Librarians and Open Knowledge: Contribution to Education in the Domain of Open Science

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ABSTRACT: This paper examines the role of librarian education in the field of Open Science, with particular focus on Citizen Science (CS) and Open Educational Resources (OER). The theoretical section presents the fundamental concepts of open science, its key principles, and the regulatory framework in Serbia, as well as the importance of libraries as intermediaries in its implementation. Special attention is devoted to the role of librarians in promoting citizen science and in the development and dissemination of OER. The empirical portion of the study analyzes the outcomes of two accredited professional development programs for librarians conducted between 2023 and 2026. A comparative analysis reveals an increase in participants' awareness of open science, as well as differences in educational outcomes depending on the topic and prior knowledge of participants. The results indicate a high level of participant satisfaction and underscore the significance of such programs for developing competencies and strengthening the role of libraries in the contemporary scientific and educational environment.

KEYWORDS: Open Science; Citizen Science (CS); Open Educational Resources (OER); librarians; professional development; accredited seminars.

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1 Introduction: Open Science

Open science represents an approach in which scientific processes and results are made accessible to the general public, with the aim of promoting transparency, collaboration, and innovation. It encompasses open access to publications, research data, software, and research infrastructure, as well as the development of the competencies necessary for implementing these principles. According to the Open Scholarship Initiative (OSI), open science is a fragmented and dynamic phenomenon, grounded in diverse interpretations of the concept of "openness" and varying practices across scientific disciplines (Hampson et al. 2020). OSI specifically emphasizes the need to involve researchers, librarians, and information scientists in the formulation of open science policies, so that research outputs become more accessible and visible to the public. Hampson and his research associates note that open science entails a practice in which others are able to collaborate and contribute to research, and in which research data, laboratory notes, and other elements of the research process are freely available under conditions that permit their reuse, sharing, and the replication of research along with its underlying data and methods.

The Organization for Economic Co-operation and Development (OECD) defines open science as enabling public access to the results of publicly funded research, with minimal restrictions. This approach promotes greater efficiency and transparency in scientific processes, better alignment with societal challenges, and the transformation of science through the application of digital tools and its engagement with the broader community (Banović 2020, 51).

UNESCO's recommendations establish that open science is grounded in several key principles that enable greater accessibility and transparency of scholarly work: Open Access, Open Research Data, Open Methods and Open-Source Software, Open Peer Review, Citizen Science, Open Educational Resources (OER), and Open Science Infrastructure (UNESCO 2021).

2 The State of Open Science in Serbia

Based on research conducted within the CeOS_SE project[1], it can be concluded that the state of open science in Serbia is relatively favorable compared to the region and to many European countries (Dakić and Trtovac

1. CeOS_SE Project – Citizen-Enhanced Open Science in Southeastern Europe Higher Education Knowledge Hubs

2023). A pivotal step was the adoption of the Law on Science and Research in 2019, which explicitly affirms a commitment to the principles of open science, identifying as one of its fundamental tenets "the conduct of scientific research in accordance with the principles of open science" (Република Србија, Министарство просвете, науке и технолошког развоја 2024). The law emphasizes that research is to be conducted with the aim of increasing the quality and visibility of scientific work, drawing on open access to publications and data and on appropriate research infrastructure.

This normative framework builds upon the "Open Science Platform" of 2018, which defines the national open access policy and introduces the obligation to publish research results funded by the Ministry of Science under the green open access model – Green OA (Република Србија, Министарство просвете, науке и технолошког развоја 2018).

The Ministry has established the Open Science Team in Serbia (TONuS) and launched the National Open Science Portal,[2] while all public universities have adopted regulations or platforms for managing institutional repositories and publishing results in open access. As a result, Serbia's progress in implementing European open science principles has been positively assessed in the European Commission's report, and what was once considered a utopian vision is increasingly becoming a reality of scientific communication (Smederevac et al. 2020, 33).

Further progress was achieved in 2024 with the adoption of Platform 2.0, which expands the concept of open science to encompass data management, transparent use of software and infrastructure, the application of persistent identifiers, and the development of competencies and evaluation systems (Република Србија, Министарство науке, иновација и технолошког развоја 2024).

Although this framework clearly establishes priorities in the field of open science, Platform 2.0 does not sufficiently elaborate on the role of citizen science and open educational resources. Their significance is therefore especially underscored, particularly in the context of education, where professional development programs enable librarians in both academic and public libraries to gain insight into their role in advancing transparency, knowledge accessibility, and the broader community's engagement in the scientific process.

