories. In this way, clearly distinguishable categories of the answers were extracted.

6.2 Study 3 results

<table>
<thead>
<tr>
<th>Expectations Category</th>
<th>No.</th>
<th>Success factors Category</th>
<th>No.</th>
<th>Barriers Category</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Situational adequate advice</td>
<td>4</td>
<td>Usability</td>
<td>6</td>
<td>Unsufficient data (quality &amp; quantity)</td>
<td>4</td>
</tr>
<tr>
<td>Added value</td>
<td>3</td>
<td>Data (quality &amp; quantity)</td>
<td>4</td>
<td>Poor data security / privacy</td>
<td>3</td>
</tr>
<tr>
<td>Usability</td>
<td>3</td>
<td>Situational adequate advice</td>
<td>3</td>
<td>Lack of usability</td>
<td>3</td>
</tr>
<tr>
<td>Functions</td>
<td>2</td>
<td>Functions</td>
<td>3</td>
<td>Useless functions</td>
<td>2</td>
</tr>
<tr>
<td>User interface</td>
<td>2</td>
<td>Added value</td>
<td>2</td>
<td>Other*</td>
<td>6*</td>
</tr>
</tbody>
</table>

*Category for single answers.

Table 3. Expectations, success factors and barriers of a DSA from students via workshop survey.

The results in table 3 show that the category **situationally adequate advice** with 4 core sentences was most frequently mentioned when asked about expectations and on third place with 3 core sentences within the dimension success factors. This category describes the DSA to give the students individual, situation-specific advice for their daily study routine. **Added value** was mentioned 3 times for expectations and 2 times for success factors. Added value means for the students a perceived simplification and support in their studies by the assistant, which is not yet available in this particular form. **Usability** of the DSA also has a key role to be considered in this survey, which is in accordance with the results of the other surveys. When asked about expectations, usability was mentioned with 3 core sentences, regarding the question about success factors even with 6 core sentences. Usability in
its negative form lack of usability is also represented in the barriers with 3 core sentences. Here, usability means the easy and intuitive use of the DSA by the students, the negative form means the absence of it. The category functions is represented in fourth place in all three research areas. With regard to expectations, functions were mentioned with 2 core sentences, success factors with 3 core sentences and barriers named as useless functions with again 2 core sentences. Functions in this context means the naming of explicitly useful and desired functions around the DSA from the students’ point of view. The category user interface was only mentioned in the expectations with 2 core sentences. User interface describes an attractive and well-structured visual interface of the DSA. The next category is called data and includes both qualitative (up-to-date and accurate) and quantitative (appropriate amount of data provided) aspects. With regard to the success factors data takes the second place with 4 core sentences and for barriers in negative form even the first place with likewise 4 core sentences. Poor data security / privacy appears only in this form as a barrier with 3 core sentences. This category describes the users’ fear that the data within the DSA are not secure and that the handling of personal, sensitive data does not meet the requirements for data privacy. Other is a category for answers that are only mentioned once. Examples are high effort, low user numbers or technical problems.

7 Discussion

7.1 Summary of the results

In this article we conducted online surveys and explorative interviews to identify and then categorize the expectations, success factors and barriers of a DSA from the perspective of students as well as organizational university employees. This is essential for the second phase of the SDLC to identify the requirements of all stakeholders. The results present the most important categories of the research subjects for the development process of the DSA. Table 4 below shows the most relevant results from all three surveys consolidated.

