Thematic Article

Presence of Open Science Skills in Learning Outcomes at the Lis Study Programs in Croatia

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Recommended citation:

Džoić, Z., & Grzunov, L. (2022). Presence of Open Science Skills in Learning Outcomes at the Lis Study Programs in Croatia. *Central European Journal of Educational Research, 4*(2), 8–17. https://doi.org/10.37441/cejer/2022/4/2/11390

Abstract

Open science is an ever-evolving phenomenon. Open science deals with the availability of data and publications, which includes an open approach with which publicly funded research is sought to be made available to all members of society and the public. It is an umbrella term that includes a multitude of assumptions about the future of knowledge creation and dissemination (Fecher & Friesike, 2014). The Organization for Economic Co-operation and Development (OECD) emphasizes libraries as a key player and fundamental drivers of open science because they have adapted their role to today's age and are now active in preserving, publishing, and disseminating digital scientific material in the form of publications, data, and other research-relate content. During their studies, LIS (Library and information science(s)) students acquire knowledge and develop a set of skills that will prepare them for work in today's information environment. In 2020. LIBER's (Ligue des Bibliothèques Européennes de Recherche – Association of European Research Libraries) Digital Skills for Library Staff and Researchers Working Group published a visual presentation of the necessary competencies for librarians and researchers. Information science studies, including those in Croatia, are exposed to constant changes in the field, including the development of open science. For this reason, it is necessary to constantly think about the adaptation of study programs through which students will acquire basic knowledge related to the promotion and advocacy of open science. The term "open science", and everything it encompasses, should be an integral part of study programs in the field of information sciences. The aim of this paper is to explore the representation of skills and competencies for open science in study programs at the LIS studies in Croatia: Department of Information and Communication Sciences (Zagreb), Department of information sciences (Osijek) and Department of information science (Zadar). This research indicated the need for greater inclusion of the concepts of scientific communication and open science in the learning outcomes at the level of programs in the study of information sciences in Zadar, Zagreb, and Osijek.

Keywords: open science, LIS study program, open science skills, LIS studies, Croatia

Introduction

The development of science and society would not be possible without communication among researchers. Scholarly communication initially took place in informal conversations and through letters. With the development of scientific journals, the internet, and rapid increase in scientific production, scholarly communication fell into the hands of commercial publishers. The term "open science" began to be mentioned at the end of the 16th and the beginning of the 17th century, when the secrecy of scientific research was increasingly striving to be overcome (Frančula, 2016). Open science deals with the issue of availability of data and publications, which includes an open approach with which publicly funded research seeks to make available to all members of society and the general public. Through open science, the public is given the opportunity to get acquainted with all the procedures within research processes. Potentially, all elements of a research project can become available

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to the public – project proposal, funding, raw data, experimental procedures, statistical procedures, course of discussion, and, finally, published papers (Frančula, 2016). A feature of modern science as we know it today is precisely in its public character, collaborative research, and free sharing of knowledge (David, 2007). Scientists who support the openness of data in science believe that the entire scientific community and the general public benefit from it. However, although open science is widely supported in theory, Pontika et al. (2015) point out that the term is still unclear to many and that it may not be obvious to various research stakeholders (funders, policy makers, librarians, and researcher) how open science is achieved at all. Open science is an ever-evolving phenomenon. The field of open science includes open access to publications, open research data, open cooperation, open educational resources, and civic science (Bueno de la Fuente, n.d.). Four subjects participate in the processes of scholarly communication: (1) a scientist as a producer of scientific information, (2) a publisher and (3) librarian as transmitters of scientific information, and (4) a scientist as a user of scientific information. (Hebrang Grgić, 2004).

Libraries have always played a major role in the process of scientific communication. By developing the concept of open science, librarians need to develop new skills to support and ensure the development and management of open science processes. Many scholars are not sufficiently familiar with institutional repositories, fair data guidelines, new ways of communicating and collaborating (citizen science), copyrights and contracts with publishers, while librarians have a role in educating about all of the above. Due to open science and the new concept of scholarly communication, LIS studies should implement knowledge and skills into their study programs so that librarians can actively participate in the processes of scientific communication.