2. National Open Science Portal

3 Citizen Science

Citizen science represents a practical expression of the principles of open science, as it actively engages citizens in various phases of the research process (Cavalier and Kennedy 2016) — from data collection, co-design, and analysis, to dissemination and collaborative knowledge creation — thereby promoting scientific literacy and community participation. Its effective implementation requires appropriate policies, including sustainable funding and institutional capacities that enable the ethical and meaningful participation of citizens (Hecker et al. 2018). In this context, libraries and higher education institutions play an important role as intermediaries and as providers of support for participatory research (Ignat, Cavalier, and Nickerson 2019).

Citizen science encompasses varying levels of citizen involvement, ranging from informing the public about scientific events to direct participation in the research process through observation, data collection, and data processing. This form of scientific engagement has historically been associated primarily with the natural sciences, but in recent times, with the recognition of the importance of involving citizens in research, it has increasingly been applied in the social and technical sciences as well (Banović, Bradić-Martinović, and Nedović 2021).

According to the European Commission, citizen science is one of the eight pillars of open science (European Commission), as it connects scientific research with societal needs and fosters the development of innovation through collaboration between scientists and citizens. In the Western Balkans region, its integration presents additional challenges shaped by specific social and institutional circumstances, post-socialist legacies, economic transitions, and infrastructural inequalities — necessitating alignment with European frameworks while accounting for local context.

4 The Role of Librarians in Citizen Science

Citizen science is increasingly becoming an integral component of library activities, positioning libraries as spaces for gathering, collaboration, and learning that connect the scientific community and citizens. Academic libraries play an important role in educating librarians, researchers, and the broader public about the principles of citizen science, as well as in fostering collaboration with the research community and public libraries. Their role encompasses the promotion of citizen science and its results, thereby contributing to the greater visibility and understanding of this approach.

Libraries should, above all, develop skills for participation in citizen science projects through training sessions and courses that familiarize students and researchers with their foundations, possibilities, and applications. They also need to build collections of protocols, forms, and educational materials produced within citizen science projects, in accordance with the FAIR principles. Libraries can likewise provide infrastructure—including IT support, servers, institutional repositories, and spaces for workshops and meetings—and serve as sites for data collection and processing. Libraries may also participate in project evaluation, particularly in the assessment of data quality and educational outcomes. Finally, libraries play an important role in communicating and promoting collections and results generated through citizen science projects (Ayris 2018, 18–19).

For the successful engagement of citizens and researchers, close collaboration between academic and public libraries is essential, particularly through the organization of workshops, the exchange of good practice examples, and collaborative work on projects (Дакић and Тртовац 2023). In this process, academic librarians serve a significant intermediary function by connecting various stakeholders, supporting the development of citizen science-based initiatives, and contributing to the strengthening of institutional capacities for their implementation.

University libraries, as structural components of the open science ecosystem, are well-positioned to serve as drivers of its development. They raise awareness of the importance of open science, provide training, open research resources to innovative approaches, and develop institutional policies and infrastructure — which is why they are recognized as pioneers and champions of open science (Ayris 2018). Simultaneously, they contribute to broader European initiatives, including the development of the digital space for open science.

By participating in citizen science projects, libraries transcend the role of intermediaries in information access and become active participants in collaborative networks among scientists, local communities, and institutions, thereby contributing to higher-quality research and education. In the literature, libraries — including non-academic ones — are viewed as important intellectual centers connecting professional and amateur researchers, with particular emphasis on the development of Web 2.0 (Gmiterek 2026, 3).

Overall, academic libraries function as key actors in the development of citizen science, serving as mediators between citizens and the scientific community. Their role in education, networking, and support for collabora-

tive projects, enables libraries to become important centers of innovation, knowledge, and social collaboration.

5 The State and Prospects of Citizen Science in Serbia

The term "citizen science" is not the only designation used in the Serbian academic and library community to refer to this type of activity. This approach to science is also termed "science for citizens," "citizens in science," or "volunteer science" (Banović, Bradić-Martinović, and Nedović 2021, 592). "Volunteer science" is the term employed by Smederevac and colleagues (Smederevac et al. 2020, 113–114), while the Centre for the Promotion of Science uses the concept in a more specific context—"civic scientific research"—in its Guide (Кениг et al. 2024, 3). In the international literature, the term "participatory science" is increasingly being used, as it more explicitly foregrounds citizen engagement (Soacha-Godoy et al. 2025).

