"Is Computer Science the Right Study Program for Me?": Concept Development of a Mobile Self-Reflection App for Prospective University Students

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Abstract: Online self-assessments (OSAs) are common tools for university orientation. Usually, OSAs are multiple-choice tests giving prospective students a recommendation on their suitability for the selected study program. However, they lack true "self-assessment", which is essential for informed decision-making. To better understand users' requirements of OSAs, we interviewed two experts, evaluated our university's current computer science OSA ($N = 228$), and conducted a survey with first-semester students ($N = 51$). The results highlight the importance of self-reflection and social exchange in study choices. Moreover, users expressed a wish for flexible and personalized content. On this basis, we conceptualized a mobile OSA app including the features that were rated most positively in the pre-studies. The app allows for flexible use by providing micro-content in a clip format. In a first proof-of-concept study ($N = 11$) the app was perceived as helpful and easy to use. Moreover, users highlighted the concept's potential to stimulate self-reflection.

1 INTRODUCTION

Career choice is one of the most important and life-changing decisions for young adults. Many graduates who want to study at a university have trouble deciding on a major given the wide range of options. The website *Studyportals*[1] lists more than 100,000 Bachelor degree programs all around the world. Even after identifying a rough direction, prospective students face problems in valuing the different options and are uncertain about the outcomes of their decision (Germeijs and De Boeck, 2003). Yet, taking the time to make an informed decision about a future study program is important to complete it successfully. A discrepancy between expectations and the actual characteristics of a degree program is one of the main reasons for high dropout rates (Ruthven-Murray, 2022). To prevent this and regulate access to limited study places, more and more universities are introducing so-called "online self-assessments" (OSAs) for prospective students (Hasenberg and Schmidt-Atzert, 2014). Despite their well-established name, OSAs often lack real *self*-assessment since they mostly use multiple-choice questions to determine the user's fit to the study program based on predefined rules. The final result is a concrete recommendation as to whether users should enroll rather than encouraging them to reflect on their interests and expectations to make an informed decision themselves. However, internal factors, e. g., "the individual's present self-concept" (Harren, 1979, p. 122), play an important role for potentially life-changing decisions such as career choice.

To better understand the current problems and requirements of OSAs, we conducted expert interviews ($N = 2$), analyzed the evaluation questionnaire of the Ludwig Maximilian University of Munich's (LMU)[2] current OSA of the Bachelor's degree program in computer science (CS) ($N = 228$), and conducted a survey with first-semester CS students ($N = 51$). Based on the results of these studies and literature research, we developed a mobile self-assessment app concept. The app includes the topics that were rated most positively in the pre-studies, e. g., personal skills, expectations, or insights into occupa-

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[1] https://studyportals.com, last accessed 2023-02-13

[2] https://www.lmu.de, last accessed 2023-02-13

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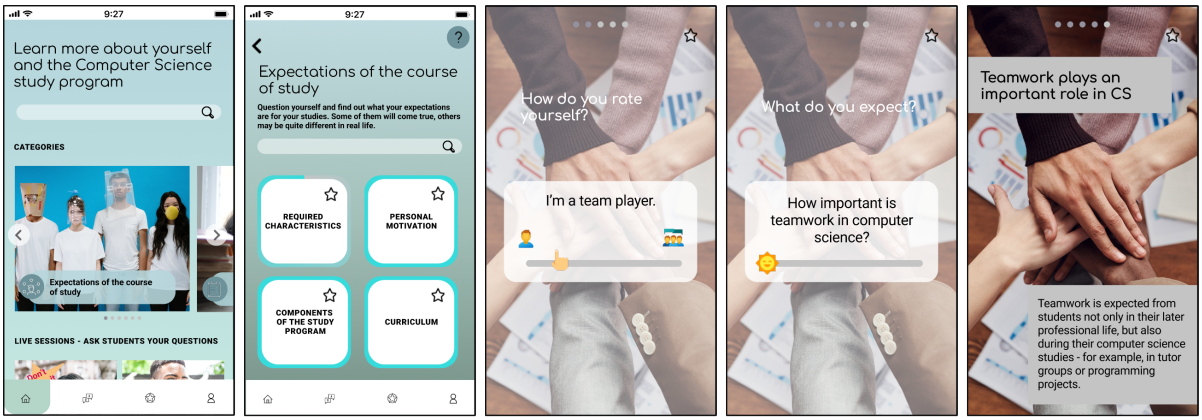

