Personalized Recommendations for Individual Learning Pathways: Supporting Ukrainian Refugee Students in Continuing their University Education

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Abstract

Among the refugees of the war in Ukraine, there is an above-average number of academics, who should be able to continue their university studies abroad. Here, digital media can lower access barriers, but lack of knowledge of the language or the education system in the host country hampers participation. In addition, needs vary from person to person, which makes counseling processes complex. This article presents a cross-institutional recommendation system that proposes personalized recommendations for suitable learning paths and makes appropriate educational opportunities accessible. We present the system's structure and mode of operation, based on the currently developed national infrastructure for digital education in Germany, as well as initial findings from its evaluation based on the use case of Ukrainian refugee students.

1 Motivation

The Russian invasion of Ukraine that began on February 24, 2022 and its serious consequences for the Ukrainian population have triggered an immense movement of refugees within Europe. According to the UNHCR, approximately 7,978,000 people from Ukraine are registered as refugees in Europe; around 1,055,000 of them fled to Germany (as of January 31, 2023)[3]. Brücker et al. (2022) reveal the first representative results with regard to the current living situation of the Ukrainian refugees and their

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[3] https://data.unhcr.org/en/situations/ukraine

plans for the future. 37% of the refugees want to live in Germany for a few or more years, another 34% until the end of the war. In addition, the level of education of the Ukrainian refugees living in Germany is above average. 72% of the refugees have tertiary educational qualifications. 13% of these degrees are bachelor's degrees, 52% master's degrees and 4% doctorates. The high level of education and the long-term intentions of the Ukrainians to stay in Germany underline the strong need for adequate support for their academic careers.

One could argue that digital teaching and learning provide sufficient means to address these needs. However, an increasingly fragmented landscape of digital offers, infrastructures and data formats hinder the potential of digitalization. In addition, tedious decisions, changes in the education system and its federal structure also make it more difficult to benefit from these digital potentials in the educational sector. For users, this means that throughout their educational career, they constantly have to register for new systems and to share their data to be able to use them (Knoth et al. 2022). For prospective Ukrainian students, this is all the more detrimental because they generally do not have any knowledge of the German language or the German education system. This article is devoted to this problem. Based on the use case described, a cross-institutional recommendation system is presented that supports individual learning paths for Ukrainian refugees in German universities.

The remainder of this article is organized as follows. In section 2, we describe the state of the art in adaptive learning technologies and educational recommenders. This is followed by a description of the Learning Path Finder introduced in this article in section 3, and its evaluation based on the use case of Ukrainian refugee students in section 4. Our findings from the evaluation are discussed in section 5. The article concludes with a summary and further recommendations in section 6.

2 State of the Art

Research on personalization and adaptivity in educational technology goes back decades (Sampson et al, 2002) and is essentially fed from two perspectives. First, from the system architecture point of view, i.e., the flexible combination of different educational tools in an adaptive infrastructure (Kiy et al., 2014). Open standards, especially Service-oriented Architectures, Web Services and Microservices established as important drivers of interoperability, regardless of educational specifics. Second, there are drivers from the data point of view, i.e., the exploitation of information about users for the selection and configuration of educational content (Fortenbacher et al., 2017). Intelligent tutoring systems and learning analytics are prominent streams in this branch of research, combining technical and educational approaches. In all of these cases, introducing such infrastructures need to be seen not just as technical programs for the future but as an expression of the existing need for reform of the education system (Williamsen, 2018).

Respecting the learner's sovereignty, supportive approaches (i.e., recommending possible options) are usually preferred against patronizing mechanisms (i.e., automatically selecting an option). Currently, recommender systems are being given an additional boost by recent advances in the field of artificial intelligence (Gloerfeld et al, 2020). Self-directed learning processes especially benefit from such assistance. Generally, a recommendation is provided in terms of specific learning content (not: tools or platforms), across different media types (Deldjoo et al., 2020). Beyond related approaches in the fields of entertainment and lifestyle, more in-depth information about the provided content (e.g., pedagogical strategies, teaching/learning objectives, or licensing models) and about the learners (e.g., existing prior knowledge, individual misconceptions, preferred learning styles, affective and meta-cognitive characteristics, or qualification goals) is applied for educational purposes. Both symbolic and stochastic approaches to such modeling can be found. However, to the best of our knowledge, adaptive learning systems exist only within the offerings of individual educational institutions or providers, but we are not aware of any mechanisms that support adaptive learning pathways across content and tools

from different providers. This is where the Learning Path Finder as described in this article enters the scene, integrating educational content from different providers.

