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Source / Izvornik: **Publications of the English Goethe Society, 2024, 12**

Journal article, Published version

Rad u časopisu, Objavljena verzija rada (izdavačev PDF)

<https://doi.org/10.3390/publications12010008>

Permanent link / Trajna poveznica: <https://um.nsk.hr/um:nbn:hr:203:579985>

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Benefits of Citizen Science for Libraries

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Abstract: Participating in collaborative scientific research through citizen science, a component of open science, holds significance for both citizen scientists and professional researchers. Yet, the advantages for those orchestrating citizen science initiatives are often overlooked. Organizers encompass a diverse range, including governmental entities, non-governmental organizations, corporations, universities, and institutions like libraries. For libraries, citizen science holds importance by fostering heightened civic and research interests, promoting scientific publishing, and contributing to overall scientific progress. This paper aims to provide a comprehensive understanding of the specific ways in which citizen science can benefit libraries and how libraries can effectively utilize citizen science to achieve their goals. The paper is based on a systematic review of peer-reviewed articles that discuss the direct benefits of citizen science on libraries. A list of the main benefits of citizen science for libraries has been compiled from the literature. Additionally, the reasons why it is crucial for libraries to communicate the benefits of citizen science for their operations have been highlighted, particularly in terms of encouraging other libraries to actively engage in citizen science projects.

Keywords: benefits for libraries; citizen science; libraries; open science



Citation: Mumelaš, D.; Martek, A. Benefits of Citizen Science for Libraries. *Publications* **2024**, *12*, 8. <https://doi.org/10.3390/publications12010008>

Academic Editors: Iva Grabarić Andonovski, Nikolina Peša Pavlović and Jadranka Stojanovski

Received: 30 November 2023

Revised: 26 January 2024

Accepted: 4 March 2024

Published: 8 March 2024



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1. Introduction: Citizen Science and Its Benefits for the Society and Its Participants

Open science is an umbrella term used to denote the concepts of openness, transparency, repeatability, replication, and the accumulation of knowledge, which are also fundamental features of scientific endeavors [1]. Open science instigates societal, cultural, and technological transformations by emphasizing transparency in the processes of designing, conducting, documenting, and evaluating research. Irreversible trends such as open data tools, open access platforms, open peer review methods, and public engagement initiatives are influencing all participants in the scientific community and possess the capacity to expedite the research cycle [2]. Open science is one of the political priorities of the European Union, which categorizes open science into eight pillars within the “Open Science Policy Platform”. The last pillar relates to citizen science, asserting that the broader public should be able to make a significant contribution to scientific research and be recognized as a “creator” of scientific knowledge [3]. Citizen science, like open science, facilitates and encourages widespread participation in science and scientific research, with a highlighted role assigned to libraries in promoting the potential of citizen science. It is emphasized that libraries play a role in handling and preserving research data and metadata, enabling the organization, skills, and collaboration necessary for citizen science [4]. The convergence of open science and citizen science is evident in their shared emphasis on transparency, public engagement, and the inclusive contribution of the broader community to scientific research.

The term “citizen science” originated in the mid-1990s, and it was first mentioned by Alan Irwin, who explained that citizen science is science that serves the interests of citizens, simultaneously involving scientific activities performed by citizens [5]. Richard Booney described citizen science as scientific projects where “amateurs” contribute observational data to scientists. In return, they gain new scientific skills, creating a reciprocal exchange, a “two-way street” [6]. Citizen science is a concept that encompasses various interpretations, but the fundamental and simplest definition characterizes it as scientific research conducted

in whole or in part by members of the broader public, typically amateur non-professional scientists. Participants collect, share, analyze, or transcribe data and observations, often over large geographic areas or extended periods, generally utilizing mobile applications and the internet. Citizen science is also known as community science, crowd-supported science, cloud science, volunteer monitoring, or simply public participation in scientific research [7]. Citizen science participants have the opportunity to participate in various aspects of the scientific process, including formulating research questions, collecting data, analyzing information, making conclusions, and sharing findings [8]. In 2013, Muki Haklay identified levels of citizen science based on participant involvement, spanning from ‘citizens as sensors’ (crowdsourcing) and ‘citizens as interpreters’ (distributed intelligence) to higher levels where participants actively contribute to defining problems and collection protocols (participatory science), or are deeply involved in the entire scientific process development (extreme citizen science) [9]. Citizen science offers numerous opportunities for scientific research, harnessing the collective power of individuals from diverse backgrounds. This approach not only expands the scope of scientific investigations but also brings research closer to the public, fostering a sense of shared responsibility and engagement in scientific discovery. Additionally, it promotes a deeper understanding of complex issues and encourages collaboration between citizens and professional scientists, ultimately benefiting society as a whole.