(a) (b) (c) (d) (e)

Figure 1: Screenshots of the online self-assessment app that is conceptualized in this work: (a) home screen with image carousel of different content modules, (b) overview page of the module "expectations of the course of study", (c) to (e) three subsequent clips of the category "required characteristics".

tions. Each topic is separated into various units – so-called *clips*. The clips can contain text, images, video sequences or interactive elements such as check boxes or sliders (see Figure 1). In contrast to the rigid structure of current OSAs, the modular design allows users to decide for themselves what content they want to engage with and when. This enables flexible use over an extended period of time, leaving space for self-reflection and decision-making. In a first qualitative evaluation of our concept with eleven users, the app was perceived as helpful and easy to use. Participants clearly liked the clip format, and the majority claimed they would use such an app if it existed.

2 RELATED WORK

2.1 Online Self-Assessments

Hasenberg et al. summarize relevant characteristics of OSAs (Hasenberg and Schmidt-Atzert, 2014): their target group are prospective students, they are easily accessible via the Internet, and they include exercises, e. g., on prior knowledge, or questions on individual interests and motivation. After completion, users get direct feedback by comparing their answers with the requirements for the course of study. OSAs are characterized by the participants' own responsibility: As the name "self-assessment" suggests, the result is not taken into account in the application process and serves solely as a decision-making aid.

Based on extensive research of OSAs currently offered by German universities (as of spring 2021)[3] and related literature (Stoll, 2019; Röder, 2017), we identified the following common topics: general suitability for studies, subject-specific exercises, personal characteristics, insights into studies, matching of expectations, subject guidance, further information, e. g., on professional fields. The content is usually presented with text, images and videos. Interactive features are limited to multiple-choice questions. Most OSAs provide a rigid structure and need to be completed in one piece or in very large chunks. There are also recent innovative approaches: Schulz et al. present a virtual reality OSA for engineering studies (Schulz, 2020).

OSAs hold the potential to be a resource-saving addition to the study counseling service, a consideration of additional factors of study aptitude, a stimulation of self-reflection, and an option for controlling the access to study programs (Stoll, 2019; Heukamp et al., 2009). However, based on the literature and our research on currently available OSAs, we identified the following drawbacks of state of the art systems: (1) OSAs usually give recommendations based on fixed criteria which are often just subjective requirements compiled by professors and university staff. To allow for actual self-assessment, graduates should rather be empowered to independently evaluate their suitability for their desired course of study. Section 2.2 outlines the potential of technology as a tool for self-reflection. (2) Most OSAs are content-heavy and therefore optimized for desktop use. In contrast, young people primarily use their smartphones to access the Internet (Howarth, 2022). Desktop-optimized OSAs waste the opportunity to integrate study orientation into the everyday life of prospective students. Section 2.3 shows the advantages and limitations of mobile applications for career choice.

[3]The website https://www.osa-portal.de (last accessed 2023-02-13) offers an overview of German OSAs.

2.2 Technology for Stimulating Self-Reflection

Designing for self-reflection is an emerging topic in Human-Computer Interaction (HCI) research (Baumer et al., 2014; Bentvelzen et al., 2022). A recent literature review of reflection support systems shows an "increasing trend in HCI studies that report on artefacts designed to enhance reflection" (Bentvelzen et al., 2022, p. 2:9). Typical application areas are learning, e. g., self-regulated learning (Carter Jr et al., 2020; Maharsi, 2018; Loksa et al., 2020) or reflective learning (Rivera-Pelayo et al., 2012) and health, e. g., self-tracking on food intake (Sun et al., 2020), sleep (Choe et al., 2015), or general physical activity (Gorm and Shklovski, 2017). Only few recent publications discuss self-reflection support tools for career choice: In their work with underrepresented job-seekers, Dillahunt et al. evaluate tools that incorporate positive feedback and self-reflection (Dillahunt and Hsiao, 2020). Aragon Bartsch et al. aim to stimulate self-reflection by providing realistic job insights (Aragon Bartsch et al., 2021).

Bentvelzen et al. identified four key aspects that describe how support for reflection is implemented in state of the art systems (Bentvelzen et al., 2022): (1) Offer users a new point of view through a *temporal perspective*, e. g., by reflecting on the future, (2) include *conversations* to add a social dimension, (3) let users *compare* their current status to an ideal (absolute reference) or to others (social reference). (4) Help users *discover* something new. We are the first to incorporate all of these four resources in the design of an online self-assessment application.

