Let's Choose STEM – An Overview on Study Program Guiding Online Self-Assessments and Future Directions

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Abstract: Online Self-Assessments (OSAs) are common tools for university orientation. They assist high school students in linking their vocational interests with matching fields of study or checking their suitability for a certain study program by considering personal interests, skills, and vocational expectations. We are the first to provide a review and classification of N=12 OSAs currently offered in Germany in the area of Science, Technology, Engineering, and Mathematics (STEM). Our results show that OSAs differ considerably in their content and duration. While the analyzed tools offer time and location independence, they still lack flexibility and adaptability with respect to the individual user. We discuss these findings and provide future directions for research as well as for OSA suppliers. The approaches we identified as promising offer immersive experiences, adaptive content, and empower students to make well-reflected decisions.

1 MOTIVATION

Study program choice can be a complex task for high school graduates given the plethora of options. The website https://www.studycheck.de (last accessed 2024–03–13) lists about 21,000 degree programs in Germany. Even after determining a broad vocational direction, prospective students have difficulties evaluating the concrete options and are uncertain about the potential outcomes of their decision (Germeijs and De Boeck, 2003). To assist students in making better career decisions, many universities have introduced Online Self-Assessments (OSA) for study orientation. These tools rely on the students' individual evaluation of their interests, skills, and personality traits. Based on these characteristics, OSAs calculate matching fields of study or assess the user's aptitude for a certain degree program. Such tests can help students understand their strengths and interests and link them to relevant career objectives (Hasenberg and Schmidt-Atzert, 2014). By providing information on different degree programs and aligning expectations, OSAs can be a resource-efficient complement to academic advising, influence the external perception of the university, and manage access to degree programs (Stoll, 2019). Therefore, both prospective students and providers can benefit from well-designed OSAs. Although many such tests exist, there is only little literature on the creation and validation of OSAs (cf. (Stoll and Weiss, 2022)). Accordingly, OSAs vary widely and there is no overview of the current state of the art.

We are the first to provide a systematic review on German OSAs. To give a diversified overview, we look at a cross-section of the Science, Technology, Engineering, and Mathematics (STEM) field. We therefore classify a set of N=12 OSAs, reveal advantages and disadvantages of state-of-the-art systems and discuss future directions for research as well as for providers. Our results show that, on the one hand, OSAs convince with their time and location independence as they offer ubiquitous access through the internet. In contrast to personal counseling, they can preserve the user's anonymity while answering personal questions. On the other hand, there is a huge inconsistency regarding their duration and content, which can make it challenging for students to trust the test results. To overcome these drawbacks, future research should develop general guidelines for OSAs, leverage adaptive content, and explore the use of further technologies, such as virtual reality.

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In the following, we first present the theoretical background of career decision making, related challenges, and how these are addressed by online career guidance systems. We then explain the methodology of our systematic review, present the resulting classification, and discuss the benefits and drawbacks of current OSAs based on their features. Finally, we summarize our findings and present our vision for future OSAs.

2 BACKGROUND

Career choice is one of the most important yet complex life decisions for young adults. Given the multitude of influencing factors, the process can be particularly challenging for high school graduates in comparison to experienced professionals (Galliott, 2017). In a recent literature review, Gati and Kulcsár elaborate on the process of career decision-making and discuss related issues and challenges of the 21st century (Gati and Kulcsár, 2021). They present the career choice process as a three-stage model comprising (1) the *prescreening* phase, (2) the *in-depth exploration* phase, and (3) the *choice* phase. First, people broadly explore the environment of career opportunities and identify promising alternatives according to their interests. Second, they narrow down the different options fitting their personality and skills. Finally, they choose the most suitable alternative. The OSAs presented in this work are either designed to be used in the prescreening phase (OSAs for general study program orientation) or the in-depth exploration phase (OSAs on certain degree programs). During these different stages, various problems can occur, e. g., lack of readiness, lack of information (about oneself or about professions), or internal and external conflicts (Gati and Kulcsár, 2021).

