SUPPORTING LEARNING COMMUNITIES VIA WEB SERVICE TECHNOLOGIES: NAVIGATING KNOWLEDGE TRANSFER BETWEEN INFRASTRUCTURAL SERVICES AND USER NEEDS

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ABSTRACT

Drawing on research syntheses from the meta project Digi-EBF as well as the German Education Server, this contribution discusses how web products and services offered by the Information Center for Education at DIPF | Leibniz Institute for Research and Information in Education address and support educational communities. In the area of research syntheses, important factors for success are a methodologically systematic and transparent procedure and an easy open access as well as a monitoring of formats by science communication. The German Education Server meets its transfer task by orientation towards dimensions of information quality, adhering to user's needs and evaluating its effectivity via different assessment and measurement methods.

KEYWORDS

Digitization, Research Synthesis, German Education Server, Web Service Technologies, Infrastructures in Education, Open Access

1. INTRODUCTION

In education, information infrastructures and web services pursue the task of providing learning communities with target-oriented and internet-based information. The challenge for providers of such services is to combine technology, content, and communication in such a way that the targeted educational communities are reached. To ensure information uptake, research in education and information science emphasizes the need for an effective connection of methodologically and qualitatively processed knowledge resources from education focussing on the communities' objectives and a user-oriented exhaustion of technological possibilities (for the necessary link of technical with pedagogical aspects in digital education, see Kerres 2020).

In our contribution, we explore how such a process of knowledge transfer based on web-infrastructure which addresses different educational communities can be organized. We will investigate spheres of action and possible barriers to knowledge transfer. How can educational communities be addressed via web services? What conditions need to be fulfilled for a successful impact of the processed information? These questions will be pursued given two concrete examples from the field of digital education. We firstly investigate research syntheses from the project "Digitizing in education" (Digitalisierung im Bildungsbereich, Digi-EBF). In this project, 20 critical reviews are compiled over a period of five years on aspects of digital education. Secondly we will investigate the German Education Server's transfer strategy, which is based on the interaction of educational communities' needs, quality demands on information systems, and impact measurement. The German Education Server is one of the most comprehensive and most frequented portals focusing on education in Germany, it addresses all aspects of education.

Both the review project and the Education Server are located at the Information Center for Education-(IZB) at DIPF | Leibniz Institute for Research and Information in Education, which defines itself as a central contact point in Germany for research and information infrastructures in education science and practice. Additionally, the Information Center prioritizes on making literature information accessible via the Education Research Portal. It supports assessment, processing and archiving of research data (Research Data Centre for Education). All infrastructural services at the IZB are accompanied by transfer activities and further developed according to customer needs.

2. ACCESS AND DISSSEMINATION OF SYSTEMATIC RESEARCH SYNTHESES

2.1 Enhancing the Knowledge Basis on Digitization in Education

The presented reviews are part of the meta-project on digitizing in education, which monitors research projects in a funding line established by the Federal Ministry of Education and Research. This project covers the areas of education in childhood, youth and family, education at school, vocational education, teacher education as well as adult and continuing education. The respective reviews accordingly focus on the outlined sectors and are part of a book series on research perspectives in the field. The co-operation project assesses the state of research on matters of digital education over a period of several years. Moreover, contemporary research knowledge on specific aspects and sector-specific questions regarding digital education is structured and synthesized in critical reviews (cf. Booth et al. 2016, Petticrew & Roberts 2006).

In the presented case, a decentralized organization structure was set up where the literature search, information management and coordination of the overall process constitutes an overarching framework at DIPF, whilst the screening, analysis and processing of the reviews takes place for the education sectors that are defined by expertise from different institutes (University Duisburg-Essen, German Institute for Adult Education - Leibniz Centre for Lifelong Learning and Leibniz Institute for Knowledge Media). With regard to the research question, the team of 13 people agreed on four central topics (1 role of pedagogical staff, 2 organizational development, 3 teaching and learning with digital technologies and 4 role of digital technologies for social learning and participation). In a next step sector-specific delineations were determined. For example, for the third volume of the series (reviews 11-15) which focusses on the topic of teaching and learning the educational sectors identified specific aspects such as the implementation of digitalization in curricula design, school internships of teachers, or usage of digital technology by children and young people.