Serbia has established itself as a regional leader in integrating citizen science within the framework of open science, aligning its policies with the guidelines of the European Commission and initiatives such as the European Open Science Cloud.[3] The adoption of the Open Science Platform (2018) and the Open Science Platform 2.0 (2024), as well as the Law on Science and Research, have affirmed a commitment to transparency, open access, and public participation in scientific research. Furthermore, the introduction of dedicated budget lines by the Ministry of Science, Technological Development and Innovation starting in 2023 demonstrates sustained institutional support for the development of citizen science (Dakić and Trtovac 2025).

This progress was facilitated by key milestones such as the signing of the Berlin Declaration, the establishment of open access repositories at academic institutions, and the integration of open science principles into research funding systems. The Centre for the Promotion of Science has also played a significant role, having funded 17 citizen science projects through public calls in 2023 and 2024, enabling active citizen participation in research.

In addition to the Centre for the Promotion of Science, the University Library "Svetozar Marković" is another key institutional actor, playing an important role in the education of librarians and researchers in the field of open and citizen science and in positioning libraries as hubs of citizen sci-

3. European Open Science Cloud (EOSC)

ence. The establishment of the Serbian Reproducibility Network[4] in 2025 further underscores the strengthening of this field and the growing orientation toward open and inclusive scientific practice.

As a result of these initiatives, citizen science in Serbia has become a visible and valued component of the research ecosystem, fostering collaboration among citizens, scientists, and institutions and establishing a foundation for its continued development.

6 Open Education

Education is one of the key drivers of social development; however, traditional models often restrict access to knowledge due to high costs, geographic barriers, and insufficient inclusivity. The development of the internet and digital technologies has opened space for new approaches to education, among which Open Educational Resources (OER) occupy a particularly prominent position.

Open Educational Resources are freely available teaching and educational materials that can be freely used, adapted, and shared. Their significance lies in the expansion of access to quality education, encouraging new teaching approaches, and supporting the professional development of educators. Through international collaboration and a range of initiatives, they represent an important instrument for building an accessible, inclusive, and sustainable educational system.

7 Open Educational Resources

The concept of Open Educational Resources emerged in the early 2000s, as a response to limited access to educational materials, and the term was first introduced in 2002 through the UNESCO initiative. Today, it constitutes a global movement promoting knowledge accessibility, collaboration, and innovation in education. By definition, OER are educational and research materials that are in the public domain or published under open licenses, allowing for their free use, adaptation, and sharing (UNESCO). They are characterized by openness, accessibility, and reusability, and encompass diverse types of content — from textbooks and scholarly papers to multimedia and interactive materials. To promote their wider adoption,

4. Serbian Reproducibility Network

UNESCO has issued recommendations emphasizing the importance of open licenses, quality assurance, and the development of appropriate technological infrastructure (UNESCO 2019).

The most widely used open licenses are Creative Commons (CC) licenses, which allow authors to retain copyright while permitting the use, sharing, and modification of works under specific conditions (BY, NC, SA, ND), whereas CC0 denotes completely unrestricted use (Creative Commons, 2025). When publishing open educational resources, it is important to specify the applicable license, obtain author consent, and indicate the terms of use (Гајин et al. 2022, 14). OER are grounded in the so-called "5R" permissions: retain, reuse, revise, remix, and redistribute. Due to restrictions on modification, the ND license is not recommended, while CC BY and CC BY-SA are the most widely employed in practice (Wiley and Hilton Iii 2018, 134–135).

Open Educational Resources contribute to greater knowledge accessibility, instructional flexibility, and cost reduction; however, their implementation continues to face challenges such as insufficient awareness, the need for quality assurance, and limited institutional and technological support. Their application worldwide confirms their significance in improving access to knowledge and developing innovative educational models. Numerous initiatives — such as OpenStax,[5] the Open Research Library,[6] DOAB,[7] and OpenAIRE[8] — provide free access to textbooks, scholarly publications, and other educational resources. These examples demonstrate the potential of OER to substantially advance education by making it more accessible, inclusive, and responsive to contemporary needs. Through international collaboration and the support of various initiatives, OER are gradually becoming an important component of educational systems worldwide.