The idea of using technology to support this challenging process dates back to the late 1960s, when the first computer-assisted career guidance systems (CACGS) were implemented to complement personal career counseling (Harris-Bowlsbey, 2013). While traditional CACGS were mostly digital versions of paper-based assessments, online tools offer a lot more opportunities: they have the advantages of reducing costs, extending access to job information, and offering new possibilities for interactive content (Vigurs et al., 2017), such as automatic and immediate feedback (Kleiman and Gati, 2004). While paper-based assessments or print media can only provide static career information, OSAs can potentially present up-to-date information and customize content for each individual user. German universities and government institutions, such as the German Federal Employment Agency[1], draw on these benefits when developing and providing OSAs. However, scientific research on this widely used instrument is limited. Gati et al. emphasize the need for career counselors and researchers to work together in the development of OSAs, to ensure their quality and usefulness (Gati and Saka, 2001; Gati and Asulin-Peretz, 2011).

Galliott performed a user study to investigate which functionalities OSAs need to have in order to eliminate students' career uncertainties (Galliott, 2017). The study showed that students are often not aware of the available services for career orientation. The authors emphasize that important information on career orientation must always be kept up-to-date. This applies not only to the content of OSAs and general careers websites, but also to the sources in which they are advertised. Additionally, the information should appeal to different target groups: Having in mind that students are often inexperienced in making far-reaching life decisions, Galliott recommends that OSAs should not only be promoted to students, but also to their parents, teachers, as well as career counseling institutions, in order for them to assist the students in the career choice process (Galliott, 2017). Related work also highlights the need for considering culture in career guidance (Akosah-Twumasi et al., 2018).

Well-known research from psychology suggests that career guidance systems need to support students in finding their professional interests to make a satisfying decision on a course of study (e. g., (Holland, 1997; Tracey, 2010)). An established taxonomy that links personal interests with occupational preferences is the RIASEC model (Holland, 1997). It is also known as Holland's hexagon model, as it consists of six areas of interest, as shown in Figure 1. The model comprises (1) the *realistic* type referring to a person with technical and practical interests, (2) the *investigative* type describing theory-led and observational interests, (3) the *artistic* type representing creative and cultural interests, (4) the *social* type referring to helping and caring individuals, (5) the *enterprising* type related to leadership and organization, and (6) the *conventional* type including administrative interests. Holland suggests to determine the level of interest for these six dimensions to find matching vocational fields. The result can then for example be compared with the qualities that a degree program requires of its students. Our systematic review (see Section 4) revealed that some of the German OSAs (EI, SIT) are based on Holland's RIASEC taxonomy.

[1] https://www.arbeitsagentur.de, last acc. 2024–03–13

[2] https://www.researchgate.net/figure/Hollands-hexagon-model-for-vocational-interests_fig4_224971173, last accessed 2024–03–13

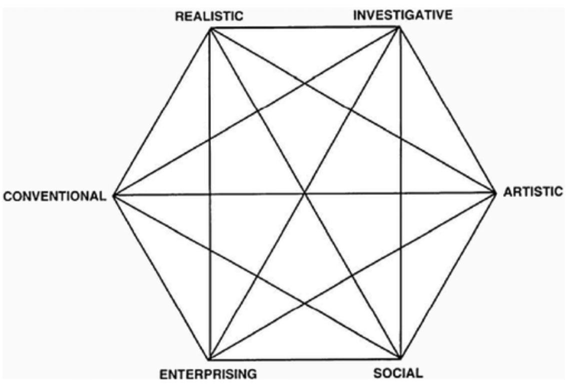

Figure 1: RIASEC model by Holland[2]

Other works further emphasize the importance of personal interests in study orientation. For example, Tracey observed that the greater a student's interest in a subject, the better they perform and the more satisfied they are with their decision (Tracey, 2010). Another study found that students, who choose their degree program according to their interests, are more likely to widen their knowledge in the field of the program and thus improve their professional identity (Smitina, 2010). In this context, a pronounced professional identity means that persons know their vocational strengths, why they chose previous career pathways, and what they want to achieve in the future. Those who have a low professional identity tend to randomly decide on a study program and thus have to face more difficulties in their further career (Smitina, 2010). The presented publications are just a small selection of well-known examples of the theoretical basis of the career choice process. Developers of OSAs can draw on a variety of proven concepts and theoretical models on vocational decision-making. However, the way in which these tests are developed in practice remains unclear. To the best of our knowledge, there is no overview of the current state of the art. We fill this research gap by providing a systematic review of up-to-date German OSAs in the STEM field and derive recommendations for research and providers.