LIBER's working group on Digital Skills for Library Staff and Researchers in 2020 made a list of discipline-specific skills and knowledge needed to practice open science (OS). The result of their work is a 'starter's guide' for open science-oriented library services and LIS study programs (LIBER, 2020) LIBER's open science skills are divided into five groups: scholarly publishing, research integrity, citizen science, FAIR data, metrics, and rewards. Each of the main skills groups contains a subset of skills and knowledge on how to create digital content, information and data literacy skills, and knowledge and skills about communication and collaboration among scholarly communities and with the public.

Scholarly publishing includes skills for management and use of institutional repositories, new open publication strategies (i.e., contracts, relations with publishers, new funding models), OA University Presses and skills on how to negotiate with publishers for OA (pay to read/pay to publish, persistent identifiers – ORCID, ISNI, URN, ISBN). This category also includes knowledge of open publication options (green, gold, hybrid) and knowledge of existing repositories (article, data, disciplinary, generic). Information and data literacy is the last subcategory of scholarly publishing and it involves development and management of current research information systems, while safety refers to open science governance, policy, and licensing in the digital environment (McCaffrey et al., 2020).

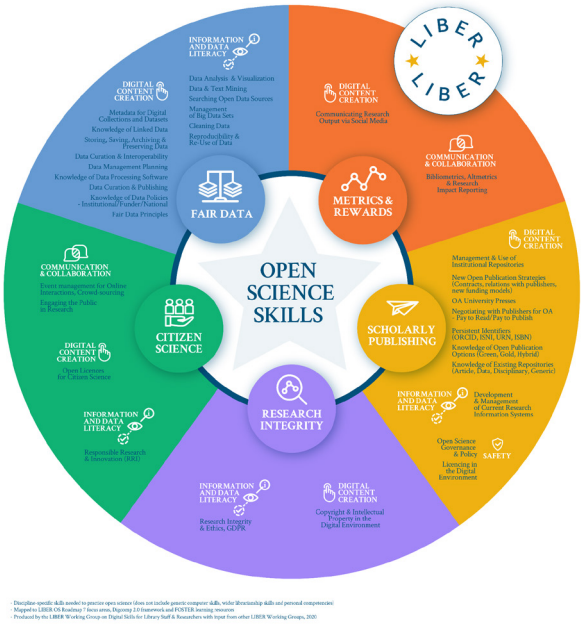
Research integrity as the main category includes subcategory information and data literacy and digital content creation. For the purposes of this category, information and data literacy is focused on ethics and GDPR, and subcategory digital content creation is focused on copyright and intellectual property in the digital environment.

Citizen science includes event management for online interactions and crowd-sourcing, engaging the public in research, open licences for citizen science, and responsible research and innovation (RRI).

FAIR data includes skills about metadata for digital collections and datasets, knowledge of linked data, how to store, save, archive, and preserve data, data curation and interoperability, data management planning, knowledge of data processing softwares, data curation and publishing, knowledge of data policies – institutional/funder/national and FAIR data principles. It also includes skills about data analysis and visualization, data and text mining, searching open data sources, management of big data sets, cleaning data, reproducibility, and re-using data (McCaffrey et al., 2020).

Metrics and rewards imply communicating research output via social media and bibliometrics, altmetrics, and research impact reporting (McCaffrey et al., 2020).

Figure 1. LIBER's visual presentation of the necessary competencies for librarians and researchers



Research

The theoretical assumptions of the paper, which briefly indicated the importance of scientific communication and open science in the LIS field, served as the basis for setting up this research.

The aim of research

The aim of this paper is to explore the representation of skills and competencies for open science in learning outcomes in undergraduate and graduate study programs at the LIS studies in Croatia: Department of Information and Communication Sciences (Faculty of Humanities and Social Sciences (FHSS), University of Zagreb), Department of Information Sciences (Faculty of Humanities and Social Sciences (FHSS), Josip Juraj Strossmayer University of Osijek), and Department of Information Sciences (University of Zadar).