The only exception we are aware of in this regard is the exchange of acquired educational credentials. While first automated mechanisms are currently being developed for formal achievements (especially at the European level, like the "Erasmus without papers" initiative[4]), informal credentials such as Open Badges have already been used in networked educational environments for some time (Hickey & Buchem, 2021). Besides institutional procedures for enrolment or grading (Knoth et al., 2023), such competency claims can be used in informal learning opportunities, social networks, etc.

In this context, Hofhues & Schiefner-Rohs (2020) question the extent to which higher education needs to change its basic assumptions, structures and processes. Technical innovation could fundamentally reshape the way stakeholders, the media and academia interact. Universities should be perceived as part of society, facing up to the challenges posed not least by digitization. With regard to the analysis of personal data and the automated generation of recommendations for individual learning paths, ethical aspects also need to be discussed (Müller et al., 2020).

In summary, there are several aspects resulting from the state of the art that must be taken into account in the evaluation of such a system. Functional maturity and performance are clear indicators of success in view of the long-established technologies used. Moreover, usability and acceptance of the system in individual use are also significant. In addition, the success criteria include, in particular, aspects of sovereign handling of personal data. This is our benchmark for subsequent evaluation.

3 The Learning Path Finder

The overall objective of the Learning Path Finder as presented in this article is to provide an easy-to-use online environment for Ukrainian refugees in Germany that want to continue their studies. It can be characterized as a recommendation engine that connects the students with suitable educational offers depending on the structures and requirements of higher education on the one hand and the already proven skills of the students on the other hand. This is modeled in four independent learning pathways, namely:

- Depending on the intended program, certain *disciplinary skills* might be required. Also, existing prior knowledge may be recognized for placement in a higher semester.
- Sufficient *language skills* in German or English are required for most study programs. Here, diagnostic assessments and learning opportunities are combined to acquire the individual skills still needed.
- The *enrolment procedure* for study programs at German universities bears administrative difficulties, for example, in the examination of the university entrance qualification. This pathway supports students from abroad before and during this process.
- Future *career opportunities* for the students after completing their studies are considered in the last pathway.

The Learning Path Finder was implemented as a component of the currently developed prototype of a national educational infrastructure (Knoth et al., 2022). Interoperability is a major principle of this infrastructure, in terms of linking and merging existing content and tools, while the respective services and their providers retain their autonomy. There are three mechanisms to ensure such interoperability via a common middleware: single sign-on for users across all services; metadata management for integrated content, tools and services; data wallet to manage personal data and achievements. All are

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[4] https://erasmuswithoutpaper.eu/

used by the Learning Path Finder introduced in this article. Figure 1 presents a screenshot of prototype, based on the Liferay[5] framework, including the pathways described.
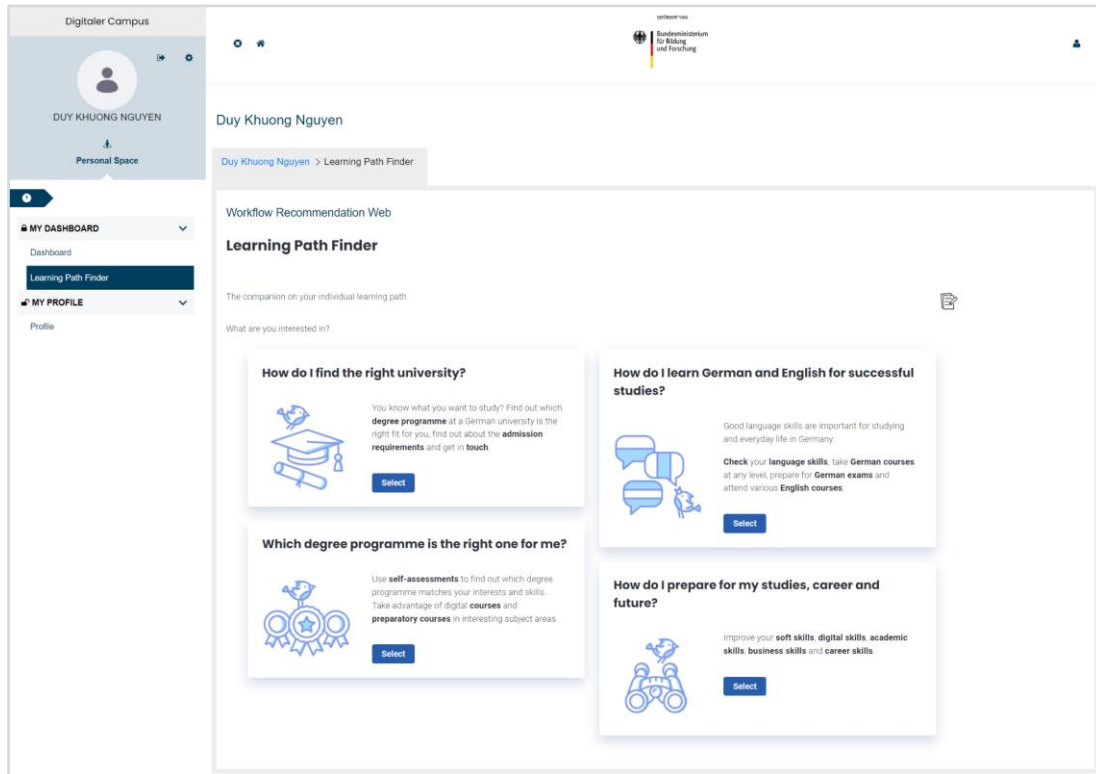