3 METHODOLOGY

This section describes the selection process and classification categories we found and used for our analysis.

3.1 Selection Process

We started the research for relevant online tools with two overview websites that independently list several OSAs developed by universities in the German-speaking area: OSA Portal[3] and "Komm, mach MINT"[4]. The first website contains OSAs for various degree programs as well as multidisciplinary OSAs. Here we selected three tools provided by different universities: BTU, GAU, and LMU. The second website gives an overview of OSAs for the STEM area, where we chose six more tools: EAH, HC, HTW, SIT, PUM, and UF. We selected common courses of study from the STEM area like mechanical engineering, biology, or computer science. For each specific study program, we chose only one OSA to examine a cross-section of this area. Moreover, every assessment is provided by a different university to draw better comparisons.

We then visited the websites of various universities to find out if they offered aptitude tests for specific degree programs or a general test for all majors. In this process, we discovered ST – a complex OSA, that does not only take vocational interests into account, but also creates a personality profile of the user according to their input. This sets this tool apart from others that deal with general vocational interests, which is why we considered it in our work. To increase the number of such general interest tests, we checked the websites of several German institutions that deal with career orientation like the German Federal Employment Agency. As a result, we identified five additional instruments relevant to our evaluation: CU, EI, HCU, MBW, and UN. Our first preselection included 15 OSAs (seven general tools and eight tools on certain study programs), as shown in Table 1. We tested all of the preselected tools by answering the questions honestly and from our point of view. Our goal was to gain an impression of the content, the duration and the results. Afterwards, we removed three general OSAs (HCU, MBW, UN) from our list, as they appeared to be similar or nearly identical to other ones and including them would not add to the classification. Our search for relevant OSAs finished when we did not find any more tools that notably differed from the already tested ones. Our final data set consists of twelve OSAs: four general and eight specific tools (cf. Table 3).

To get more insights into the conception of the tests, we looked up the developers' contact information, if available, and reached out to them via email. We asked them who was involved in the conception, how the content was produced and what was their targeted duration of the OSA. We also wanted to know if the OSA was originally planned as an online tool or if an offline version was adapted, on which platforms it was available, which technologies were used and if the tool was scientifically evaluated.

[3] http://www.osa-portal.de, last accessed 2024–03–13

[4] https://www.komm-mach-mint.de/schuelerinnen/teste-dich-selbst/self-assessments, last accessed 2024–03–13

Table 1: URLs and providers of the 15 OSAs considered for the classification. The OSAs that are not included in the classification are shown in parentheses. All websites last accessed 2023–12–01

ID	**Provider – Description**	**URL**
BTU	Brandenburg University of Technology – Online self-assessment for the mathematics degree program	https://www.b-tu.de/elearning/college/mod/quiz/view.php?id=250
CU	Check-U by the German Federal Employment Agency – Exploration tool for apprenticeships and studies	https://www.arbeitsagentur.de/bildung/welche-ausbildung-welches-studium-passt
EAH	University of Applied Sciences Jena – Online self-assessment for the mechanical engineering degree program	https://selfassessment.eah-jena.de/osa.php?id=13
EI	Einstieg GmbH – Vocational interest test	https://interessencheck.einstieg.com
GAU	University of Göttingen – Virtual study orientation of the Faculty of Chemistry	https://www.studienorientierung.uni-goettingen.de/navigator/chemie/index.php?pid=1000
HC	Coburg University of Applied Sciences and Arts – Orientation test for study programs in the STEM area	https://www.studiengangstest.de/test/index.php/392996
(HCU)	HafenCity University Hamburg – Vocational interest test	https://hcu-studienorientierung.cyquest.net/navigator/interessentest/
HTW	Berlin University of Applied Sciences – Online self-assessment of study programs in the power engineering & automation area	https://studienwahl.htw-berlin.de/index.php?t=TGQ7L
LMU	Ludwig-Maximilians-Universität München – Online self-assessment for the physics degree program	https://www.self-assessment.lmu.de/course/view.php?id=10
(MBW)	Ministry of Science, Research and Arts Baden-Württemberg – Online self-assessment for study orientation	https://www.was-studiere-ich.de
PUM	University of Marburg – Online self-assessment of the Bachelor's degree program in Biology	https://survey.online.uni-marburg.de/qss/index.php/235912
SIT	Hochschulkompass – Study interest test	https://www.hochschulkompass.de/studium-interessentest.html
ST	University of Tübingen – General study program choice test	https://www.studienwahltest.uni-tuebingen.de
UF	University of Freiburg – Online study selection assistant for the computer science degree program	https://www.osa.uni-freiburg.de/informatik/
(UN)	Uniturm.de by Pharetis GmbH – Online study program choice test	https://www.uniturm.de/studienwahl/studienwahltest-studiumsfinder