Research questions

The following research questions were asked in the paper:

- Do the learning outcomes at the level of the undergraduate and graduate program of the Department of Information Sciences in Croatia include knowledge and skills related to the phenomenon of open science?
- Are open science skills included in the content of courses at the Departments of Information Sciences in Croatia?
- Are there differences in the representation of skills in undergraduate and graduate studies?
- Which skills are underrepresented?

Methodology

The method used for the purposes of this research is content analysis. The qualitative content analysis is category-based. Categories refer to aspects within the text, which put the meaning of those aspects in a nutshell. Text evaluation is therefore restricted to the selected category system (Mayaring, 2019).

The content analysis will identify which open science skills, which every LIS professional should possess today, are included in the learning outcomes at the program-level of the Department of Information Sciences in Zagreb (ZG), Zadar (ZD) and Osijek (OS).

For the purposes of conducting content analysis, the following are first defined:

- Sources of content – web pages of the Department of Information Sciences in Zagreb, Zadar, and Osijek
- Categories of content analysis – for the needs of research, an already defined framework of open science skills was used: LIBER's visual presentation of the necessary competencies for librarians and researchers
- Content analysis sample – undergraduate and graduate program of information sciences in Zadar (ZD), undergraduate program of information sciences and graduate program of information sciences – librarianship in Zagreb (ZG) and undergraduate program of informatics studies and graduate program of informatics studies in Osijek (OS)
- Content analysis unit – program-level learning outcomes listed in the undergraduate and graduate programs of information sciences from three cities – Zagreb (ZG), Zadar (ZD), and Osijek (OS)

LIBER's visual representation, whose skills were used as categories for content analysis, is presented in the theoretical part of the paper. The sample of content analysis consists of undergraduate and graduate programs of information sciences from the already mentioned three cities – Zagreb, Zadar, and Osijek. Comprehensive study programs are available on the web but, for analysis purposes in this study, the focus was only on program-level learning outcomes. The program of undergraduate and graduate study of information sciences in Zadar was published in 2015, while the program of undergraduate study in Osijek was published in 2017 and the graduate program in 2015. The year of publishing the undergraduate program in Zagreb is 2016. It can be seen from the above that 5 to 7 years have passed since the publication of the study programs.

Content analysis units are the learning outcomes at the program-level listed in the undergraduate and graduate programs of information sciences from the three cities listed. Learning outcomes are important because they show what knowledge and skills students need to know, understand and overcome as a part of the learning process at specific Department and University. There are general learning outcomes that describe the level of academic achievement within the Bologna Process and specific learning outcomes for an area, for a particular study program and specific learning outcomes of the course. Course learning outcomes should certainly be directly or indirectly related to program-level learning outcomes (Divjak, 2009).

Description of conducting content analysis

For research purposes, the learning outcomes at the program-level of the Department of Information Sciences in Zagreb, Zadar, and Osijek have been translated into English to make it easier to identify their overlap with LIBER's skills and competencies of information experts in open science.

Content analysis was performed using the MAXQDA program, which supports the application of data, text, and multimedia analysis methods.

For the purposes of this research, LIBER's open science skills have been translated into 43 codes, which have been developed in the MAXQDA interface so that they can be added to the corresponding learning outcomes at the program-level.

Results

The analysis of learning outcomes at the program-level showed that in all three study programs no outcome is directly related solely to the skills of open science and that no outcome mentions the concept of open science. However, the open science skills proposed in the LIBER diagram are indirectly linked to certain learning outcomes at the level of the information science program. Scientific communication is an area that has always been closely related to information science and includes knowledge and skills on scientific communication, scientific journals and review process, ethical issues in scientific communication, principles of open science and evaluation of scientific work, bibliometrics, and citation indexes. Open science skills are related to various aspects of information sciences, and for the purposes of this paper, open science skills are considered in a broader context. For example, the outcome outlined in the undergraduate program in Zadar is:

"demonstrate acquired knowledge and skills in the field of selection, organization, storage, preservation, retrieval and retrieval of information".

This outcome in the program is not directly related to open science, but the basis of the outcome is actually equal to the principles and skills of open science listed in the LIBER diagram, that is the skills that fall into the category:

FAIR data (data management, data curation and interoperability, storing, archiving and preserving data, metadata for digital collection)

Since the learning outcomes at the program-level are more general, this analysis sought to establish what the general learning outcomes are through which students, by mastering them, will acquire open science skills listed in LIBER's diagram.