8 Libraries as Drivers and Supporters of Open Education

Open education, as an important segment of open science, is grounded in the principles of transparency, inclusivity, and collaboration, enabling broad

5. OpenStax
6. Open Research Library
7. DOAB
8. OpenAIRE

knowledge accessibility and the development of contemporary teaching practices. In this context, librarians play a significant role as intermediaries between sources and users, owing to their expertise in information management and support for the academic community (Bueno-de-la-Fuente, Robertson, and Boon 2012).

Their role is reflected in curating and providing access to open educational resources, offering education on copyright and open licenses, fostering collaboration among teachers, researchers, and students, and supporting the development of innovative digital platforms. In this way, libraries contribute to the development of digital literacy and to the broader dissemination of open educational practices (Дакић, 2022[шт. 2025]).

Significant support for librarians in the area of open education is provided by LIBER (Ligue des bibliothèques européennes de recherche) through its Working Group on Educational Resources, whose goal is to strengthen access to, creation of, and use of open educational resources in academic libraries (LIBER). A similar role is fulfilled by the European Network of Open Education Librarians (ENOEL), which brings together professionals to share experiences, develop resources, and implement UNESCO's OER recommendations (SPARC EUROPE). The collaboration of these organizations contributes to strengthening the role of libraries and to their more active participation in international open education initiatives.

9 The Application and Development of Open Educational Resources in Serbia

In Serbian practice, the term otvoreni obrazovni izvori (open educational resources) is used alongside related terms such as otvoreni obrazovni sadržaji (open educational content) (Nikolić 2015) and otvoreni obrazovni resursi (open educational materials) (Пантић 2017, 56–57) (Matijašević-Obradović, Brkanlić, and Vučurević 2017, 1–2). This terminological inconsistency presents a notable challenge in surveying the Serbian-language literature on this subject.

Open Educational Resources are gaining prominence in Serbia; however, their creation and distribution have yet to be adequately regulated by law. The Institute for Education Quality and Evaluation has underscored the need to introduce a legal framework, ensure quality control, and develop a national platform that would facilitate access to these resources (Гајин et al. 2022).

Although the concept of open educational resources in higher education in Serbia has not been fully developed, interest in the topic is growing. The Education Development Strategy through 2020[9] provides a foundation for their application, yet actual practice lags behind the stated objectives. The distribution of open educational resources is handled primarily by educational institutions through the portals BAEKTEL and petlja.org (Obradović et al. 2020), but the number of available platforms remains insufficient, necessitating a broader expansion of OER availability and promotion within the country.

In addition to the above, it is necessary to identify financing models and incentives for authors, as well as to secure technical, informational, organizational, and policy support for open education projects. It is unrealistic to expect that the same financing and mandatory deposit model applied to scientific papers in projects supported by the Ministry of Science and the European Commission would be extended to university textbooks. Beyond authors foregoing a portion of their potential income, a significant challenge is posed by publisher resistance in the effort to protect financial interests (Pajić 2022, 46–47).

The University Library "Svetozar Marković" in Belgrade actively contributes to the development of open educational resources. Since 2025, its representative has served as co-chair of the LIBER Working Group on Educational Resources, facilitating the transfer of European knowledge and practices into the national context. Two librarians are also members of ENOEL, where they participate in the exchange of experiences, the development of guidelines, and the promotion of open education, contributing to the formulation of strategies aligned with European standards.

Based on the foregoing, it can be concluded that teachers, students, librarians, faculty administrations, and the relevant state institutions in Serbia must collectively harness the potential of open educational resources and the available technical infrastructure in order to realize open education in practice (48).

10 Librarian Education in the Context of Open Science

As part of the initiative to promote open science within continuing professional development programs, the University Library "Svetozar Marković"

9. The Education Development Strategy through 2020

has engaged in the education of library and information professionals and has accredited a series of programs. Among the longest-running are "Copyright in Library and Information Practice," implemented in the period 2015–2025, and "Wiki Librarian" (2014–2025). In addition, the following seminars were successfully conducted: "Communication on the Internet: Open Science in the Service of Society" (2019–2021), "Internet Resources for a Better Society: Open Science – Documents and Sources" (2019), "Author Profiles for e-Science: Opening, Maintaining, Connecting" (2024–2025), as well as "Citizen Science: Librarians as a Link Between Science and Citizens" (2023–2025) and "From Shelves to Screens: Librarians and the Future of Open Educational Resources" (2025–2026) — the latter two conceived and successfully implemented by the authors of this paper.