Figure 1: The Learning Path Finder connects existing educational offers with
individual needs and preferences by process models and decision tables.

Depending on the individual preferences and skills of the students, the order of these pathways as well as the individual components within those pathways are adapted to their respective life situations. The technical implementation of the Learning Path Finder consists of two components:

- A *process model* for each of the pathways, including steps to be carried out along with their order and conditional transitions.
- A *decision table* for mapping of individual user data and educational offers to the conditions defined in the process descriptions.

Liferay incorporates the Camunda[6] workflow engine, which uses Business Process Model and Notation (BPMN) as its primary modeling language to represent such processes. Each process in the Learning Path Finder is modeled using BPMN and is uniquely identified by a process key. Once the BPMN diagrams are created, Camunda's workflow engine can automatically execute the process according to the diagram. The engine uses the BPMN model to determine the flow of the process, including the activities that need to be performed and the order in which they need to be performed. Moreover, Camunda uses the Decision Model and Notation (DMN) standard to model and automate decision-making processes. Decisions in the Learning Path Finder are modeled in DMN. The DMN

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[5] https://www.liferay.com/
[6] https://camunda.com/

requires user data, which is requested via the data wallet at runtime. Examples for the process description and decision table are provided in Figure 2.
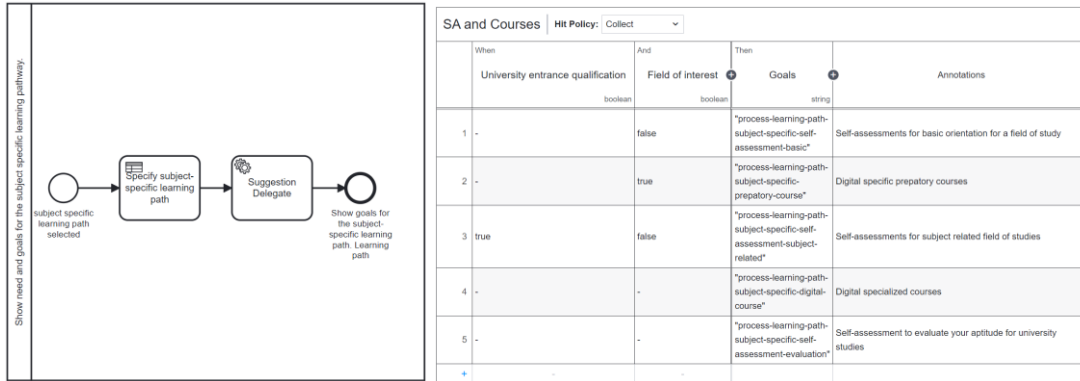

Figure 2: The Learning Path Finder connects educational offers with individual needs and preferences by process models (using BPMN, left) and decision tables (using DMN, right).