The team developed a common research strategy for the selection of relevant databases (e.g. German Education Index at the German Education Research Portal and ERIC), as well as the period covered, languages of publication (German and English) and handling and storage of researched data. In a second step, the research was adapted for the sectors involved and further specified. Following the same logic, the team of researchers agreed on a comparatively open overarching coding procedure for organizing and analyzing the literature. This still enabled further differentiations and exclusions for the particular sectors. So far, three volumes have been completed as part of the series on the state of research in digital education, "Digitalisierung in der Bildung. Forschungsstand und -perspektiven" (Wilmers et al. 2020; Wilmers et al. 2021 and Wilmers et al. 2022).

2.2 Accessing Review Results

By publishing the reviews, the review team pursues the objective of facilitating a broad but also targeted access to information while considering different user groups and their needs. Access to the reviews is in particular determined by open access for the entire volume as well as the individual chapters. Because the latter are organized by education sectors, especially practitioners and administrators will find it easy to access the information they think is relevant. Other individuals can access the volumes in total. The volumes also each contain a method chapter for a more in depth and transparent inspection of the review method without the individual reviews having to draw on all methodological aspects.

Table 1. Access to review findings and target groups

	Products and Access	Examples from volume 2
Level 1	Book Series: Research perspectives in the field of digitization in education (vol. 1-4) Open access book publication *Target group: Researchers*	Education in the digital world: Organizational development in educational institutions
Level 2	**Individual chapters** **Open access publication**	
Level 2a	Chapter 1: Methodology *Target Group: Researchers and review specialists*	• Reviews of Organizational Development in Educational Institutions. Methods and Discussion of Bias in Review Processes in Educational Research
Level 2b	Chapter 2-6 Critical Reviews *Target group: Researchers, practitioners, policy-makers* • Chapter 2: Education in childhood, youth and family • Chapter 3: School education • Chapter 4: Teacher education • Chapter 5: Vocational education • Chapter 6 Adult and continuing education	• The implementation of digitization in non-formal educational organisations • School Development in a Digital World: Strategies, Frameworks and Implications for School Development • Implementing Technology Infusion in Teacher Education Programs: A Critical Review • Digitally supported cooperation of organisations in vocational education and training • On the relevance of digital transformation for organizational management in adult and continuing education
Level 3	Data storage in the Research Data Centre Education, DIPF Open access archive *Target group: Review experts and researchers in the field of digitization in education*	DOI https://dx.doi.org/10.7477/414:2:0
Level 4	Dissemination products in form of texts, podcasts, via social media, presentations and events Open access products or public events *Target group: Practitioners (especially pedagogical staff from all education sectors), administrators and decision-makers, associations in the field*	• Contributions to the DBS podcast series "education for your ears" ("Bildung auf die Ohren") • Information via social media • Blog posts and interviews • Provision of information on platforms such as e-teaching.org • Workshop for professionals of adult education centres • Events for researchers and practitioners: Dialogue forum

Contents of the reviews are furthermore disseminated particularly regarding findings from individual sectors. There are many means of dissemination that can be applied in parallel and in any case they afford a translation of important findings into easily readable formats. Such formats are, for example, brochures, policy briefs or short articles or blog entries, podcasts and interviews as well as event formats with presentations or workshops for practitioners (cf. examples from Table 1 and Waffner 2020). Such processing of research findings is highly time-consuming – particularly because usually several formats are offered simultaneously – and optimally the authors of reviews receive journalistic and technical support from their respective institutions.

Table 1 shows different target-specific means of access and points of entry for the contents of reviews. Diverse interfaces thus emerge for knowledge transfer. Level 1 and 2 allowing access to reviews and method chapters, while level 3 implies access to the searched literature via long-term archiving and level 4 contains additional products that transfer findings to practice and politics.

2.3 Chances and Challenges of Addressing Specific Learning Communities via Technical Services

Provision of a maximum number of means of access alone does not as such guarantee that these are used by the communities as table 1 visualizes for several areas – although digitization undoubtedly accelerated science communication (Moll & Schütz 2022, p. 14). As a starting point for a reflection of how learning communities can be reached via web service technologies, we can look at download figures for the first volume on digitization in education (reviews 1-5). The entire first volume was downloaded 7452 times from early October 2020 to early March 2022 via the highly visible access point of the Waxmann publishing house and PeDOCS (at DIPF). PeDOCS is the largest German open access repository for literature from the field of education. Individual reviews (not counting the method chapter) were downloaded between 1046 and 2714 times. Added to this, there is a non-measurable open access spread via dissemination and publishing of the texts on diverse websites and platforms. The high number of downloads confirms the appropriacy of the chosen format and we can guess that besides scientists at least professional institutions and associations have become aware of the reviews. This is also confirmed by random sample tests.