Table 2: Specification of categories for the classification of OSAs.

Category	**Meaning**
Assessment Goal	Overall goal of the OSA. This includes the differentiation between a general interest test and an aptitude test for a specific degree program.
Starting Point (SP)	There are three situations students can be in when doing an OSA: (1) They have no idea what to study, (2) they have a general interest in STEM, or (3) they are interested in a concrete study program.
Content	Information presented to the user, e. g., standardized questionnaires, contents of a course of study or information about studying in general.
Duration (Durat.)	Planned duration of the OSA (as specified by the developers).
No. & Type of Questions	Number and type of questions or tasks as an indicator for the OSA's complexity and design.
Device	Platforms targeted by the OSA: desktop (D), mobile (M), or app (A).
Platform	If detectable: technologies or platforms the OSA is based on.
Results	The type of results the OSA provides after its completion.

3.2 Classification Categories

During the testing phase, we identified eight categories for our classification of the OSAs (cf. Table 2). These are all aspects in which the selected tools differ from each other or which are relevant to analyze the benefits and challenges for the development of OSAs.

4 CLASSIFICATION

Table 3 gives an overview of our classification. The eight categories are presented in the columns and the tested OSAs are listed in the rows. If we were unable to identify data for the particular category, we indicated N/A (not available). The classification reveals that the tested tools have huge differences in their complexity and content. The number of questions ranges from nine to 213, while the content includes knowledge questions, standardized questionnaires based on scientific models such as the RIASEC model (Holland, 1997), as well as further questions on personality traits, social competencies, etc. Furthermore, it shows that each OSA is available in a desktop and a mobile version, while its content remains static. Finally, we found that the used technologies are hard to identify, and the results solely include study program recommendations according to the user's interests or skills, but provide no motivation for reflecting on the system's output. Out of twelve contacted developers, we received six answers within one week (EAH, GAU, HC, LMU, ST, and UF). Roles involved in the development ranged from deans of studies, scientific employees, students, as well as a Ph.D. student, who designed the tool as part of their dissertation. The content was largely created based on topics of the study program, with the goal for it to be interesting for students with all kinds of knowledge states, and without the inclusion of scientific methods. The answers revealed that all six OSAs were initially developed as an online tool with a strong focus on the desktop version. Moreover, each of them is intended to last between one and two hours. Concerning the used technologies, most developers have resorted to certain providers such as the open-source LMS Moodle[5] or the commercial tool Cyquest[6]. None of the respective OSAs have been subjected to scientific evaluation.

5 DISCUSSION

In the following, we discuss the results of our classification, derive advantages and disadvantages of current OSAs, and make recommendations for developments.

5.1 Evaluation of the Tested Tools

Through our classification, we were able to get a broad overview of the spectrum of currently used OSAs and to detect relevant differences between them. We will now discuss the individual features of the tested tools, to be able to better assess their potential to support study program choices.

[5]https://moodle.org, last accessed 2024–03–13
[6]https://www.cyquest.net, last accessed 2024–03–13

Table 3: Classification of the twelve OSAs regarding the categories described in Table 2.