2.3 Designing Mobile Interactions through Micro-Tasking

Chunking, or breaking content into smaller micro-tasks, is a promising approach in mobile interaction (Cheng et al., 2015). This method addresses the problems of limited screen size (Ahmad et al., 2018) and the usually short duration of smartphone interaction, which is prone to interruptions (Leiva et al., 2012; Nagata, 2003). When applied in the learning domain, this approach is called "micro-learning" or "learning bits". Major et al. define small learning units presenting information to the learner in an appropriate size so that it can easily be processed (Major and Calandrino, 2018). Another popular domain using this approach is micro-productivity: Micro-productivity apps are designed to help users work on the go and use their time productively by breaking down complex tasks, such as editing documents (Iqbal et al., 2018) or programming (Williams et al., 2019). Chunking is also applied in personal informatics by dividing large data sets to reflect more frequently on small portions of information. Jimenez Garcia et al. describe this approach as "active mini-cycles of self-reflection", which can lead to a deeper understanding of complicated issues, and ultimately more informed decisions (Jimenez Garcia et al., 2014). Aragon Bartsch et al. use the concept of micro-tasking in the career choice domain to provide students with realistic insights into the working life of professionals (Aragon Bartsch et al., 2021). In this work, we use the concept of micro-tasking to provide users with a large amount of information on the CS study program. By dividing the content into smaller units, users can process the information in their own pace, leaving room for self-reflection. This concept allows flexible use at home or on the go, according to individual preferences.

3 REQUIREMENT ANALYSIS

To inform the design of our prototype, we interviewed two vocational advisors. Moreover, we analyzed the evaluation questionnaire of the LMU's current CS OSA ($N = 228$) and conducted a survey with first-semester students who had participated in the OSA before their enrollment ($N = 51$).

3.1 Expert Interviews

We conducted semi-structured interviews with two experienced vocational student advisors: a high-school teacher (E1) and the head of our university's student advisory office (E2). The two most relevant insights we gained are the importance of self-reflection and social exchange. According to the experts, self-reflection is essential for study program choice. To support the study orientation phase, prospective students need to reflect on their own skills, values, and expectations, which can be supported by providing information and helping them ask themselves relevant questions. According to E1, every consultation should support the students in a way that allows them to make the final decision on their own. This is also confirmed by E2, highlighting that many personal factors contribute to this potentially life-changing decision. E2 also stated that peer exchange is beneficial for study orientation. In particular, contact with students or professors of the respective discipline can give a first impression of the program, answer questions and provide personal experi-

ence reports. These are valuable insights to clarify possible questions, achieve realistic expectations of the study program, and consider one's own fit.

3.2 Evaluation of our University's Current OSA

The LMU's current CS OSA is a typical multiple-choice online test. It includes subject-specific questions on problem-solving behavior, technical expertise, and logical thinking. Due to its text-heavy content, it is not optimized for mobile use. Participation is mandatory to enroll in the Bachelor's degree program, but the result is not considered for admission. In addition to the aptitude test, the OSA contains pre and post-questionnaires for evaluation purposes. To gain insights into the assets and drawbacks of the OSA, two researchers conducted a Thematic Analysis (Braun and Clarke, 2006; Nowell et al., 2017) of the (optional) open question "Do you have any further comments on the online self-assessment?".

242 of 2539 participants gave an answer to this question between June 11th, 2019, and November 24th, 2020. After data cleansing, we separated the answers of 228 participants into 253 single statements and grouped them among the four derived themes "general", "efficacy", "content", and "implementation". The overall sentiment of the answers was positive: 24 participants claimed to have liked the online self-assessment and 19 expressed their gratitude for the test. Participants commented positively on the OSA's efficacy: they found it fun (10), helpful (6), informative (4), and inspiring (4). Moreover, 13 users stated to have found the test helpful to assess their fit to the degree program, whereas only 3 claimed the opposite. The main critique was on the content level: People criticized the lack of solutions for the tasks (42). Moreover, some participants did not understand (28) or like the questions (15). On the positive side, a number of people found the content interesting (10) and liked the questions (4), but some also wished for a different type of content (9), e. g., questions that are better suited for dyslexics. Users had few but mostly negative comments on the structure, e. g. they wished for more tasks (7) and did not like the distribution of points (6).