Citizen science has the ability to connect scientific subjects with people’s daily experiences, transforming them into inquiries that relate to their everyday life. By prioritizing the methods and procedures over the final results, citizen science offers a dynamic and adaptable approach to communication, one that aligns with the project’s specific circumstances and remains open to shifts within that framework [10]. Nevertheless, it is crucial to observe that numerous empirical scientific articles across various disciplines have addressed research questions using data derived from citizen science. Many studies have also affirmed the high quality of citizen science data, thereby contributing valuable information to scientific outcomes [11]. Engaging in citizen science enhances the relevance and practicality of results across various fields. Although citizen science may not always result in high-profile academic papers or traditional forms of academic success, it can generate outcomes that significantly impact the lives of those at the core of the research. Citizen science contributes to improved research both technically, by considering a broader range of factors, and ethically, as it promotes greater equity [12].

The key participants in citizen science prominently include citizen scientists and professional researchers. There are an abundance of data available concerning the benefits that participants derive from engaging in citizen science. Jones, M. G. et al. conducted an extensive study that included a literature review on this topic, where they identified benefits for citizen scientists such as social engagement, interaction, improvements in knowledge, skills, and attitudes, as well as changes in behaviors [13]. Additionally, research by Pateman, M., Dyke, A., and Elizabeth, S. also listed benefits such as greater employability, stress reduction, formation of new relationships and communities, social learning, and better understanding of the scientific process [14]. Regarding the benefits of citizen science for scientists, Veeckman et al. state that increased research capacity, newly acquired data and information, more innovative research, and more societally relevant research are bridging the gap between scientists and science and diversity in science [15]. Besley, Oh, and Nisbet indicate that scientists are motivated by the desire to improve the public’s favorable perception of science, raise awareness about scientific concepts, and persuade the public about the significance of the scientists’ contributions [16]. Citizen science offers benefits by engaging citizens in scientific endeavors, providing valuable data for researchers, fostering public understanding of science, and enhancing the collaboration between the scientific community and the general public.

2. Citizen Science and Benefits for Libraries

As stated by Ignat, Cavalier, and Nickerson, facilitators in citizen science could also be libraries. These spaces offer secure environments with access to information, resources, and communities. The collaboration between citizen science and libraries requires a close coordination among researchers, libraries, and the public [17]. There are numerous ways in which libraries can provide support for citizen science. Ignat et al. noted some examples like ensuring access to citizen scientists' contributions and the research outcomes they contribute to, promoting and nurturing literacy skills, establishing partnerships with entities, and facilitating local engagement and dissemination [18]. All types of libraries can be involved in citizen science, but this work will focus on public libraries and research libraries given that more research has been found in the literature on these types of libraries.

A public library offers entry to information, lifelong learning, and creative works using various resources and services. It is open to all community members, irrespective of race, nationality, age, gender, religion, language, disability, economic and employment status, and educational attainment. This institution is established and sustained by the community, either through local, regional, or national government support or through other community organizations. The main objective of the public library is to offer a diverse range of resources and services across various media, catering to the educational, informational, and personal development needs of both individuals and groups, encompassing recreation and leisure as well [19]. Citizen science initiatives can be effectively executed within public libraries, and there is potential for these libraries to be "leaders and innovators in citizen science" [20]. Engaging public libraries in citizen science has the potential to offer alternative learning opportunities. When combined with heightened social cohesion, this collaboration may create fresh insights into public libraries, transforming them into spaces where knowledge is not just shared but also collaboratively constructed in a horizontal manner [21]. In accordance with the mentioned paragraphs, public libraries, characterized by inclusivity and a wide array of resources, have the potential to take a leading role in citizen science. This involvement may contribute to collaborative knowledge construction through alternative learning experiences and increased social cohesion.