The project team also worked with more flexible formats of science transfer such as blog contributions and podcasts where the impact can also be measured via download. For example, the first five reviews were accompanied by five podcasts published between 14 October and 2 December 2021 – as of March 2022, there were on average 200 downloads via the German Education Server and the streaming service Spotify. By far the highest number of downloads occurred via the German Education Server while Spotify downloads accounted for 8 to 20% – these figures demonstrate that it is essential to embed the offer into an educationally-specific environment. A further dissemination via more general channels such as Spotify can, however, generate an additional audience. Reviews provide a systematic and transparent way of gaining insights and they are an important step in supporting additional target groups with information that can be generated in different intensities before, during and after a review process. In any case, lots of resources are needed to accomplish this purpose. Literature on transfer concepts places a growing emphasis on the communication process as a precondition for successful knowledge transfer (Leibniz-Gemeinschaft 2019), while – at the same time – the possible effects of research become more difficult to monitor in such iterative and communicative processes as Thiel and Rott (2022) point out. In this ongoing discussion on ways of providing evicence-informed knowledge, reviews have gained significance because they are associated with a function of supporting evidence-based decision-making. Schrader accordingly describes systematic reviews as "building blocks for evidence construction" (2014, 207 pp., cf. Heinrich 2018, 325 pp.) and Beelmann mostly sees research reviews as beneficial with respect to "low-threshold provision of state of art summaries of research" (2014, 59). The main focus is therefore on the provision of trustworthy knowledge implying various possibilities to use this knowledge in different ways (for a discussion on the importance of trustfulness in knowledge transfer see Mohajerzad & Specht 2022).

To achieve the goal of transferring review findings and make them available in different forms on a permanent basis different approaches seem to be relevant which have short-term, mid-term and long-term effects. Open access and online databases and platforms such as the German Education Server function as crucial interfaces because they guarantee immediate and sustainable access to knowledge while also offering additional points of contact for specific target groups.

3. PROCESSES OF WEBBASED KNOWLEDGE TRANSFER IN EDUCATION: STRATEGIES OF THE GERMAN EDUCATION SERVER

3.1 Evaluating the German Education Server's Transfer Strategies

The German Education Server is an online information system for the field of education which in 1996 was launched as a project funded by the German ministry of education and research (BMBF). In 1999, it was institutionalized at DIPF. The German Education Server addresses very diverse educational communities including all professions in education and the public at large (Kühnlenz et al. 2012). To reach its broad audience, the German education server employs various transfer strategies using different methods and frameworks. In the following these strategies are examined in detail. First, a content analysis supported by research literature is carried out to identify the services of the German Education Server as well as the user needs they can satisfy. To illustrate this interplay, functionalities are demonstrated for digital education whose relevance has been even stressed further in the light of the Covid-19 pandemic. Secondly, the extent to which the German Education Server as an information system adheres to information quality guidelines is investigated. For this purpose, the 15 IQ-dimensions of Rohweder et al. (2021) are employed, which are derived form a survey of IT-users and include principles such as accessibility, the appropriate amount of data, believability or concise representation. The consideration of these essential factors contributes to the underlying principle of information quality stating that the value of information depends on its usefulness for the user (Rittberger 2009, 3). At last, service usage is analysed via web analytics to measure the impact and outcome of the services building again the bridge back to the needs of educational communities.

3.2 Services of the Education Server and their Adherence to Standards of Information Quality

The German education server was established with the aim to meet two primary needs of educational communities: First and foremost, the metaserver is responsible for gathering information about education that is spread across the internet and making it accessible via one location (Kühnlenz et al. 2012). This service thus reacts upon the federal structure of education in Germany: Decisions on the final structure and organization of education are subject to 16 federal states. Each state has the constitutionally guaranteed right to devise its own education programs, which then are disseminated through different services of the respective states. The German Education Server makes information about these diverse programs and structures available in one place, thus supporting synoptic access to information sources relevant to educational policy. Second, the German Education Server meets the challenge the internet posed for users at that time and still does to a certain point today: finding their feet in the world wide web of information with its heterogeneous quality. The information system was hence initiated to provide quality-checked, curated collections of web resources on education. Meanwhile, providing the user with quality vetted information in one location is only one aspect of reaching the intended audience.

The principal asset of information portals like the German Education Server can be described as "transformation of knowledge into information" (Kuhlen 1989). In this process of informatizing, knowledge is processed for specific target groups and made transportable and codable (ibid.). This 'information work' has produced more than 65,000 indexed sources that have been catalogued according to standardized measure and can be easily searched. In regard to dimensions of information quality, the German Education Server aims for a large but manageable amount of data to compete with general search engines like Google while also providing orientation. The topic of "digital education", for example, has been indexed in more than 1,500 internet resources while a search in the Google-engine results in 105 Mio pages.