The seminar "Citizen Science: Librarians as a Link Between Science and Citizens" was developed as a direct outcome of the successfully completed European project "Citizen-Enhanced Open Science in Southeastern Europe Higher Education Knowledge Hubs (CeOS_SE)." The project was designed with the aim of raising awareness of open and citizen science and improving existing practices in Southeastern Europe. Funded through the Erasmus+ program and coordinated by LIBER (2022–2024), its primary objectives were to develop open science policies, educate researchers and students, and promote citizen science in academic and public libraries, while encouraging the active participation of citizens in scientific research. The University Library "Svetozar Marković" actively participated in this project and produced guidelines for the implementation of citizen science as an important segment of open science in the Balkan countries.[10]

The seminar is structured so that the theoretical component explains the concept, development, and significance of citizen science, while the practical component, in the form of a workshop, highlights examples of good practice and motivates participants to apply the acquired knowledge, design their own projects, and develop activities aligned with the needs of their institutions and communities. A total of 11 program cycles were implemented, attended by more than 500 librarians. For librarians in higher education libraries, this seminar is of particular significance as it enables the acquisition of knowledge and skills necessary for supporting researchers in the design and implementation of citizen science projects.

Building on the growing importance of open educational resources, the authors of this paper designed and accredited a professional development

10. Citizen-Enhanced Open Science in Southeastern Europe Higher Education Knowledge Hubs (CeOS_SE)

program titled "From Shelves to Screens: Librarians and the Future of Open Educational Resources" for 2025. The seminar's objective is to familiarize librarians with the key concepts and principles of OER, including the "5R permissions," and to equip them to create, organize, and promote these resources. The program also incorporates examples of good practice from national and international contexts, enabling librarians to effectively apply and promote OER within the institutions and communities in which they operate.

Although the seminar was developed in early 2025, its implementation did not begin until September due to specific social circumstances. The limited time frame did not allow for the inclusion of all interested parties; however, the training was successfully conducted in Belgrade and Niš for librarians from the network of academic libraries (93 participants), as well as in Kraljevo, Čačak, Smederevo, and Pirot for librarians from public and school libraries (143 participants).

11 Comparative Analysis of the Effects of Educational Programs in Open Science

Both courses are evaluated through an electronic survey, which serves as an important instrument for assessing quality and informing the improvement of future programs. Upon completion of each instructional cycle, participants receive an email invitation to anonymously complete a questionnaire containing carefully designed questions. The questions address the assessment of course content, presentation methods, the relevance of topics, as well as general impressions and suggestions for improvement. The Google Forms application was used to develop and distribute the surveys, enabling straightforward creation and efficient data collection. The system automatically organizes data in tabular form, facilitating analysis and systematization. This approach allows for the rapid acquisition of reliable data relevant to assessing course effectiveness and planning further program development.

Based on the collected responses, valuable findings were obtained that provide insight into the level of awareness, interest, and application of open science principles in Serbia. These findings constitute an important foundation for the further development of educational activities, as well as for a better understanding of the development and adoption of the open science concept within the academic and research community. An analysis of the results reveals discernible progress in participants' level of awareness across the observed periods and between the different seminars. Among participants

in the first, older seminar on citizen science, an almost even distribution of responses is observed: 52.4% of respondents were familiar with the concept, while 47.6% had no prior knowledge (Fig. 1). These results indicate that during the period 2023–2024, the concept of open science remained insufficiently integrated into the broader professional community.

Conversely, results obtained from the seminar on open educational resources, conducted in 2025, indicate a significantly higher level of prior familiarity (71.9%) (Fig. 2). An increase of nearly 20% highlights the growing awareness and visibility of the open science concept within a relatively short period. This difference may be attributed to temporal factors—namely, the more intensive promotion of open science principles through various projects and initiatives. Additionally, the subject matter of the second seminar is thematically closely aligned with open science, which likely attracted participants who already had some prior knowledge or interest in this area.