A research library is a library that houses a comprehensive assortment of materials focused on one or multiple subjects. Typically, it encompasses a thorough compilation of materials related to specific topics and it is created to address the requirements of scholarly investigations, ensuring they are equipped with genuine materials comprising high-quality content [22]. Research libraries are primarily affiliated with research-intensive universities and possess extensive collections dedicated to scholarly research. Interestingly, it is noteworthy to mention that LIBER has formulated its own definition of a research library because of the change in the landscape of European universities. Those changes are marked by the establishment of new universities, university mergers, and an increased collaboration among higher education institutions [23]. LIBER's proposed 'Endorsement Proposal' emphasizes that research libraries wishing to join should adhere to LIBER's values. LIBER's values are as follows: providing excellent services to library and information users, ensuring intellectual freedom, fostering collaboration with various partners, responsibly managing collections and resources, demonstrating leadership and innovation, and promoting inclusivity, equality, and the realization of potential are key principles to be embraced [24]. The concept of citizen science is gaining popularity, with various hubs emerging at European universities to support it. Research libraries have the potential to play a pivotal role in promoting both citizen science and open science [25].

It is interesting to note that some studies have shown that scientists do not perceive the benefits of citizen science. For instance, Golumbic and colleagues published a study revealing that many scientists find it challenging to accept the idea that the public can make actual contributions to science. Although the scientists acknowledge the advantages of citizen participation for the public, they express no desire to actively engage with the public and prefer to conduct traditional studies without involving the public [26]. In a study conducted by Riesch and Potter, scientists pointed out key issues in citizen science

from scientist's perspective, including concerns about the quality of data, how their work is perceived by the broader scientific community, and the ownership aspects related to publication [27]. In their study on Flemish scientists, Duerinckx et al. point out additional disadvantages such as the challenge of securing long-term commitment from participants in the project, increased administrative workload, and issues related to financing, as well as legal, ethical, and privacy aspects [28]. Libraries have the opportunity to examine such and similar views of scientists on citizen science and shape specialized programs and education related to citizen science. Despite some scientists holding negative opinions about citizen science, libraries can leverage this insight to tailor their programs and education to the needs of scientists. This approach allows libraries to build a bridge between scientists and citizen science, identifying and addressing specific biases or concerns scientists may have.

Although libraries consistently emphasize the importance of their involvement in citizen science in terms of benefits for participants (both citizen scientists and researchers), it is worth noting that libraries themselves can derive certain benefits. Clearly, due to their mission and vision, they are oriented towards societal well-being, and their own benefits are seldom highlighted. However, more frequent acknowledgment of the direct benefits for libraries engaged in citizen science may encourage other libraries to join. The following text will examine literature from which an attempt will be made to compile a list of benefits of citizen science for libraries.

3. Materials and Methods: Literature Review

For the compilation of the list of benefits of citizen science for libraries, articles by experts from various types of libraries were analyzed, as well as those by other facilitators who organized citizen science activities in collaboration with libraries. Google Scholar was used as a tool for information retrieval. The key words used for the search were 'citizen science' and 'libraries', with the addition of the word 'benefits' and its synonyms such as 'advantages', 'perks', 'pluses', 'opportunities', 'gains', and 'positives'. Publications on public and research libraries were included in the search.

A descriptive review of the literature was chosen for its ability to provide a general overview of the available literature on the topic and present different perspectives and viewpoints, rather than conducting a detailed analysis or synthesis of results. Since the aim was to compile a list of benefits of citizen science for libraries, a descriptive review of literature provided an appropriate approach for gaining a general insight into various aspects of the topic. Additionally, Google Scholar provides a wide range of literature from various sources, which was useful for encompassing the diversity of perspectives and information in this literature review. Google Scholar is a freely accessible database, which is consistent with the transdisciplinary ethos of citizen science.

3.1. Public Libraries

The goals of citizen science are in harmony with those of public libraries and numerous community organizations. Public libraries and citizen science shared objectives include promoting fair access to information, expanding knowledge, fostering participatory lifelong learning opportunities, and cultivating and supporting diverse communities [29]. Goulding, in her review paper on community engagement activities in public libraries, concluded that the role of the public library extends beyond being a space for borrowing or reading books, and even beyond accessing digital materials. Instead, she emphasizes that the public library is evolving into a vital community resource and facility. It serves not only as a venue for community events but also as a hub that facilitates connections between individuals. The library acts as a conduit linking people to their local communities and fostering connections between communities and the broader society [30]. Maroto stated that the benefits of citizen science for public libraries include access to materials, instruments, and resources, raising awareness of innovation, building relationships with scientists and researchers, and engaging patrons [31]. Citizen science aligns with the goals of public

libraries and community organizations by promoting equitable access to information, expanding knowledge, and fostering diverse communities.