The indexed sources are fundamental elements to a central processing format called 'dossiers' which follow the principles of concise representation. Based on the collected resources, the dossiers consist of processed and catalogued information spanning the entire education system. While at the beginning the Education Server uniquely focused on the school sector (Kühnlenz 2006, o. A.) the thematic scope has systematically been expanded over the past 20 years, now meeting the quality criterion of comprehensive coverage. Digital

education is treated as a cross-section topic with dossiers covering all education sectors (https://www.bildungsserver.de/bildung-in-der-digitalen-welt-12679-de.html) as well as dossiers focussing on special aspects of the topic, e.g. digital education and the inclusion of special needs students (https://www.bildungsserver.de/inklusion-und-digitale-bildung-behinderter-12816-de.html.

The German Education Server also includes formats of science communication adherent to the principle of understandability as one dimension of information quality. Blog posts and podcasts are offered on topics such as research findings, civil society involvement, and helpful resources for educational practice. A podcast series on digital education was presented focusing on aspects such as teacher education and the implementation of digital tools (http://blog.bildungsserver.de/category/podcasts/bildung-im-digitalen-wandel). A blog series on artificial intelligence hosts interviews on learning analytics, virtual reality and reading apps (https://blog.bildungsserver.de/category/themen/kuenstliche-intelligenz-bildung/). These low-threshold formats are aimed at transferring knowledge from research into other domains.

In the context of digital education, the German Education Server places an emphasis on Open Educational Resources (OER), and three web services are offered in this regard. The information service Open Educational Resources (www.o-e-r.de) presents topical collections of online-resources. The OER-blog introduces stakeholders and initiatives in the field of Open Education. The search engine ELIXIER enables educators to search for freely accessible instructional material for school practices (https://www.bildungsserver.de/elixier/).

Closely connected with the principle of openness is another strategy of the German Education Server: integration of users into the transfer and information processes. The social tagging system Edutags represents both notions: It allows users to collect and share information and enables searches for open-licenced material (https://www.edutags.de/). The German Education Server thus introduces a reciprocal process by feeding back knowledge from the target groups into the system, which can then support the education community.

3.3 Transfer Outcome and Impact: Measuring the Use of the German Education Server

By offering such a diverse web service and web resources, the German Education Server addresses educational researchers as well as practitioners, policy-makers and administrators in the educational field. Furthermore, it also targets general groups such as parents or media representatives. However, this does not automatically imply that the addressees will use what is being offered. Various methods are applied to check whether the German Education server meets the requirements of a web service, that is fit for use and relevant to information consumers (Rittberger 2009, 3). One option to measure the effectiveness of web services is to conduct user surveys. These can be implemented to ascertain user intents and satisfaction with quality. According to earlier studies, one reason for accessing the German Education Server is the concrete research of specific information and addressing a relevant information need (Breiter et al. 2011, 52; Griesbaum 2014, 22).

The frequency of use of the German Education Server can also be an indicator of its coverage of the need for well-sorted collections focusing on education in Germany. In 2021, the German Education Server and its connecting portals recorded nearly 6,000,000 visits. Compared to the year before an increase of more than 50% is evident. One reason for this rise might be an increased need for quality information in the second year of the pandemic, especially regarding digital education and respective materials on homeschooling and state directives. Further analyses of user behaviour confirm this assumption. In 2021, more than 25% of new users were recorded in 2021 for the portal. The dossier on digital learning at home, for example, was visited 69,000 times in 2021 and the dossier for online continuing training during the Covid pandemic was visited more than 100,000 times. In comparison to 2019, the period before Corona and remote teaching, the most popular sites on digital learning, i.e. "online texts for children" and "media competence" were far from as popular: they were viewed 14,000 times respectively 10,000 times.

One relevant criterion for information quality from a service perspective concerns the relevance, i.e. whether users find information to serving what they are looking for. A comparison of search terms and clicking behaviour is a helpful measuring method here. Looking at a recent dossier "The war in Ukraine Worksheets and Other Material", we can see that 53 % of the 13.118 page views within four weeks were generated via search engine queries on terms such as "worksheet war in Ukraine", or "teaching conflict in Ukraine" or "war in Ukraine". Therefore, a web analysis reveals first trends regarding an achievement of usage objectives. These can be validated by further user studies such as true intent studies.