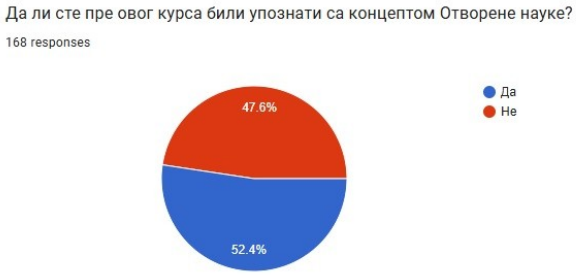

Figure 1. The concept of open science within a citizen science seminar

Further analysis reveals that both citizen science and open educational resources remain relatively new and insufficiently recognized concepts among library professionals. The low percentage of respondents familiar with the concept of citizen science (36.3%) indicates that this concept is in an early stage of recognition and is not sufficiently represented in professional discourse and practice (Fig. 3). This finding implies the need for additional activities aimed at its promotion and dissemination to potential users. On the

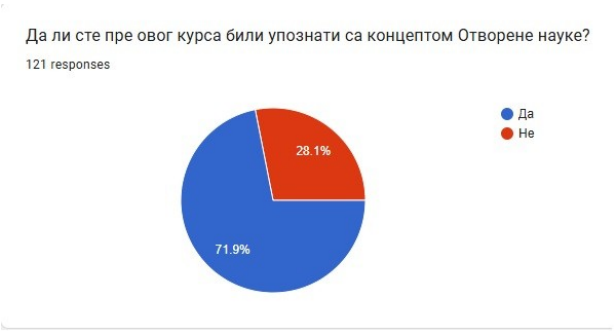

Figure 2. The concept of open science within a seminar on open educational resources

other hand, a somewhat higher percentage of respondents familiar with the term open educational resources (58.7%) suggests a higher level of awareness, yet one still insufficient to conclude that the concept is widely established (Fig. 4). Although the difference relative to citizen science is significant, the fact that more than 40% of respondents were unfamiliar with this term confirms that this field also requires educational outreach and greater visibility.

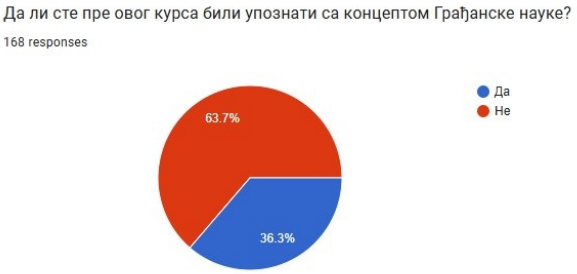

Figure 3. Citizen science: understanding of the concept

A comparative review of the results confirms that open educational resources are somewhat more familiar and accessible to respondents, likely

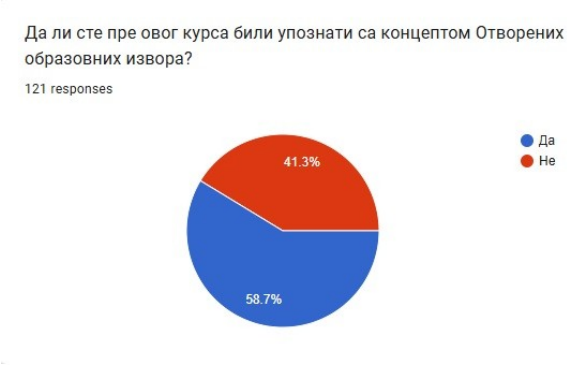

Figure 4. Open educational resources: understanding of the concept

due to their more direct applicability in educational contexts. Nevertheless, both concepts retain an innovative character, which justifies their inclusion in professional development programs. At the same time, a certain discrepancy was observed between respondents' formal knowledge of the concept of citizen science and the actual practice of their libraries. While respondents do not always recognize the term itself, numerous examples indicate that libraries are already implementing activities that fall within this domain. Projects such as the "Digital Herbarium" or initiatives focused on the conservation of the Great Bustard demonstrate the involvement of diverse social actors—from students, teachers, and local associations to international volunteers—which constitutes one of the defining characteristics of citizen science. Similarly, activities such as digital literacy programs for senior citizens or collaboration with researchers in linguistics, ethnology, and local history suggest that libraries already function as spaces for knowledge exchange and for the engagement of citizens in various forms of research work. Of particular significance is the finding that all respondents (100%) agree that libraries can serve as an appropriate intermediary between citizens and researchers. This result reflects a high level of recognition of libraries as mediators and as potential institutional leaders in citizen science activities. Furthermore, the fact that 84.6% of respondents expressed a willingness to actively engage in such initiatives indicates strong motivation and openness to further involvement.