Privacy issues are highly relevant in such scenarios. We explicitly decided to not have a central storage of user data, but to give the user full sovereignty over his or her personal data. This is realized via a wallet in terms of an app on the mobile phone. Personal details, preferences and certificates of achievements acquired during the educational journey can be stored there. Connected educational services can request the wallet of the respective user for such data via the infrastructure. However, these must be explicitly released by the user before use. The only user data that is permanently stored in the central parts of that infrastructure is the account information, which connects users with their wallets. This connection is established during the first usage session (or later, if necessary, as soon as the user decides to do so). Figure 3 shows the reference to the wallet app in the user interface of the platform and the wallet app on the cell phone with selected user data.
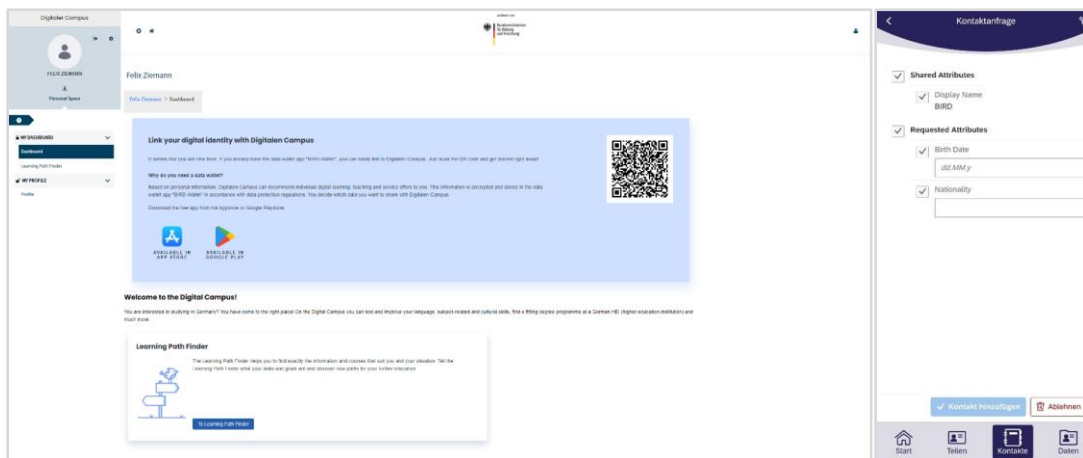

Figure 3: Personal data of the students is kept only in the data wallet on their mobile phone (right). This app is connected to the server application of the Learning Path Finder at the first start (left).

The described offering for the Ukrainian refugee students is just one example of how the developed Learning Path Finder can be used. Other use cases might be implemented in a similar manner. In any case, expert knowledge is required to model the respective processes and transitions and to connect with existing contents and tools. The evaluation described below is focused on the Ukrainian use case.

4 Evaluation and Field Test

Based on general considerations on the evaluation scenario and the hypotheses to be tested, we describe the methods we selected and the tools we used or developed for the evaluation, which is followed by description of the outcomes.

4.1 Scenario

As derived from the state of the art, we particularly consider aspects of sovereign handling of digital data in connection with usability and acceptance - in addition to functionality and performance of the system - for the evaluation. Our hypotheses for evaluating the Learning Path Finder are targeting the overall assumptions and objective for the design of educational technology and have been described as follows:

H1:   The disclosure of personal data by users correlates with their satisfaction with the recommendations of the Learning Path Finder (The more users are satisfied with the recommendations of the Learning Path Finder, the more willing they are to share their personal data).

H2:   There are pieces of personal information that tend to be entered or shared more or less frequently (perception of sensitivity of the data).

H3:   The satisfaction of the users with the recommendations of the Learning Path Finder and their evaluation of the user experience correlates with their duration and regularity of using the Learning Path Finder.

Moreover, there are specific hypotheses on the acceptance of the system in relation to social and cultural aspects:

H4:   The younger the participants and the more educated they are, the easier it is for them to understand the platform. Due to the fact that the participants are probably all younger and have a higher level of education, the differences tend to be small.

H5:   An origin outside Germany and a lower level of education have a positive effect on the perceived usefulness of the platform, as a greater number of offerings are tailored to these groups of people.

H6:   The statements on trustworthiness and quality of data each correlate with trust in the platform with regard to the personal data shared, as the resulting benefit is often decisive for sharing personal data.

The evaluation protocol aligns with the development process of the Learning Path Finder, from the availability of an early prototype in Q3/22 to the launch in Q2/23. We follow a well-established evaluation procedure containing three steps with increasingly larger and more practical target groups:

1.   project-internal tests with a focus on functional correctness (Q4/22)
2.   reviews by external experts with a focus on suitability and usability (Q1/23)
3.   field tests within in the target group with a focus on acceptance (Q2/23)

The former comprises classical methods from software engineering and testing and is therefore omitted here. The latter will start soon and is therefore not yet covered by this article, since we are still

waiting for official agreements to carry out the field tests. In the following, the focus is on the expert reviews and the findings derived from them.

The experts consulted for the evaluation are experienced advisors for prospective international students who come to Germany and want to enroll at a university. It was important that the special circumstances of Ukrainian refugees were not only known to the experts consulted, but also that they were already familiar with them in their consulting practice.