Figure 2. Most represented OA skills in all undergraduate programs (Osijek, Zagreb, Zadar)

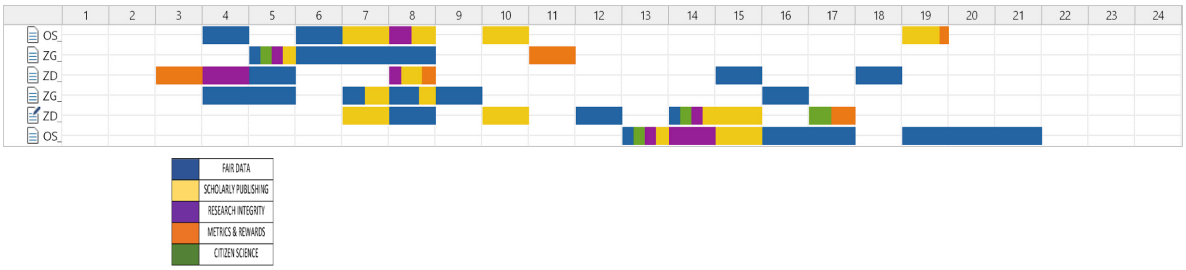
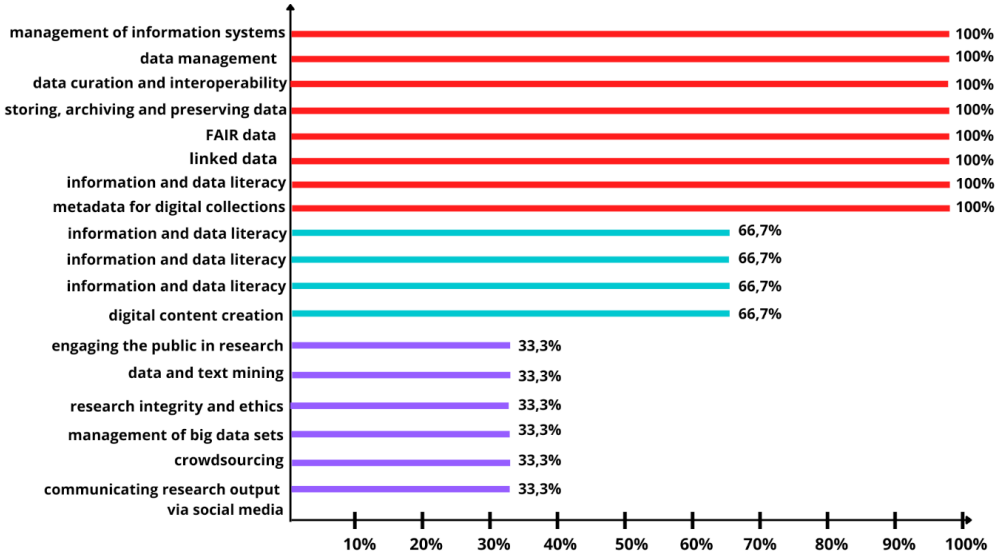


Fig. 2 shows which category of open science skills is most represented in the learning outcomes at the program-level in all three cities and at the undergraduate and graduate-level of study. The above table shows that the most represented category is FAIR data, followed by the category scholarly publishing. The least represented category is citizen science.

Figure 3. Representation of OA skills in all undergraduate programs (Osijek, Zagreb, Zadar)



In Fig. 3. it is shown which skills of open science, which information experts should possess, are most represented in the learning outcomes of the program at the undergraduate-level. It can be observed that there are eight skills listed in the learning outcomes in all three undergraduate programs. These skills are in LIBER's categories:

- FAIR data (data management, data curation and interoperability, storing, archiving and preserving data, and metadata for digital collections) and
- Scholarly publishing (information and data literacy – management of information systems).