Senabe et al. argue that, based on the views of librarians, integrating public libraries into citizen science could facilitate unconventional learning opportunities. This, combined with enhanced social cohesion, has the potential to cultivate fresh outlooks on public libraries, transforming them into spaces where knowledge is not merely shared but also collaboratively constructed in a horizontal manner [32]. This assertion can be extended to all types of libraries, not just public libraries.

Cigarini et al. explored the potential of public libraries to become hubs for citizen science. In this context, the authors surveyed librarians. The respondents emphasize some of the benefits: the initiative attracted new library users and fostered new local connections; citizen science brought additional resources to the library while strengthening social networks in the community; librarians emphasized the opportunity the activity provided for them to acquire new skills and practices and citizen science enhances social cohesion and improves the perception of the library's societal value [21]. The next project discusses the benefits for libraries from the perspective of collaborators in the implementation of a citizen science project. The authors, Lasky et al., presented the project "North Carolina Candid Critters". Project leaders acknowledged that collaborating with local libraries enabled them to establish more direct connections with rural communities. Libraries played a crucial role in distributing equipment, a task that would have been impractical on such a large scale from a single facility without additional funds [33]. Citizen science projects demonstrate the transformative role of public libraries, attracting new users, building community connections, and enhancing resources. Collaboration with libraries proves pivotal in establishing direct links with diverse communities and efficiently distributing equipment, showcasing the broader societal value of libraries.

3.2. Research Libraries

From broader perspective, Cohen et al. stated that by linking researchers with citizen scientists, the library serves as a channel for citizen science initiatives and functions as an intellectual center—a space for both accessing scientific knowledge and actively participating in scientific pursuits [34]. This also means that libraries can be recognized as institutions that can support scientific research, which is not always the primary mission of libraries.

Ignat et al. stated that with the help of citizen science, libraries could enrich their collections and make them more accessible [17]. Mumelaš explained it further and stated that depending on the project type, libraries can encourage citizen scientists to use sources more frequently, whether in the form of printed or online materials. Examining successfully implemented projects reveals that participants, with prior education and clear instructions, can swiftly and effectively supplement and enhance, for example, digitized collections by participating in their description and tagging. In addition to raising awareness about the sources and collections the library possesses, citizen scientists also assist in the execution of library processes [35]. Bonney and Dickson have argued that citizen science influences scientific communication and encourages the publication of research results in open access. Libraries can facilitate broader access to published scientific papers [36]. One of the benefits of citizen science projects for libraries are the development of new competencies and professional advancement. Ridge states that such projects encourage library staff to acquire additional skills, including community engagement methods, project management, communication of scientific topics, and improved business process management [37]. According to the research by Kaarsted et al., research librarians already possess the skills necessary for integrating citizen science, which they can further enhance. In the mentioned study, survey respondents were asked questions aimed at understanding the skills available in their libraries. More than three-quarters of respondents indicated they have skills in advocacy, organizing events, facilitating workshops, teaching, and communications. Between 50 and 74% of the respondents reported skills in seven areas: project coordination, project management, evaluation, research data management, publishing FAIR (findability,

accessibility, interoperability, and reusability) data, preservation of data and protocols, and General Data Protection Regulation (GDPR). The only areas with less than 50% of the respondents indicating competencies were writing grant proposals and others [25]. The LERU advice paper highlights additional advantages of citizen science for universities, and these benefits can also be relevant to research libraries. One advantage involves supporting the educational and societal goals of universities by nurturing interest and active participation in science across various demographics, especially among teachers and students, through their involvement in research projects. Additionally, there is a reinforcement of the connection between universities and society by directly engaging citizens in research that holds significant implications for their local environments. The encouragement of collaboration with a diverse array of stakeholders who can provide valuable insights, suggestions, and ideas to improve existing research activities is another noteworthy benefit. Furthermore, the utilization of non-anonymized data from consenting citizen scientists can play a pivotal role in exploring new research inquiries, particularly in areas such as health and socio-economics [38]. Research libraries stand to benefit significantly from the integration of citizen science initiatives. By leveraging citizen science, libraries can enrich their collections, improve accessibility, and raise awareness about their holdings. Additionally, participation in citizen science projects contributes to the development of new competencies among library staff, fostering professional advancement and enhancing skills in areas such as community engagement, project management, and scientific communication.