As for the later field tests, there will be differences regarding the personal background and the voluntary nature of participation in the future target group. These conditions are taken into account when analyzing and assessing the evaluation results from the expert reviews.

4.2   Methods and Tools

The collection of data follows some overall principles. For all persons that take part in one of our evaluation procedure steps, their participation should be

- voluntarily,
- as less time-consuming as possible and
- as less invasive as possible.

In this way, we encourage the willingness to participate and increase the response, while maintaining their data privacy.

 For Step 1, all members of the development team first performed project-internal tests. Then, five team members who had not previously been involved in its development worked with the system. They were recruited through a mailing list which is used for internal communication. A short guide was provided to support them in using the Learning Path Finder and to ensure that all relevant test cases were covered. We received feedback as short written reports of their experiences.

With regard to steps 2 and 3, the expert reviews and the field test, we integrated logging mechanisms into the system for a better understanding and traceability of the usage in relation to the feedback that we receive. In detail, timestamps and anonymized user-ids are linked to user actions while working with the Learning Path Finder. For step 2, the expert reviews, the participants worked with the Learning Path Finder for five days. Each of them received a questionnaire which was divided into following sections: "access & setup", "orientation & navigation", "functions", "offers", "usability" and "impressions and comments". The questionnaire contained the evaluation of statements as well as open text fields for the description of the individual experiences. Contact persons were available to support them during this time.

For the field tests in step 3, we will provide a standardized questionnaire to evaluate how the users perceived the use of the Learning Path Finder in combination with the data wallet. Herefore, we chose the UEQ+ a modular extension of the User Experience Questionnaire (UEQ) allowing to align it with our specific research scenario. Following the UEQ+ recommendations (Schrepp & Thomaschewski, 2020), we did a small study with seven participants (similar to step 1) to confirm six relevant aspects that should be part of our questionnaire. We provided them a detailed description of the Learning Path Finder and asked them to assess the relevance of the various aspects, that are contained by the UEQ+, for an evaluation of the user experience of the system. The following aspects were stated as most relevant for our specific evaluation scenario and therefore will be part of our questionnaire for the field tests: efficiency, perspicuity, usefulness, trustworthiness of content, quality of content and trust. Moreover, there will be further questions in the survey dedicated to the hypotheses given above.

4.3   Outcomes

From the expert evaluations, we received extensive qualitative feedback by 7 out of the nearly 10 persons involved. Their individual reviews were merged in case of similarities and categorized into (A)

feedback related to the Learning Path Finder and (B) feedback related to the data wallet. The former component is further differentiated into content regarding (A1) the user interface, (A2) functions and processes and (A3) offers and services. Table 1 shows an overview about the categories and the associated feedback. In the following, this feedback is explained in more detail.

Component	Category	Feedback
(A) Learning Path Finder	(A1) User Interface	Visual Aesthetics
		Simplicity and Understandability
		Inner Navigation
		Usefulness of Information
		Responsiveness
		Language
	(A2) Functions and Processes	Effort of the users
		Visibility of Features
		Performance
		Restriction of Access
	(A3) Offers and Services	Registration
		External Navigation
		Language
		Classification
(B) Data Wallet		Understandability
		Data Backup

Table 1: The feedback by the expert reviews was merged and categorized, sorted by frequency.

Most of the feedback addressed the user interface (A1) of the Learning Path Finder. Its main focus, a bundled provision of individually selected services and offers, was rated as highly useful. The orientation and preparation for educational offers is much more intuitive and efficient here than with common search engines, like Google. Moreover, the start page of the Learning Path Finder (see Figure 1) was rated as very positive because it provides a well-structured and easily understandable overview of the offers and services and where to find them. Nevertheless, according to the reviews we received, the general design of the user interface needs to be improved so that it corresponds more to other common platforms. In detail, the visual aesthetics and the inner navigation has been criticized by some of the experts. Besides, a few elements and texts were stated as not self-explanatory, depending on the experiences and language skills of the users. Therefore, users should be provided more offers of assistance for better accessibility. An improved user interface should also be responsive for an easier and more intuitive use of the Learning Path Finder on other (mobile) devices.

From installing the data wallet and registering for the Learning Path Finder to setting up the communication between them; with regard to inner functions and processes (A2), most of them already work correctly from a technical perspective. However, the current performance should be improved for a better user experience. Aside from that, the setup, namely the registration, installation of the data wallet and their synchronization, that are mandatory for using the Learning Path Finder, considering individual preferences and skills, were stated as a barrier for users. When they have to invest time and

effort right from the beginning without having seen the potential and experienced the benefits of the platform, it can cause a higher dismount of potential users.