OSA	Assessment Goal	SP	Content	Durat.	No. & Type of Questions	Device	Platform	Results
BTU	Suitability (Mathematics)	3	Knowledge questions	N/A	21: Multiple choice (MC), open text, drag & drop	D, M, A	Moodle	Submitted answers
CU	Matching study programs, skills vocational interests,	1	Questions on vocational interests, skills, social competency	125 min	213: Scale (0 - 100), either/or	D, M	N/A	Matching study programs & apprenticeships, areas of interest, submitted answers
EAH	Suitability (Mech. Engineering)	3	Knowledge questions, studying in general	N/A	40: True/false, MC, open text	D, M	alpha-test GmbH	Submitted answers
EI	Vocational interests	1	RIASEC model (Holland, 1997)	15 min	60: Scale (0 - 100)	D, M	N/A	Matching study programs, jobs & apprenticeships
GAU	Suitability (Chemistry)	3	Knowledge questions, studying in general	45 min	23: True/false, MC	D, M	CYQUEST GmbH	Submitted answers
HC	Suitability (STEM)	2	Knowledge questions, studying in general	60 min	150: Scale (Likert)	D, M	N/A	Submitted answers, skill evaluation
HTW	Suitability (Power Engineering)	2	Knowledge questions	N/A	9: MC	D, M	alpha-test GmbH	Submitted answers
LMU	Suitability (Physics)	3	Knowledge questions	120 min	53: Scale (Likert), yes/no	D, M	Moodle	Submitted answers
PUM	Suitability (Biology)	3	Knowledge questions, studying in general	N/A	117: True/false, MC	D, M	N/A	Submitted answers, skill evaluation
SIT	Vocational interests	1	RIASEC model (Holland, 1997)	15 min	82: Scale (0 - 100)	D, M	TYPO3 CMS	Areas of interest, matching study programs
ST	Vocational interests, personality profile	1	Questions on vocational interests & personality	145 min	115: Scale (Likert)	D, M	N/A	Personality & interest profile, matching study programs
UF	Suitability (Computer Science)	3	Knowledge questions, studying in general	60 min	51: Yes/no, MC	D, M	Wordpress, H5P, JavaScript	Submitted answers

5.1.1 Content and complexity

The benefit of an OSA highly depends on the content it covers. Only two of the tested OSAs (EI, SIT) are based on scientific methods – more precisely Holland's RIASEC model (Holland, 1997). However, they only cover the user's interests and calculate matching fields of study. It is notable that these tests are comparably short: We were able to complete both of them in under ten minutes. Related work suggests that such a short test cannot reflect the complexity of career decision-making (Gati and Kulcsár, 2021). Showing interest in a certain area does not automatically imply a good suitability for the course of studies. More information about the user needs to be collected, e. g., on their skills or on personality traits.

Furthermore, each of the tested OSAs is static, i. e., its content does not adapt to the user's input. In this way, the instruments cannot respond more deeply to the user's particular interests without increasing the number of questions and the time required for the OSA. This means that two potentials of digital technologies – flexible use and adaptability – are overlooked in state-of-the-art OSAs.

5.1.2 Platform

All of the tested OSAs are accessible in a desktop and mobile version. One of them is even available in an app (BTU). However, our survey of the OSA developers showed, that their main focus during the development lied on the desktop version which might also be visible in the targeted duration for the OSAs. Here we see the need to better adapt career guidance systems to the requirements of their specific user group, namely young adults. Especially in this target group, the use of mobile devices has now overtaken stationary desktop PCs.[7] This shift creates new challenges for the design of study orientation tools. In their recent work, Aragon-Hahner et al. emphasize that smartphone use is characterized by a small display size and a shorter attention span (Aragon-Hahner et al., 2023b; Choi and Lee, 2012). Therefore, they examine micro-content for mobile OSAs. A first evaluation delivered promising results, but their system is still a research prototype in the development phase.