Quantitative data indicate that 95.3% of respondents rated the course as useful, which unequivocally confirms that the program effectively addressed the needs of the target group. Such a high percentage of positive evaluations testifies to a well-conceived content framework, an appropriate selection of subject matter, and an effective mode of delivery.

Qualitative analysis of participant comments largely underscores the practical value of the program, the opportunities for collaboration, and the significance of practice-based examples (e.g., "The course was genuinely well-designed; it provided useful information, facilitated the exchange of experiences with colleagues, and above all, it is commendable that it is rich in practical examples, whether domestic or international" or "The workshop was very useful and creative. The information provided opens up unlimited possibilities for collaboration and for connecting citizens through the library with scientific work, as well as with other forms of human creation"). Participants particularly emphasize the expertise and approach of the instructors, as well as the interactive nature of the instruction, which signals a successful combination of theoretical and practical approaches (e.g., "The seminar presenters are approachable, positive, and engaged in interaction with the attending librarians, and hold attention through interesting practical examples. They deserve all praise." or "An excellent topic was chosen for the course, as its educational function — and consequently its practical value — is indisputable. Highest praise for the instructors: an exceptional level of knowledge and preparedness, a skillful combination of essential information and presentation techniques that sustain participants' attention, and a warm and approachable rapport with attendees. The highest marks in every respect!"). Participants also recognize the broader social significance of the topic, highlighting the potential for applying the acquired knowledge not only in libraries but also in the educational system, particularly through collaboration with primary and secondary schools. This suggests that the course may have a long-term impact and contribute to strengthening cross-sector collaboration.

In the area of open educational resources, although a relatively small percentage of respondents (18.9%) currently organizes activities related to open education, the results demonstrate that the promotion of such activities encourages librarians' interest in more actively engaging with and using OER. As many as 95.9% of respondents consider the library to be an appropriate service provider for teachers seeking and using open educational resources, while 68.8% express a willingness to engage in activities in this area.

Respondents most frequently identify teachers as the key actors in the creation of OER (85.2%), which suggests a perception that educators are the primary developers of educational content. A high percentage of respondents also recognizes librarians (79.5%) and researchers (71.3%) as significant participants in this process, confirming the growing role of libraries and the scientific community in the development and promotion of open educational resources. Approximately half of respondents believe that students (50.8%) can also actively contribute to the creation of OER, while a smaller proportion identified school-age students (26.2%) as potential contributors (Fig. 5).

Figure 5. Potential participants in the development of open educational resources

The results also reflect a highly positive evaluation of the course by participants, both in terms of its usefulness and the quality of implementation, and relevance of the subject matter. Quantitative indicators reveal that the majority of respondents (57.5%) find the course useful in every respect, attesting to its broad applicability in a professional context. Approximately 36.7% of participants rate the course as excellent and indicate their intention to apply the acquired knowledge in their future work, underscoring its practical value and the immediate applicability of the content. A very small percentage of respondents (5.8%) expressed certain reservations regarding practical application, while it is particularly noteworthy that no participant rated the course as unnecessary. This distribution of responses unequivocally suggests a high degree of acceptance and program success.

Qualitative analysis of comments is consistent with these findings. Participants emphasize the professionalism and inspirational quality of the instruc-

tors, as well as the consistently high quality of their seminars, as evidenced by participants' expressed willingness to attend future programs. The importance of newly acquired knowledge is underscored, along with expectations of its application — implying a long-term impact of the course. Some comments reflect the perception of the topic as innovative and promising for the development of library practice, reinforcing the significance of such educational initiatives. Participants also describe the course as informative, content-rich, and dynamic, with the capacity to hold attention and stimulate interest, thereby demonstrating a successful integration of theoretical and practical approaches in its delivery.

A comparative analysis of results from both seminars reveals clear differences in perceptions of the quantity of newly acquired knowledge, which can be linked to varying levels of prior familiarity with the respective topics. In the citizen science seminar, the largest proportion of respondents (45.5%) reported acquiring 50–80% new information, while as many as 24.6% considered themselves to have acquired 90–100% new knowledge (Fig. 6). Conversely, in the OER seminar, although the 50–80% category also predominated (50.8%), the proportion of respondents who reported the highest level of new knowledge acquisition (90–100%) was considerably smaller (16.4%). Examining the lower categories, the results further demonstrate that in the OER seminar, a somewhat higher proportion of respondents fell within the 30–50% range (25.4%, compared to 23.4% in the citizen science seminar), as well as within the lowest category of 10–30% (7.4%, compared to a significantly smaller share in the citizen science seminar). This suggests that a portion of participants already possessed some degree of prior knowledge in the area of open educational resources (Fig. 7).