The core of the Learning Path Finder is the amount of offers and services (A3) that are available for the users. The use of Single Sign-on as authentication method prevents users from registering for all offers and services separately. Unfortunately, an important provider is not yet involved in it. This was also mentioned by the experts and has to be adjusted soon. Moreover, language barriers, depending on the available languages of the provider's websites, as well as the navigation between the Learning Path Finder and the external websites of the providers was criticized. Currently, there is no intuitive way to return to the Learning Path Finder once the user has finished an activity on an external website. Finally, the allocation of some of the offers and services is not optimal yet and should be revised so that all of them are where the users expect them to be.

Last but not least, the overall design and structure of the data wallet (B) has to be more intuitive so that its functionality is easy to understand for all of the users and to reach a higher efficiency. This could be motivating for the users to use the data wallet and to benefit from its potential in combination with the Learning Path Finder.

From the log data collected, it is possible to automatically determine which paths and offers were selected by the users, how often, and how long individual sessions lasted. This will be particularly helpful for evaluating the later field tests. The language learning path was selected most frequently by the expert test users, apparently because its relevance for the target group of Ukrainian refugees was intuitively rated highly.

5 Discussion of the Results

The findings from the expert evaluation as presented above are helpful and indicate a successful use of the system also by the later target group. However, there are some limitations and fundamental challenges that shall be discussed here.

The qualitative feedback by the experts regarding the evaluated prototype revealed, above all, different expectations on the maturity of the resulting system. While the software engineers (with a background of a publicly funded research & development project) had the intention to provide a prototype with extensive functionality in a still simple layout that allows basic functional and performance testing, the experts (with a professional background in consultancy) expected a final product with a polished user interface that also covers all special cases of their consulting practice. For this reason, absolute error-freeness and comprehensive support were expected, although the expert tests were only intended to bring this about at this point. This is not a new finding for R&D projects, however, it once again confirms the importance of appropriate framing when conducting the tests. The feedback provided should also be seen under this light.

There are several aspects where the results from the expert reviews can be (at least partly) transferred to the later target group of Ukrainian refugee students. For example, additional help texts and explanatory videos, less text and more images as desired by the expert reviewers could also be helpful for the prospective students and other target groups. Also, the recommendation to use simple language and to contact available experts on German as a second language for such a translation is helpful, in general.

In other cases, no immediate statement on the later behavior of the users and their perception of the system can be derived from the expert feedback. For instance, they assumed that language barriers could be reduced for students by using the system in comparison to their own searches. Considering the broad availability of automated translators, this has to be further evaluated. Also, the expert reviewers recommended providing an orientation and advice service without data wallet functions and without the need for registration. However, this possibility already exists (but has apparently not been

recognized) and can of course then not make any suitable but only generally valid, superficial recommendations. Again, this is an aspect to be further investigated in the later field tests.

Overall, these findings are not surprising and could basically have been expected from such expert reviews. However, this confirms the need to perform such review procedures before going live, and to adapt the prototype accordingly.

6 Conclusion and Recommendations

In this article we presented an infrastructure to provide personalized recommendations for educational pathways of learners across the offers of single institutions or providers of content or tools. On the basis of a national infrastructure for digital education we described the special use case of supporting Ukrainian refugee students on their way into the German academic system, depending on previous knowledge and individual goals. In designing the system, we paid particular attention to protecting personal data and preserving user autonomy. These aspects are also reflected in our evaluation concept. Initial results from the expert review were presented and discussed critically, while the field test is still pending.

A key finding from the development and evaluation process is that expectations of involved parties regarding the maturity of the targeted solution need to be better aligned. This requires appropriate framing of the evaluations, targeted communication measures, an adequate allocation of resources and early involvement of expert reviewers in the design process (Bußler et al., 2021). Although this is not a new insight, but rather a direct consequence of agile development methods and participatory design, it is still rarely practiced. In addition to changes in the setup of projects, this may also require a readjustment in resource planning and funding logic.

A further desideratum of the work presented here is the continuing, if not growing, need for consolidation of existing standards in the areas of educational metadata and competence profiles (Roertgen et al., 2023). This is an indispensable basis for making existing educational offerings accessible across institutions on the one hand and for making individual recommendations with regards to these offerings on the other.

Acknowledgements

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