5.1.3 Results

The result types of OSAs mostly depend on the starting point of the assessment. While tests with a SP level 1 usually suggest matching study programs, higher-level tests (SP 2 & 3) most often only mirror back the user's answers. In the rare cases where an assessment is provided, it is rather general. HC, for example, yields results that show in which areas users have the most skills, but not for which courses they are particularly suited. In all cases, there is no guidance on how to deal with the test results. On the one hand, users should critically question the given career recommendations and verify the validity of the test in order to avoid overtrust in the results. On the other hand, it can be difficult for users to evaluate the results if a recommendation is completely omitted. The decision on a study program can be very complex and many personal and environmental factors have to be regarded to make a useful recommendation (Galliott, 2017). Therefore, developers have to be careful when formulating the test results. Users should be encouraged to reflect on the system's output in order to be able to finally make a "self-assessment" in the literal sense. Overall, 75 % of the general OSAs calculated study programs according to our expectations, although this estimate is highly subjective and might not apply to all users. The only exception (ST) lacked questions about computer science and was therefore not able to suggest a fitting course of study for our test user.

5.2 Advantages of Existing OSAs

Given that all of the tested OSAs are available in a desktop and a mobile version, a clear advantage is that they are time- and location-independent. OSAs scale well for a large user base, since their execution does not require the presence of a career counselor or a teacher. Moreover, as there is no interaction with a real person, the user might feel safer and potentially respond to the questions more honestly and with less pressure (Cameron et al., 2017). Another advantage is that OSAs can be repeated as often as desired to reassess one's competencies after looking up more information on the field of studies. Thus, they can support well-informed decisions about whether to apply for a specific degree program.

5.3 Disadvantages of Existing OSAs

The development of an OSA is time-consuming and laborious. Developers must not only have deep insights into the study program(s), but should also be familiar with questionnaire design and have an overview of psychological research on personality traits and decision making. Our contact with universities revealed that the authors of course-specific OSAs have different areas of expertise, which can lead to a large variance in the quality of the tests. This raises ethical concerns, that will be discussed in the next section. We believe, that it is of utmost importance for the test results to be reliable, correct and comprehensible to avoid confusion and career indecision.

Most of the OSAs provided results subjectively matching our test user's interests, regardless of their duration. We still suspect a bias in the results, since the given answer options sometimes seemed to lead the user in a certain direction by making the "correct" answer obvious. At the same time, very general tests bear the risk of distorting the results by oversimplifying the career choice process. For example, an OSA might ask "Could you imagine working in a biology laboratory?" with this being the only question related to biology. People who would rather like to work outdoors might unintentionally score low on this question, even if biology would in fact be a good fit for them.

Overall, our analysis shows that a careful selection of questions and content is crucial for avoiding biased results. To cover the full spectrum of study orientation, another important aspect of OSAs is that they are impartial and independent. While most OSAs are offered by state institutions, there are also some commercial providers (e. g., EI), who only include companies and universities with a registration or cooperation in their results. Not showing all relevant options is a clear shortcoming of commercial tools, as this deprives students of potentially helpful systems, increasing the problem of uninformedness (Galliott, 2017). Finally, avoiding social interaction also comes with the downside of not having a professional contact person at hand. This means that students cannot discuss the results directly with a consultant, which would be particularly important in case of uncertainty. We found that some tools do not even list a contact person (EAH, EI).

[7] https://www.postbank.de/themenwelten/innovationen/digitalstudie-2022-mobile-internetnutzung-entwickelt-sich-rasant.html, last accessed 2024–03–13

5.4 Ethical Aspects

Making a career decision is one of the most important choices in one's life (Gati and Kulcsár, 2021). In fact, the decision on an unsuitable study program can have far-reaching psychological consequences (Gati and Kulcsár, 2021). Discontinuing a course of study might lead to uncertainty on future career pathways and fear of making another wrong decision. Moreover, starting a course of study includes investing financial resources and implies social consequences (Gati and Kulcsár, 2021). Therefore, OSAs need to fulfill general ethical principles, for example by ensuring accuracy and accountability. Our classification shows that common OSAs often provide recommendations for suitable courses of study. However, since the majority do not apply scientific methods, these calculations are usually based on criteria subjectively determined by the providers. Also, the calculations are not transparent. Given the mostly practice-oriented expertise of the developers, there is a risk that the calculated recommendations are not an ideal fit for the user and thus might violate the previously described ethical principles. Thus we recommend for designers of OSAs to involve experts from different fields in the development of the tools, and carefully formulate the test results. To prevent users from blindly following a recommendation, research by Aragon-Hahner et al. suggests to incorporate self-reflection in decision support systems for career choice – not only on the user's personal skills and interests (Aragon-Hahner et al., 2023a), but also on the recommendations given by a study orientation test (Aragon-Hahner et al., 2023b).