From the evaluation, we conclude that the general idea of an online self-assessment is well received and can be a fun and helpful method of assessing the user's fit to the prospective study program. However, the preferred length and content of the test underlie individual preferences. Therefore, flexible content according to the user's needs is a major goal of our concept development.

3.3 Survey with First-Year Students

To complement the findings of the OSA evaluation, we conducted an online survey with first-year CS students at the LMU. The survey included open-ended questions about what students wish they had known in retrospect before they began their studies, what they (dis)liked about the current OSA, and what content they missed. We also included Likert ratings on the perception of the current OSA and the test's capability to stimulate self-reflection. In addition, students had to rate possible features of a mobile OSA app with German school grades from 1 (very good) to 6 (very bad) and could propose additional features. The questionnaire concluded with a 5-point Likert rating of whether they would have used a mobile OSA app if it existed and whether they would have preferred a mobile version over the current desktop-based OSA. Two researchers again performed a Thematic Analysis of the open-ended questions and discussed any discrepancies. For reasons of length, we only report the results relevant to the design of the prototype.

We recruited participants via the mailing list of a compulsory first-semester lecture. 51 people with an average age of 22.5 years ($min = 18, max = 46$) completed the questionnaire (27 male, 22 female, two diverse). All of them participated in the current OSA as part of their university application process.

When asked what they would have liked to know in advance about their study program, 30 participants reported specific information gaps. They would have wished for "more information" (4) as well as more details on course preparation (6), requirements for students (5), prior math knowledge (4), and the university (4). Less frequently mentioned aspects were the unexpected theory-heavy nature of the program (2), a wish for information on minor subjects (2) and career opportunities (1), and individual problems with the study start (2). The rating of the item "The test made me think about my suitability for the computer science study program." received mixed results (Median $\tilde{x} = 3$, 5-point Likert scale from 1="fully disagree" to 5="fully agree"). We observed a similar result for the statement "Participating in the OSA gave me a more accurate idea of the computer science program at the LMU." (Median $\tilde{x} = 3$). In response to the open-ended question "In what way did the test make you reflect?" 17 participants stated that did not at all reflect through the OSA. Four participants were made unsure by the test whether the program was feasible for them. Three people stated that the test revealed a lack of prior knowledge. In contrast, eleven participants could positively confirm their choice. Another seven students stated that the test was fun and moti-

vating. Five participants found that the OSA could provide insights into the study program and four were encouraged to engage further with the OSA's content. When asked "What content and topics did you miss in the OSA?" participants responded that they would like to see more math questions (8) and more programming and computer science tasks (7).

To identify relevant content modules, we extracted the items that were most frequently rated as very good (1) or good (2). The resulting features are: sample assignments (88 %), insights into future career options (86 %), contact to enrolled students and mentoring (78 %), videos of example lectures (75 %), contact to student advisors (75 %), further links and information material (73 %), and information about student life in the city (67 %). For the open-ended questions on participants' own ideas, we grouped the answers of all 51 participants into the themes "exchange and contact" (28) "information on professors" (4), "video recordings from lectures" (11), "experience reports" (7), "career options" (6), "information about study program content" (7), "information about personal study management" (3), and "presentation of minor subjects" (2).

The majority of participants indicated that they would have liked to use an app for study orientation (Median $\tilde{x} = 4$). Opinions varied on whether students would have preferred a mobile version over the current desktop-based system (Median $\tilde{x} = 3$). This might be due to the text-heavy nature of the current OSA, which is not suitable for mobile use.

From the survey, we conclude that OSAs are generally perceived as helpful. There is an interest in a mobile version, but the current content is not easily transferable. Participants' responses also suggest that self-reflection can only be partially supported through the current version of the OSA. The features proposed by the students are diverse, so it might be difficult to implement a one-size-fits-all solution. Therefore, the mobile app should be designed in a way that the content can be adapted to personal preferences.