If we look at papers that analyze specific examples of specific libraries and citizen science projects conducted in libraries or with library support, we can also observe some directly mentioned benefits. Overgaard and Kaarsted, in their work presenting the citizen science project “A Healthier Funen”, explained how, through collaboration with the media, they managed to reach a large audience/citizen scientist. They also emphasized the importance of partnerships with other stakeholders. As a direct consequence of the success of the “A Healthier Funen” citizen science project, the authors mentioned the establishment of a citizen science network between the university and the hospital [39]. Ayris and Ignat argue that if research organizations can foster both collaboration and competition as integral components of their research activities, positive outcomes will ensue. They suggest that a practical method for implementing citizen science at the institutional level involves establishing a single citizen science point of contact, referred to as BESPOC (Broad Engagement in science, Point in Contact). As an example, they point to UCL Library Services, which has identified key priorities for citizen science activities and intends to integrate them into a comprehensive UCL program. The aim is to seamlessly integrate outreach activities to new communities into the library’s regular operations. Additionally, they propose the creation of a virtual office for open science, serving as a central hub for BESPOC [40]. Wiederkehr presented the benefits of conducting citizen science activities within the ETH Library. Similarly to previous authors, he addresses the advantages in terms of increased media visibility for libraries through citizen science projects. Additionally, implementing citizen science projects within the library (in the case of this library, it was a crowdsourcing based on their Map Collection) has spurred the development of new library programs and tools. It was also emphasized that the ETH Library “had become a recognized competent partner in citizen science projects” [41].

The authors Opryshko and Nazarovets describe the project “Grinchenko’s Dictionary and Modernity”, which emerged as a product of a previously established citizen science project, the Dictionary of Borys Grinchenko. This confirms how libraries, based on implemented citizen science projects, can introduce new similar initiatives and additional programs. The authors also emphasized the importance of partnerships within the institution (in their case, Borys Grinchenko Kyiv University) as another benefit of citizen science for libraries [42]. About the experience of the University Library “Svetozar Marković” and their projects “Wiki Marathons” and “Transcribathon” wrote Mumelaš, Martek and Mučnjak. As benefits of conducted citizen science activities for the library, there is emphasized

robust collaboration and outreach across diverse institutions throughout Serbia, integration of Wiki articles into the faculty curriculum, heightened visibility of materials in cultural institutions, the enhancement of library staff knowledge, and the establishment of robust business connections with libraries in Serbia [43]. Holley, in her review article, discusses the benefits of crowdsourcing for libraries, and in addition to those mentioned, she also adds advantages such as “building new virtual communities and user groups, improving the quality of data, adding value to data, and making it discoverable for diverse audiences”. The author also mentions benefits such as “gaining first-hand insight into user desires, and encouraging a sense of public ownership and responsibility towards cultural heritage collections” [44].

In examining papers that analyze the benefits of citizen science for research libraries, several overarching advantages become apparent. Citizen science initiatives facilitate the broadening of audience reach, enhancing visibility and engagement with diverse communities. The establishment of collaborative networks and partnerships emerges as a significant benefit, fostering connections within and outside the institution. The seamless integration of citizen science into regular library operations is highlighted, enabling libraries to efficiently incorporate outreach activities. Furthermore, citizen science activities contribute to increased media visibility, emphasizing libraries as active contributors to scientific endeavors.

It is necessary to emphasize that there are likely additional benefits for libraries that engage in or support citizen science activities. Only peer-reviewed papers that are mentioning direct benefits were considered. It should be noted that some libraries involved in citizen science do not share their experiences through written papers. Moreover, those that do often focus on the benefits for the local and scientific community.

4. Discussion—List of Benefits

Based on the reviewed literature, benefits of citizen science for libraries have been identified. The benefits were determined based on their direct mention in the literature and are depicted in Figure 1. The investigated benefits are divided into two categories: external and internal. External benefits refer to the library’s impact on the broader community, including partnerships with other organizations, attracting new users, and creating visibility in the media. On the other hand, internal benefits focus on improving internal processes and capacities of the library, such as collection development, leveraging employee expertise, and their personal development.