In addition, we want to scrutinize whether it is always an advantage to let someone stay in their comfort zone. As argued before, an advantage of OSAs is that they do not require personal contact and therefore a student might feel more comfortable during their career assessment (Cameron et al., 2017). However, becoming confident in personal conversations can be an essential skill for students, especially for future job interviews. Yet, if a student is not ready to leave their comfort zone or has other reasons for not taking part in personal career counseling, e. g., health or accessibility, OSAs are a valuable alternative. In summary, we suggest that OSAs should not replace humans completely, but rather be used in combination with personal career counseling (Gati and Asulin-Peretz, 2011).

5.5 Possible Improvements for OSAs

Existing inconsistencies in the duration and content of tests could be resolved through general guidelines that establish criteria that make an OSA efficient and helpful to users. Such guidelines could include scientific methods, e. g., the RIASEC model (Holland, 1997), on which OSAs need to be based, in order to make them reliable (Gati and Asulin-Peretz, 2011; Gati and Saka, 2001). In addition, there could be further content specifications, e. g., that an OSA must be composed of various areas relevant to the career choice process. CU is an illustrative example of a comprehensive study orientation test. This tool includes questions about social competencies, skills as well as vocational preferences. By establishing best practices to help students reflect on their career aspirations, the wide variation in the complexity of OSAs could be addressed.

The users of OSAs should be able to access their results at a later date. This can be important, e. g., when they have an appointment for further career guidance and want to discuss the test results with their career counselor (Gati and Asulin-Peretz, 2011). At some universities, taking the OSA for a specific course of study is a requirement for enrolling in this program. In this case, the OSA needs to provide an option to print or save the test result, for example in the form of a certificate of attendance. Therefore, users often need to register on the platform. One the one hand, this is an advantage as it allows them to know exactly where they can find their test results and – if necessary – find further information such as contact details. This is already implemented in some of the existing OSAs (BTU, CU, LMU, SIT, ST). On the other hand, having to create a user account constitutes an additional barrier for career guidance and hinders serendipitous participation in the test. Developers should therefore consider whether the lowest possible entry threshold or a closed system is more suitable for their purpose.

Overall, the development of OSAs should be more systematic and scientific. A contact person should always be listed on the website. In the optimal case, an OSA is developed by or with the help of experienced career counselors. The contact information of these experts should be provided to the users to reliably answer arising questions about the tool and its results. In the process, a personal conversation can eliminate a still-existing indecisiveness and help with further career orientation (Galliott, 2017).

5.6 Further Technologies for Career Guidance

Our classification focuses on the current state of the art of OSAs. Most of the systems presented use a "classic" question-answer format, are text-heavy, and offer little flexibility due to their static structure. Our previous considerations show that an effective OSA requires a certain scope. As a result, providers are likely to resort to the obvious option of a desktop-based tool. In the process, they lose sight of the requirements of their target group, as young people are no longer used to sitting in front of a computer for hours filling out questionnaires. Given the complexity of career choice, it seems hard to develop a one-fits-all solution. Designers could overcome this problem by making OSAs adaptive, so that they can respond in more detail to the user's input, ask more targeted questions and provide more relevant content.

Modern career guidance systems explore the possibilities of mobile apps (Aragon Bartsch et al., 2022) or immersive technologies (Demareva et al., 2020) and provide relevant information in an interactive format. Aragon Bartsch et al. give job insights by sending users mobile chat messages about a professional's daily work routine in a temporal context (Aragon Bartsch et al., 2022). They found that this method provides more realistic and personal impressions than traditional means for career orientation. A different example is the project "Dein Erster Tag" by Studio2B GmbH[8]: They give students the possibility to immersively experience 360° videos of different working environments in virtual reality (VR). One advantage of such interactive systems is the ability to "visit" the workplace or campus without having to spend time and money to physically get there. VR, in particular, allows to visit otherwise inaccessible places and can render a realistic environment, giving users the feeling of being present in the virtual space (Christou, 2010; Zheng et al., 1998). At present, the main disadvantages of VR systems for career guidance are the comparatively high costs for hardware and maintenance, which schools are often unable to afford. Nevertheless, VR can present a promising addition to the decision-maker's toolset.