4 CONCEPT

Based on the results presented in the previous section, we derived a mobile OSA app concept and created an online click-dummy with the Figma prototyping software[4] (see Figure 1). The app is structured in five different modules, including the most popular topics from the survey with first-year students: (1) "expectations of the course of study", an assessment of personal characteristics and abilities followed by a comparison with necessary qualities as a CS student, (2) "sample assignments" representing important study content and allowing users test their personal abilities, (3) "everyday university life" to give an overview of typical student life, (4) "career opportunities" to show future possibilities, and (5) a "computer science quiz" about domain facts. The different categories are displayed as an image carousel on the start feed of the prototype (see Figure 1a). As shown in Figure 1a-b, clicking on a category (e. g., expectations of the course of study) shows the overview of clip sequences available for this topic (e. g., required characteristics). Users can see their progress through the border around the modules and add them to their personal collection by clicking the star icon in the upper right corner. Each clip sequence covers one specific aspect of the selected category and is separated into multiple clips, which represent the micro-content units (see Figure 1c-e). Clips usually contain pictures or short videos, short texts, e. g., questions or explanations, and optional interactive elements such as sliders or buttons for user input. We are adopting a successful social media feature, the so-called "story" function[5] that is well-suited for mobile use. The individual clips (see Figure 1c-e) are only seconds to a few minutes long and together they form a thematic block. Users again have the option of selecting and bookmarking clips they want to save and can thus compile the desired content themselves. Moreover, we include two social components as recommended by E2 and the literature (Bentvelzen et al., 2022). First, the app offers live Q&A sessions with enrolled students and university staff (see Figure 1a). App users can hand in questions before each live session or ask them directly in the chat. Second, we include a "question of the week" feature, in which multiple CS students answer the same question, for example: "What skills do you think are required to study computer science?". A new question is added to the collection every week.

The OSA app aims to support self-reflection by applying the design resources identified by Bentvelzen et al. (Bentvelzen et al., 2022): The *temporal perspective* is incorporated through tasks on prior knowledge (past) and information on career opportunities (future). The live Q&A sessions provide *conversations* between the students and establish contact with university members. Exercises on prior knowledge and the "question of the week" feature allow for *comparison* with a "typical" computer science student. Finally, the clip-format facilitates a self-directed *discovery* of information.

[4]https://www.figma.com, last accessed 2023-02-13

[5]see, e. g., https://about.instagram.com/features/stories, last accessed 2023-02-13

5 USER STUDY

To perform a first proof of concept, we evaluated the prototype in a qualitative user study. We recruited high school students with the prerequisite of being interested in the CS study program ($N = 11$). The goal of the study was gathering feedback on the clip format and evaluating the app's potential to support self-reflection on study choice.

Nine students and two recent graduates (five female, six male) took part in the study. The participants had to complete a short online questionnaire on demographics and their current status of study orientation. We then performed online "think aloud" interviews (Charters, 2003) via the video conferencing software Zoom[6]. The sessions were recorded for transcription purposes and took 45 to 60 minutes per user. Participants were compensated with 10 euro vouchers for an online store. After short introduction, we guided the participants through various usage scenarios to explore the prototype: First, participants should familiarize with the welcome track and home screen. Before exploring the category "everyday university life", we asked people what content they expected in this module. After browsing the category, we asked users how they liked the content presentation through clips. We repeated the process for the "career opportunities" module and asked follow-up questions if necessary. We finally directed users towards the modules "sample assignments" and "CS quiz" and let them freely explore the content. We asked questions about the style and difficulty of the provided tasks as well as the level of interactivity. In a second scenario, we asked participants to further explore the interaction with the clip format in the "expectations of the course of study" category. The final scenario treated the live Q&A sessions as well as the "question of the week" and users' attitudes towards these features. Participants finally had the opportunity to state any further remarks on the app's content and implementation. We concluded the study with another short online questionnaire including eight Likert items on the overall impression and usability of the app as well as the question of whether participants would use such an app if it existed. The examiner took notes during the interviews and a second researcher reviewed the resulting data table to verify the results.

6 RESULTS

Most participants stated that they had not yet informed themselves in detail about studying CS (Median $\tilde{x} = 3$, 5-point Likert scale from 1="fully disagree" to 5="fully agree") and also did not yet have a precise idea about the course of studies (Median $\tilde{x} = 3$).

Observations showed a generally positive user experience with the prototype. This is also reflected in the Likert ratings: In the post-study questionnaire, all eleven participants rated the app as helpful, easy to use, and clearly structured (Median $\tilde{x} = 5$ for all statements). They perceived the app's content as well-integrated (Median $\tilde{x} = 5$). Moreover, all users mentioned during the "think aloud" interviews that the app holds the potential to stimulate self-reflection on study choice. Especially the sample assignments (4) and the expectations of the course of study (3) were rated as helpful for promoting self-reflection. The live Q&A sessions and the "question of the week" module were also clearly liked by users. According to the participants, these features facilitate connecting with enrolled students (4) and hold the potential to give realistic insights (3). One participant also noted that new content on a regular basis increases engagement with the app. All participants claimed that they could imagine participating in the live sessions.