<table>
<thead>
<tr>
<th></th>
<th>Student online survey</th>
<th>Organizational units interviews</th>
<th>Student workshop survey</th>
<th>Ø ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Expectations</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Situational adequate advice</td>
<td>4\textsuperscript{th} rank</td>
<td>3\textsuperscript{rd} rank</td>
<td>1\textsuperscript{st} rank</td>
<td>2.67*</td>
</tr>
<tr>
<td>Functions</td>
<td>5\textsuperscript{th} rank</td>
<td>5\textsuperscript{th} rank</td>
<td>4\textsuperscript{th} rank</td>
<td>4.67*</td>
</tr>
<tr>
<td>Study structure / planning</td>
<td>1\textsuperscript{st} rank</td>
<td>2\textsuperscript{nd} rank</td>
<td>-</td>
<td>1.5**</td>
</tr>
<tr>
<td>Usability</td>
<td>2\textsuperscript{nd} rank</td>
<td>-</td>
<td>3\textsuperscript{rd} rank</td>
<td>2.5**</td>
</tr>
<tr>
<td><strong>Success factors</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usability</td>
<td>1\textsuperscript{st} rank</td>
<td>1\textsuperscript{st} rank</td>
<td>1\textsuperscript{st} rank</td>
<td>1*</td>
</tr>
<tr>
<td>Data related</td>
<td>-</td>
<td>2\textsuperscript{nd} rank</td>
<td>2\textsuperscript{nd} rank</td>
<td>2**</td>
</tr>
<tr>
<td>Integration of other systems</td>
<td>4\textsuperscript{th} rank</td>
<td>4\textsuperscript{th} rank</td>
<td>-</td>
<td>4**</td>
</tr>
<tr>
<td><strong>Barriers</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor data security / privacy</td>
<td>2\textsuperscript{nd} rank</td>
<td>3\textsuperscript{rd} rank</td>
<td>2\textsuperscript{nd} rank</td>
<td>2.33*</td>
</tr>
<tr>
<td>Data related</td>
<td>-</td>
<td>1\textsuperscript{st} rank</td>
<td>1\textsuperscript{st} rank</td>
<td>1**</td>
</tr>
<tr>
<td>Lack of usability</td>
<td>1\textsuperscript{st} rank</td>
<td>-</td>
<td>3\textsuperscript{rd} rank</td>
<td>2**</td>
</tr>
<tr>
<td>Unattractive user interface</td>
<td>5\textsuperscript{th} rank</td>
<td>4\textsuperscript{th} rank</td>
<td>-</td>
<td>4.5**</td>
</tr>
<tr>
<td>Useless functions</td>
<td>-</td>
<td>5\textsuperscript{th} rank</td>
<td>4\textsuperscript{th} rank</td>
<td>4.5**</td>
</tr>
</tbody>
</table>

* Named on all three surveys. ** Named on two of three surveys.

Table 4. Overall presentation and aggregation of the results.
This overview is intended to summarize the most important findings regarding expectations, success factors and barriers from all three studies and allow a final ranking of the findings. In Table 4, all categories (top 5) which occurred in at least two of three different single result tables (Table 1-3) were taken into account. The rankings of the research subjects from the individual tables are displayed numerically. An average of these individual rankings was then calculated to show the overall relevance of the categories. Since the average ranking is formed by the individual rankings, a lower average value means a high ranking. It should be noted that for values with * the corresponding category was in the top 5 in all three studies and for ** only in two of three studies.

**Expectations.** Situational adequate advice was mentioned as an expectation of the DSA in all three surveys. With individual rankings of 4, 3 and 1, the calculated mean value is 2.67. It can therefore be concluded that the situational adequate advice represents a core element of the expectations among the participants. The category functions was also mentioned with an average value of 4.67 across all three surveys and thus plays a very important role with regard to expectations. In two out of three studies, the categories study structure / planning (1.5) and usability (2.5) were mentioned and are thus strongly included in the expectations. **Success factors.** With an average value of 1 across all three surveys, usability is by far the strongest success factor. This is followed in two of three surveys by the category data related (2) and integration of other systems (4). **Barriers.** The most significant barrier is poor data security / privacy with an average value of 2.33 in all three surveys. Data related (1) and lack of usability (2) were also mentioned under barriers in two of three surveys. Unattractive user interface and useless functions (both 4.5) follow further down the ranking, but were mentioned in two of three studies.

### 7.2 Conclusion

Considering the overall results, it became clear that usability and the negative form lack of usability can be identified across all research subjects and stakeholders. It should be emphasized that all stakeholder groups considered usability as the most important success factor. This allows the conclusion that usability has a particularly important role to play in the development of the DSA. In this context it should also be mentioned that the category unattractive user interface was recognized as an important barrier. In addition to usability, this emphasizes the high relevance of a user friendly interface and easy handling. Thus, usability should be reviewed by the user group in the development process and adjusted according to their suggestions. Further important categories are functions or useless functions which can be found in the expectations and barriers, as well as the category data related which is represented in the success factors and barriers. With regard to the student user group, it is important that the right functions are implemented in the DSA so that they can be optimally supported in their studies. The organizational units, otherwise, should be given the opportunity to embed their service portfolio in the DSA through various functions. Considering the category data, it is very important for students to obtain reliable and up-to-date data through the DSA. Students also do not want to be overwhelmed with large amounts of data. The task of the organizational units is, with regard to the category data related, mainly the providing of data. For this reason, a digital link, which can automatically extract data from the data source of the organization (e.g. homepage), is of utmost importance for them. This should not imply in any form that other important, but not so strongly represented categories are to be disregarded, but merely show the special importance of these categories. In fact, software developers would do well to consider the expectations, success factors and barriers listed here in their entirety in order to ensure maximum satisfaction and acceptance of the DSA user groups. In general, it can also be said that this research is aimed in particular at the development of digital study assistance systems and makes no claim to general validity in the area of software development for other projects.
Multi-perspectve research for a DSA

References


Multi-perspectival research for a DSA


