Information Behavior of Researchers, Digital Information Environment and Design of Digital Information Services

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# Introduction

Information behavior of researchers has always attracted the attention of researchers in information science. In human information behavior studies we can find many models of information behavior of scholars. However; we still focus on contexts of information behavior of scholars in various contexts, trying to find new patterns and information needs of researchers in digital environment. In this context, the aim of this paper is to contribute to understanding of information behavior of researchers. We report on a qualitative study of information behavior of researchers in Slovakia in the digital information environment. Results are set into the context of a larger study focused on attitudes of researchers to digital publishing and open science. The background theoretical frameworks are based on the analyzed models of information behavior of researchers, models of open science and digital science and information environment. Information ecology of the academic information environment is also considered. We discuss the Implications for digital information environment, and present our models of academic information ecologies and design of digital services of academic libraries.

**Theoretical framework & Research questions**

The concept of human information behavior is referred to ways of how people need, manage, seek and use information (Fisher, Erdelez and McKechnie, 2005). Ford (2015) explained the concept of human information behavior as perceiving information-related need, assessing the suitability of information, using characteristics of information (nature, medium, source, mode, circumstances of discovery). Related concepts of information practices and information interactions are determined by Savolainen (2008) and Fidel (2012). They describe information activities as socially and culturally established ways of identification, seeking, using and sharing information. Main information practices of researchers include searching, collecting, reading, writing, collaborating, monitoring, notetaking, translating and data practices. Case and Given (2016) explain that information behavior includes information seeking, but also unintentional and passive behavior. Based on this we regard human information behavior as an integrated multilevel human activities focused on information use and adaptations to the information environment.

Models of information behavior of researchers identified such information activities as starting, chaining, browsing, differentiating, monitoring, extracting, verifying, ending (Ellis 2005) with many cognitive and social factors (Foster 2004). In digital environment we can recognize remote scientific collaboration and attitudes of researchers to social networks (Greifeneder et al. 2018). Disciplinary studies found deep differences in information use patterns among scholarly disciplines (e.g. Brown 2010, Tenopir et al. 2015, Given and Willson 2015). These patterns are connected with the concepts of digital scholarship and big data in science (Borgman 2015, MacKenzie and Martin, 2016, Steinerová 2018).

Folllowing these and other similar studies we ask these research questions: Which factors shape the information behavior of researchers in digital information environment? What are their attitudes to open science and digital publishing?

**Methodology**

Our qualitative study of information behavior of researchers was part of a broader project on modelling the digital information environment. We developed a design of the study based on a conceptual structure composed of the research process, the information process, information infrastructure and factors of influence. We conducted a series of semi-structured interviews with selected 19 researchers from sciences, social sciences, humanities and computer science. The data was acquired in 2015-2016 and we used 25 questions for interviews. Our participants were composed of 13 males and 6 females, the average age was 54,4 years and expert experience 30 years. The disciplines included humanities (39%), sciences and medicine (28%), social science (22%) and computer science (11%). We coded and categorized the data with the use of the qualitative data analyses. We applied open coding and selective coding (Pickard, 2013) and iterated semantic analyses by different researchers. The representation of the content analyses was visualized by an original method of concept mapping (Steinerová 2018a). In conclusion, we represented the discourse of researchers by 23 concept maps.

**Research Results & Discussion**

Results of the analyses confirmed common patterns and disciplinary differences in information infrastructures of 19 selected researchers. Disciplinary differences are based on domain-specific research objects, methodologies, procedures and research data. Information behavior of researchers in the digital environment is shaped by such factors as the use of electronic sources, web systems and digital library services. Research data are embedded in the research process; the typical information behavior is monitoring of established journals, use of digital repositories and university networks (e.g.arXiv.org., PubMedCentral).

As for the attitudes to open science, we found that the discourse of researchers was both supportive and critical. Researchers considered advantages of open access (increase of citations, speed of publishing). They expressed their concerns regarding commercial influences and evaluation of digital publications. We found strong technological determination of sciences and “big data” sciences (e.g. physics, astrophysics, archaeology) and tendency towards building digital libraries in humanities (e.g. archival memory system, atlas of Slavic languages, Maya culture digital collections).

The discourse regarding publishing reflected the three modes of publishing in the selected groups of disciplines (sciences, social sciences and humanities, technical sciences). Researchers accepted publishing in registered sources of WoS, supported digital publishing, but expressed their concerns with regard to the evaluation of outputs, new types of digital publications and especially relations between quality, speed and quantity of digital publishing. The details are described in concept maps. Researchers perceived especially barriers of administrative overload, lack of funding and access to information infrastructure. Common strategies for research agencies, universities and information institutions were required with regard to open science.

**Implications for design of digital information services and information products**

Our findings pointed to information needs of scholars connected with building information infrastructures which include information sources, libraries, information institutions, information services and information products, but also information policies. As a result we proposed a new model of digital services of academic libraries as part of information infrastructure for researchers. It includes special pathways in access to information sources, collaboration in digital spaces, research results publicity and building research communities. As for the services, especially value-added services supporting information analyses, visualization of data and information and support of digital publishing are proposed. Social values of information should be included into the design of digital services, including ethical dimensions of digital information (Steinerová 2019).

**Conclusions**

Our study pointed to common information behavior activities of researchers which were included into an ecological model of research information interactions. We identified main disciplinary difference, based on problem statements, methods, data, publications, information strategies, contexts, collaboration (Steinerová 2018). Following our findings, we can derive information needs of researchers and propose design of digital information services. We recommend integration of sources and services, research data management and support of digital publishing and digital literacy. These recommendations are integrated with building of online repositories and research evaluation systems. We also propose design of value-added and innovative services of academic libraries in digital environment focused on stronger publicity of research results and relations of researchers and librarians with public. The factors of open science are transparency, open access, participation, digital resources and tools. Following strategies of open science, we developed a new model of academic libraries based on interactivity, support of information analyses, and digital publishing. An interactive space for support of innovative research teams and academic communities should represent a new digital information environment for researchers of the future. Value-added services of social networking, project management, interdisciplinary collaboration, digital publishing, research data management, but also digital ethics and digital literacy can be the component of the ecological re-design of the digital interactive information services for researchers.

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