5.7 Limitations

In this paper, we categorized and evaluated OSAs developed by German universities or institutions. We focused on tools that deal with study programs in the STEM field since this segment seemed sufficiently broad and yet easy to confine. OSAs from other countries or languages as well as other fields of study were not within the scope of this work. We considered twelve instruments sufficient to make verifiable statements about the characteristics of OSAs and to obtain sound results. The selection of the tools was not fully random in order to cover a wide variety of different approaches. Due to resource limitations, the analysis was conducted by a single researcher, hence, there might be biases in the evaluation. The answering of the questionnaires was mainly done to investigate the questions and to get a tentative impression of the results as well as the time it takes to complete the questionnaires.

[8]https://www.deinerstertag.de/berufsberatungen/, last accessed 2024–03–13

6 CONCLUSIONS AND OUTLOOK

Career guidance is essential for students to find out their professional identity. Due to the young target group that often uses digital devices, tools for online career orientation gain importance. OSAs can both help students figure out promising career options and assist in selecting those that match their personality, vocational preferences, and interests. To get an overview of the current state of the art of online career guidance systems, we classified N=12 existing OSAs from the German-speaking area. The evaluated tools range from tests for general study program orientation to aptitude tests for specific degree programs in the STEM area.

Our results show that OSAs have the potential to be a resource-saving complement to face-to-face career counseling. They are independent of time and location and provide a safe anonymous space in which prospective students can independently assess their suitability. However, we also found that current OSAs differ considerably in their complexity, i. e., their content and duration. Only few are based on established scientific methods. As the developers of OSAs usually have domain-specific backgrounds, the tests are most likely optimized for their content but not necessarily for their methodology. These drawbacks could be overcome with universal guidelines. However, a one-fits-all solution seems difficult to achieve. It is thus important to tailor each individual OSA to the needs of the specific user group. In a recently published book (Stoll and Weiss, 2022), the "Network Online Self-Assessment" summarizes the experiences of eight working groups in developing and evaluating OSAs over the past ten years. Such work should receive more attention so that new developments can draw on the experience of earlier creators. In the best case, an OSA should be developed by or with the help of experienced career counselors and incorporate solid and proven scientific methods.

While all of the tested tools are available in a desktop and mobile version, they rely on static question-answer formats and could, in principle, also be conducted on paper. They are thereby wasting the potential of modern technologies to provide flexible and adaptive content that is optimally tailored to the user group of young adults. Current OSAs usually only include requirements and contents of study programs, rather than experience reports as well as real insights into daily working routines of students (Aragon Bartsch et al., 2022). Such content could reinforce a student's vision of a study program. Other supporting technologies might be 360° videos or more interactive virtual or augmented reality approaches providing deeper insights into careers and potential future workspaces or incorporating virtual tasks, counselors and fellow students (cf. (Demareva et al., 2020)).

The output of the assessment ranges from mirroring the user's answers to giving concrete career recommendations. All tested tools lacked guidance on how to interpret the test results from a decision-maker's perspective. Some of them did not even list a contact person. To avoid insecurities, OSAs should not replace humans completely, but rather be used in combination with personal career counseling (Gati and Asulin-Peretz, 2011; Galliott, 2017). A forum or chat could relieve student counselors, make frequently asked questions visible, and give interested and current students the opportunity to get in contact. Only few OSAs allow the results to be stored or shared (or even printed). That can be important, e. g. when students have an appointment for further career guidance and want to discuss the test results with their adviser (Gati and Asulin-Peretz, 2011).

If designed well, OSAs have the potential to support students in the prescreening and in-depth exploration phase of their career choice process. However, the choice itself must and should be made by the student. The question here is what actually constitutes a good choice. In our view, it is important that it is based on sufficient knowledge about the course of studies, but also that it gives the decision-maker a good "gut feeling". Therefore, OSAs should empower users to reflect on their personal traits and expectations and, if necessary, seek additional information, e. g., from a professional adviser.

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