In two out of three programs (66.7%) at the undergraduate-level, specific information literacy skills according to the LIBER diagram (responsible research and innovation (RRI), searching open data sources, responsibility and re-use of data, data analysis and visualizations) are not mentioned, but only mentions the term

information literacy. Although the concept of information literacy is not strictly stated, in one program (33.3%) the skills that belong to the information literacy category within the LIBER diagram are listed: management of big data sets, data and text mining, research integrity, and ethics.

From Fig. 3. It can be noticed that the skill crowdsourcing, which implies public involvement in research, is mentioned in only one learning outcome (33.3%) and that is within the Zadar program. Involvement of the public is not mentioned as such in the outcome itself, but by mastering the outcome to "demonstrate written and oral communication skills in communication with the public, users and in the transmission of information in the professional community" information experts could be introduced to the possibilities of public involvement in projects ready to take such an approach.

Figure 4. Representation of OA skills in the learning outcomes of study programs at the undergraduate-level (Osijek, Zagreb, Zadar)

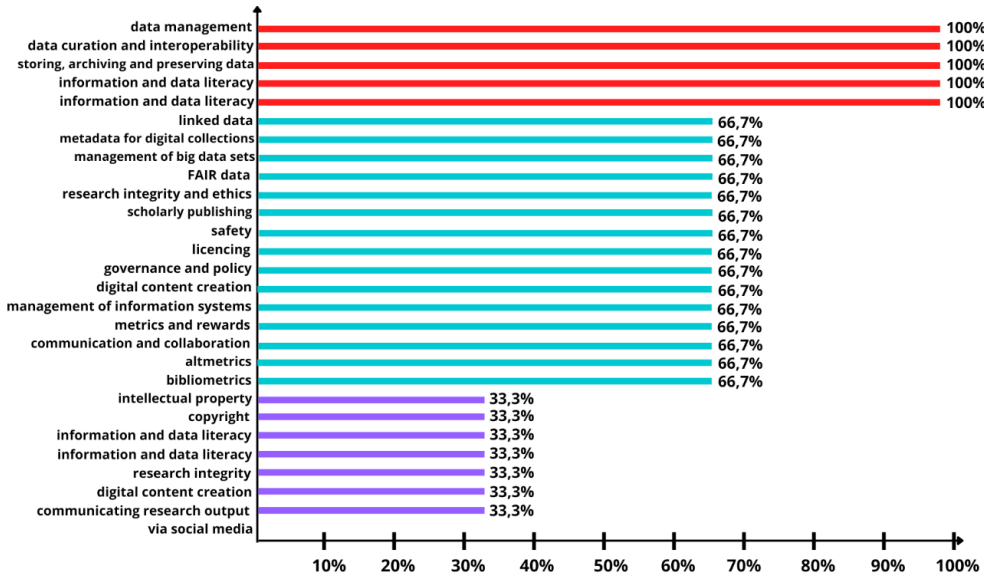
A comparison of the open science skills represented in the learning outcomes at the undergraduate – level can be seen in Fig. 4. which also shows that the learning outcomes at the undergraduate-level include the most skills from the FAIR data category in all three departments. The category scholarly publishing or its subcategory information data and literacy – management of information system is also represented in all three programs at the undergraduate-level, and is mentioned mostly in the learning outcomes of the program in Zadar.

Fig. 4. confirms that the category of information literacy is mentioned in all three programs at the undergraduate-level. The difference in the programs is the representation of information literacy with regard to the areas from the LIBER diagram. Some of the areas, such as management of big data sets and data text and mining (from the category FAIR data), are directly mentioned as one of the outcomes at the undergraduate-level, as well as management of information systems (from the category scholarly publishing). The rest of the subcategories of information literacy (from the categories citizen science and research integrity) are not precisely mentioned in the outcomes, but as the term information literacy is mentioned in the programs, the mentioned categories are also marked as part of the outcomes within the program.