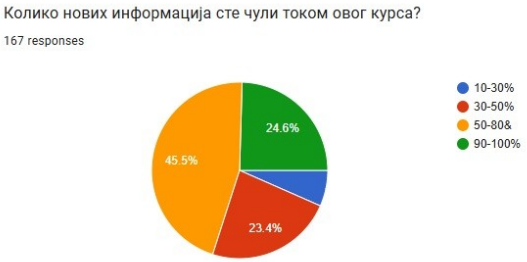

Figure 6. Knowledge acquired about citizen science

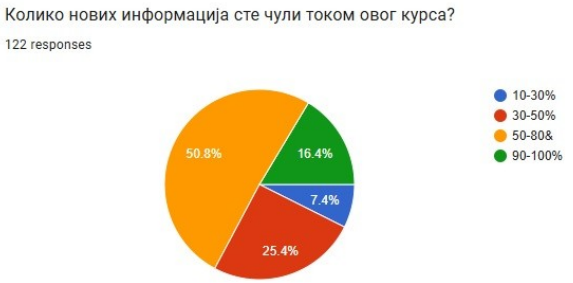

Figure 7. Knowledge acquired about open educational resources

Taken together, it can be concluded that the citizen science seminar had a more pronounced effect in terms of the acquisition of entirely new knowledge, as evidenced by the greater proportion of responses in the highest category (90–100%). In contrast, the OER seminar contributed more to the extension and deepening of pre-existing knowledge, as reflected in the greater representation of intermediate categories. These results are consistent with the previous findings on participants' levels of awareness: citizen science is a less familiar concept, and the course therefore has a stronger introductory effect on the topic, whereas open educational resources are already partially present in professional practice, meaning the course serves a predominantly knowledge-building function.

The outcomes of the conducted educational programs indicate that professional development programs for librarians in the field of open science have a significant impact on raising the level of awareness, developing competencies, and strengthening the professional role of librarians. Clear progress was observed in participants' knowledge of the open science concept, as well as greater readiness to actively engage in activities related to citizen science and open educational resources. At the same time, the results indicate that these concepts remain insufficiently represented in professional practice, highlighting the need for continuous education, greater visibility, and systemic support. Of particular significance is the fact that librarians recognize their role as intermediaries between researchers, educators, and the broader community, which creates space for further strengthening of cross-sector collaboration. The high level of participant satisfaction and the expressed motivation to apply the acquired knowledge confirm the relevance and effectiveness of

such programs. Accordingly, the further development and enhancement of educational initiatives represent an important step toward the broader application of open science principles in library and information practice and in society as a whole.

12 Conclusion

Open science represents a significant direction in the development of the contemporary scientific and educational system. Its goal is to expand knowledge accessibility, ensure research transparency, and engage the broader social community. In this context, libraries and librarians are assuming an increasingly important role as intermediaries between researchers, educators, and citizens, as well as drivers of transformation toward a more open and inclusive approach to knowledge. Citizen science and open educational resources are of particular significance as practical mechanisms for implementing open science principles across diverse social and educational contexts.

Although these concepts are largely well-developed internationally and supported by numerous initiatives and infrastructural frameworks, their implementation in Serbia is progressing slowly. A lack of systemic regulation, a limited number of platforms, and lower visibility of these practices highlight the need for a more systematic approach to their advancement. On the other hand, growing professional interest and the role of libraries in promoting and applying open science principles offer considerable potential for further development.

The empirical findings of this paper support the conclusion that professional development programs play a crucial role in raising the level of awareness, developing competencies, and stimulating librarians' participation in open science domains. The comparative analysis demonstrates that different thematic approaches yield different educational effects — ranging from the introduction of entirely new knowledge to its deepening and practical application. At the same time, strong motivation among librarians to engage in citizen science activities and to develop open educational resources was observed.

Viewed in its entirety, libraries hold considerable promise for becoming one of the key institutional drivers of open science implementation; however, fully realizing this potential requires the development of national strategies and the continuous improvement of library professionals' competencies. The development of these initiatives would contribute to the advancement of library and information practice and, more importantly, to the construction

of a more open, accessible, and inclusive knowledge system as a broader societal objective.

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