Table 2 summarizes the findings of the German Education Server's analysis, from which the transfer strategy can be derived. It illustrates that this strategy is based on a combination of web-based technologies and high-quality information, which ensures that the service is both fit for use and useful. Web analytics, among other tools, can be used to assess the strategy's success. To that end, the web system's goals must be translated into indicators that can be used to track progress toward those goals (Alby 2019, 25f.). Column four lists the metrics and methods for outcome measurement employed by the German Educational Server. Furthermore, user research methods such as surveys are supplemented to validate how well the system serves the users' intent.

Table 2. Elements of the transfer strategy of the German Education Server

Use for Educational Community	Education Server Web service	Information quality dimensions	Outcome measurement
finding information that is distributed across the web in one place	65.0000 sources can be searched	appropriate amount of data consistent representation	web analysis (frequency of usage)
being able to rely on sources being of high quality and relevance	sources are edited and indexed	believability free of error objectivity	survey (estimation and attitude regarding the system)
finding sources regarding the education topic that is relevant for the user	coverage of the entire scope of education coverage of cross-sectional topics with special portals	completeness	web analysis (frequency of usage by topic) survey (study of true intent)
finding relevant web resources on an educational topic	thematic dossiers	concise representation relevancy	web analysis (comparison of search terms and page views)
finding relevant web resources on a cutting-edge topic	current dossiers	timeliness relevancy	web analysis (frequency of usage of dossiers in a period following publication of the dossier)
finding understandable information on developments in education and educational research	science communication activities (blogs, podcasts)	understandability relevancy	web analysis (time spent per page in relation to calculated reading and listening time)
finding quality-checked teaching material	Education search engine ELIXIER Information service Open Educational Resources	accessibility relevancy believability	web analysis (clickstream analysis)
users collect relevant online resources	social bookmarking system Edutags	completeness	web analysis (number of collected tags)

However, the measurement of the transfer outcome on the level of the target group, step four in the transfer process as defined by Henke et al. (2016), are limited from the information system's perspective. Usage metrics hardly reveal in how far sources found via the German Education Server are then also put to further use. Even surveys conducted immediately after the use of an information system only provide information about intentions and assessments, not actual user behavior. The next level of transfer, the impact on society, is even more difficult to quantify because changes on the societal level never have a single cause (Henke et al. 2016, Kurz et al. 2021, Diehl et al. 2021). Nevertheless, the figures of usage indicate that the underlying transfer strategy is leveraging some results and, at the very least, reaching various educational communities, such as the school sector.

4. CONCLUSION

For the two examples of research syntheses within the BMBF-funded project Digi-EBF and German Education Server, we have shown how different educational communities are addressed by web services provided by the Information Center for Education at DIPF. In this context it seems essential to consider that knowledge transfer via web technologies does not equate a reduction of knowledge but can imply an enrichment of knowledge as knowledge transfer always serves both ends (Moll & Schütz 2022). Also, the mere provision of knowledge does not necessarily lead to its use - knowledge transfer and use is a very complex construct involving researchers and users to the same degree. This dialogue is not resolved by research synthesis or its by-products alone, but both can serve different learning communities by serving for further knowledge transfer. In the field of review production, important success factors concern a consistent and transparent method, as well as a selection of relevant topics and clear review questions, easy open access and monitoring of findings by means of science communication formats. The German Education Server incorporates and combines knowledge transfer strategies from various disciplines in order to reach the targeted educational communities. Information science frameworks guarantee that the German Education Server as a web system meets its transfer task. Its primary function, the transformation of knowledge into information, adheres to the standards for high-quality information, which also serve as prerequisites for the successful transmission of knowledge. Additionally, to reach a large audience, knowledge communication methods like online dossiers, blog entries, and podcast episodes are offered. The transfer method is expanded into a reciprocal process with additional services and features that allow users to actively contribute to the German Education Server's catalogue of resources. The education server routinely assesses its services using web analysis techniques and other user research techniques in order to ascertain outcomes and impact and, if necessary, modify the services provided.

The potential of these different means of transfer can be put to use for educational practice and research in different ways. The web services at the Information Center for Education most of all aim to inspire an adaptation and integration of knowledge into different contexts. Effects of this transferred and adapted knowledge are relevant for transfer research in educational contexts. Reverse as well as continual flows might be further analyzed, for example via user surveys or project monitoring. Research syntheses as well as the German Education Server can draw on a expertise from education science, information science and computer science expertise to initiate such a transfer circle that gears knowledge from science to practice and from practice to science.

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