Fig. 5. shows which of the open science skills are represented in the learning outcomes in graduate-level programs. It can be noticed that in all three programs there are fewer skills than at the undergraduate-level, but

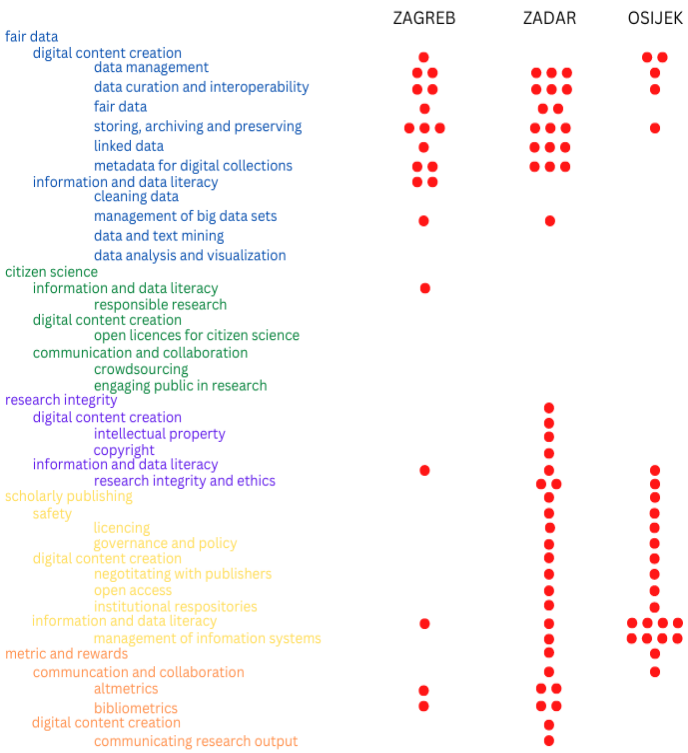
certainly many more skills were mentioned in two of the three programs at the graduate-level (66.7%), more precisely 18 skills were mentioned in two programs. Skills related to research integrity (intellectual property and copyright) and information and data literacy are represented in only one program, in Zadar.

Figure 5. Representation of OA skills in all graduate study programs (Osijek, Zagreb, Zadar)



In Fig. 6. it can be seen exactly in which graduate-level programs certain open science skills can be found. It can also be seen that the highest number of skills was observed in the learning outcomes at the level of the program in Zadar, and the least in Zagreb. For example, the category of citizen science is almost not represented at all, except in one learning outcome in the Zadar program, which concerns information literacy, more precisely responsible research. From Fig. 6. It is easy to see which skills are mentioned at the graduate-level in only two and which in only one of the analyzed programs. From the above, it can be concluded that at the graduate-level the skills needed to advocate for citizen science, crowdsourcing and public involvement in research are underrepresented.

Figure 6. Representation of OA skills in the learning outcomes of study programs at the graduate-level (Osijek, Zagreb, Zadar)



By comparing Fig. 3 (undergraduate-level) and Fig. 5 (graduate-level) it can be concluded that the number of skills is much higher in the learning outcomes at the graduate-level programs. As such, for the purposes of the research, the list of courses at the graduate-level and their content on the websites of all three departments was analyzed. In this way, open science skills that are recognized in certain parts of the general learning outcomes at the graduate-level will be able to be presented on concrete examples from the course content.

Table 1. Correlation of course content with LIBER skills in graduate-level courses at the Department of Information Sciences (Zadar, Zagreb, Osijek)

Department of Information Sciences (Zadar)		
COURSE	**COURSE CONTENT (TEACHING TOPICS)**	**LIBER's OPEN SCIENCE SKILLS**
Digital humanities	• heritage on social networks, crowdsourcing and gamification of heritage	**crowdsourcing** **engaging the public in research**
Modeling and construction of digital collections and services	• digital libraries and crowdsourcing	**crowdsourcing** **engaging the public in research**
Information literacy	• information literacy: topics and concepts • Internet information retrieval strategies • database search	**responsible research & innovation** **searching open data resources**
Department of Information and Communication Sciences (Zagreb)		
COURSE	**COURSE CONTENT (TEACHING TOPICS)**	**LIBER's OPEN SCIENCE SKILLS**
Journals and scientific communication	• bibliometrics, Journal Citation Reports, influence factors, citation rate factor • open access to scientific information (ways of realization), analysis of openly available repositories and journals • copyright and scientific communication environment	**bibliometrics, altmetrics & research impact reporting** **management and use of institutional repositories** **open access** **copyright and intellectual property in the digital environment**
Bibliometrics	• bibliometric methods • sources for bibliometric research • bibliometric indicators. • bibliometric analyzes.	**bibliometrics, altmetrics & research impact reporting**
Big data	• sources of big data • properties of big data • data mining and predictive analytics • data collection and laws	**management of big data sets**
Department of Information Sciences (Osijek)		
COURSE	**COURSE CONTENT (TEACHING TOPICS)**	**LIBER's OPEN SCIENCE SKILLS**
Digital data protection	• plan the process of protecting digital documents in different environments • apply metadata schemes to protect digital documents • apply methods and techniques to protect and ensure long-term access to digital documents	**storing, saving, archiving & preserving data** **metadata for digital collections and datasets** **open access** **FAIR data**