The clips were perceived as a suitable way of content presentation by all users. This is reflected in the verbal feedback as well as the Likert item "The clip format is a good way of displaying the app's content." (Median $\tilde{x} = 5$). In particular, five users positively highlighted the choice of short video elements to convey real insights. Seven participants stated that the functionality of the clip mode was known to them through other apps, while four needed a short introduction: We explained the touch gestures to skip or pause the clips and how to return to the overview page. Afterwards, all users felt confident navigating the app.

In the post-study questionnaire, the majority of users responded positively to the question of whether they would use such an app if it existed (Median $\tilde{x} = 5$, $min = 3$).

7 DISCUSSION AND OUTLOOK

A limitation of our work is that the app's design was informed by the feedback of first-year students, i. e., people who already decided for studying CS. Unfortunately, we were not able to contact students who made a decision against studying CS at our university or had dropped out during their course of studies. We did not involve high school students in the requirement analysis since they are often overwhelmed by the career choice process (The Behavioural Insights

[6]https://zoom.us, last accessed 2023-02-13

Team, 2016; Kulcsár et al., 2020) and might find it hard to imagine what would help them on an abstract level (Myers, 1994). A second limitation is that our concept is based on the CS OSA of the LMU. Therefore, not all results might be transferable to other fields of study and universities. Moreover, the evaluation of our concept was performed in a controlled setting with a click-dummy prototype. However, we think that our study presents a viable proof of concept yielding interesting impulses for future research.

Our mobile app is designed to replace traditional desktop-based OSAs. It is tailored to the smartphone usage behavior of young adults (Howarth, 2022) and offers the possibility for regular use in small chunks (Cheng et al., 2015). Our pre-studies have shown that the content preferences of users differ in the amount and difficulty of tasks. To allow for flexible use, the content should be selected with great care. Tasks should be presented as a broad range of options rather than mandatory skills to avoid discouraging qualified participants with less prior knowledge.

In our final user study, participants highlighted the potential of self-reflection support through a comparison of expectations with the actual properties of the study program and through social features. This is in line with the findings of Bentvelzen et al., who identified *conversation* and *comparison* as two key aspects of self-reflection support systems (Bentvelzen et al., 2022). Current OSAs often neglect these social aspects despite their importance for career decision-making (Harren, 1979). We implement social features through live sessions and the "question of the week". Our concept therefore relies on the active participation of university staff and students. The app's content needs to be maintained and live sessions require a moderator willing to offer them regularly. In return, the concept scales well to inform a large number of users. Up-to-date content potentially leads to a better image of the university and more informed prospective students (Stoll, 2019). To reduce the effort of live sessions, we also see potential in (asynchronous) online forums or other question-and-answer formats, e. g., FAQ. In contrast to conventional OSAs, we refrain from making a specific recommendation. This might be unfamiliar to users who are used to tests with a final result. Future work needs to investigate whether this could have a negative impact on user satisfaction.

As a next step, we plan to implement a working prototype for field testing. We would like to investigate whether the app is used in several short sessions as intended. In addition, we would like to see if users work through the entire app or choose their preferred content based on their interests. It would also be interesting to study the level of engagement in the live sessions and whether this feature facilitates social interaction. A long-term goal could be to explore personalization and adaptive features, such as gradually unlocking new content modules, e. g., more difficult sample assignments.

8 CONCLUSION

In this work, we presented the concept development of a mobile OSA app for CS studies. We first performed a requirement analysis by interviewing two experts, evaluating the LMU's current OSA ($N = 228$), and conducting an online survey with first-semester students ($N = 51$). In contrast to traditional OSAs, the goal of our concept is to stimulate self-reflection in order to assist users in making an informed study decision. We apply the micro-tasking method to optimize the OSA for mobile devices and allow for repeated use in multiple sessions. The app consists of different content modules composed of short clips that can be viewed by users in their desired order. A first proof-of-concept study ($N = 11$) showed that the app was well-received by users. They liked the clip format as a means of content presentation and confirmed a possible stimulation of self-reflection through the app's features. We hope that our concept inspires future research in the area of mobile decision support systems, especially for life-changing decisions that require careful consideration and a high level of self-awareness.

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