Table 1. shows the courses at the graduate-level in the Department of Information Sciences in Osijek, Zagreb, Zadar whose contents (teaching topics) can be related to certain LIBER open science skills. LIBER's open science skills are colored according to the codes from the MAXQDA program in order to see which category of open science skills is most represented in the contents of the analyzed courses.

Some interesting things can be noticed by analyzing the learning outcomes of graduate programs and analyzing the implementation plans and the content of the course. For example, the analysis of learning outcomes showed that the least open science skills are included in the program of the Department of Information and Communication Sciences in Zagreb, and on the other hand this Department has several courses from which it can already recognize their connection with open science skills (e.g., Journals and scientific communication, Bibliometrics, and Big data). This certainly indicates an insufficient emphasis on such important content and skills in the learning outcomes at the program-level. Regardless of the fact that the learning outcomes at the

program-level are more general, we believe that the term scientific communication is general enough to indicate the importance of openness of research process and that it should be mentioned as such in the outcomes.

Scientists who support the openness of data in science believe that the entire scientific community and the general public benefit from it.

Additionally, the analysis of learning outcomes in graduate-level programs showed the underrepresentation of the citizen science category in all three cities. On the other hand, the contents of the course of the Department of Information Sciences in Zadar (Digital humanities, Modeling and construction of digital collections and services) include teaching topics related to the concept of crowdsourcing and public involvement in research that is difficult to identify from the outcomes.

Conclusion

The aim of this research was to explore the representation of skills and competencies for open science in learning outcomes in undergraduate and graduate study programs at the LIS studies in Croatia.

The research showed that none of the outcomes at both levels in all three cities directly mentions open science skills from LIBER visualization, but as the outcomes are quite broad, we can identify the foundations for knowledge and skills in mastering the open science process.

There is also variation in the representation of skills at different levels of study. More open science skills can be added to the learning outcomes at the graduate-level, which can also be seen from the course content analyzed for the purposes of this research. In the contents of the course at the graduate-level there are teaching topics related to open science. The list of courses at the graduate study in Zagreb stands out, where the very name of the course shows their connection with the concept of open science (Journals and scientific communication, Bibliometrics, and Big data).

The research revealed that the least represented skills from LIBER in this category are citizen science at both levels. Unlike graduate studies, undergraduate studies are underrepresented in the categories scholarly publishing and metrics and rewards. The most common category at the undergraduate and graduate-level is FAIR data. The reason for this may be that the study of information sciences in Croatia is greatly focused on information and data (i.e., selection, organization, management, connection, protection, and preservation).

This research indicated the need for greater inclusion of the concepts of scientific communication and open science in the learning outcomes at the level of programs in the study of information sciences in Zadar, Zagreb, and Osijek. Although open science skills are included in the content of certain courses, we believe that the importance of promoting and encouraging open science should be recognized by outcomes at the program-level due to information professionals being the ones who need to support and ensure the development and management of open science processes.

The research gave very interesting results which should certainly be expanded to analyze in detail all syllabi and their various elements (course learning outcomes, literature, teaching topics) at all levels of study (undergraduate, graduate, and doctoral). Such research would give a more complete picture of the inclusion of open science skills in information science programs in Croatia.

Acknowledgments: We thank Emma Hák-Kovács University of Guelph ON, Canada for the English language editing.

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