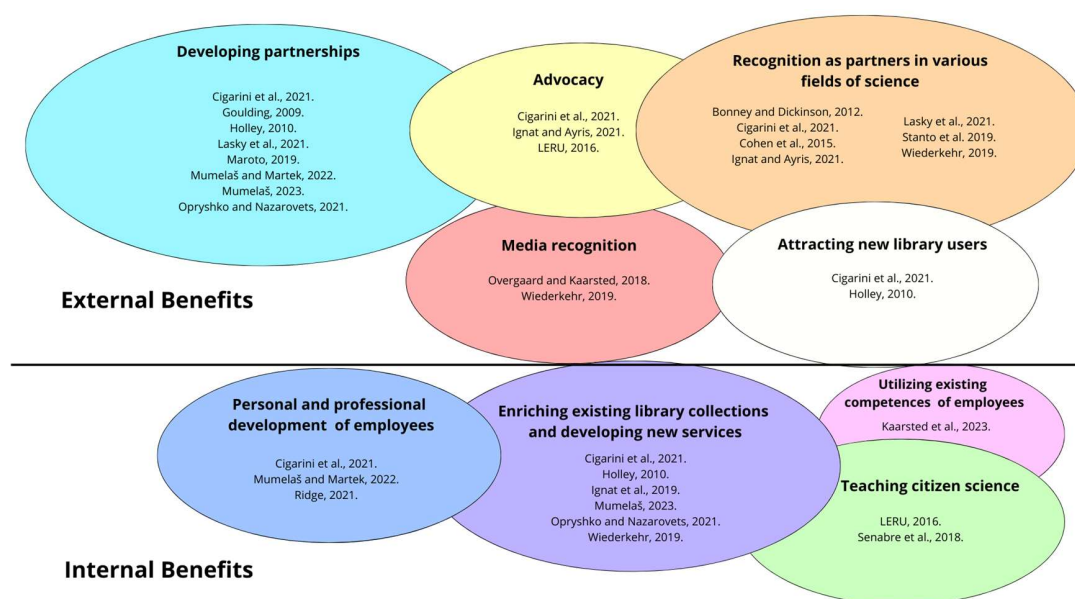


Figure 1. Benefits of citizen science for libraries [17,21,25,30–44].

Each category is visually represented in a specific size corresponding to how many times different authors have mentioned it. It can be seen that the most frequently mentioned benefits are developing partnerships, recognition as partners in various fields of science, and enriching existing library collections and developing new services. The least mentioned benefits are utilizing existing competences of employees, media recognition, and teaching citizen science. Some authors have mentioned multiple different benefits, so they appear in multiple places.

Based on the literature review shown in Figure 1, a list of benefits of citizen science for libraries is proposed:

- (a) Recognition as partners in various fields of science.
- (b) Advocacy.
- (c) Teaching citizen science.
- (d) Developing partnerships.
- (e) Attracting new library users.
- (f) Media recognition.
- (g) Enriching existing library collections and developing new services.
- (h) Utilizing existing competences of employees.
- (i) Personal and professional development of employees.

Libraries have the potential to be acknowledged as collaborative partners in a range of scientific disciplines. Through active participation in citizen science initiatives, libraries position themselves as valuable contributors and supporters, engaging with diverse scientific fields and fostering collaborative efforts. This recognition stems from their role in providing access to research materials, contributing to data management practices, and advocating for open access principles. By aligning with these activities, libraries strengthen their position as essential partners in advancing scientific knowledge across various domains.

By advocating for citizen science, libraries support the idea that the public can contribute to scientific research. This approach promotes active citizen participation in research, resulting not only in increased data accessibility but also in the development of shared responsibility for scientific topics. Libraries, as advocates of this model, position themselves as promoters of inclusivity in knowledge creation, thereby reinforcing their role as relevant and progressive institutions in society.

Engaging in citizen science provides a valuable opportunity for education within the library setting. By actively participating in citizen science initiatives, libraries contribute to the education of librarians, scientists, and citizen-scientists alike. Furthermore, the establishment of a dedicated unit such as BESPOC within the library framework can serve as a focal point for organizing and delivering targeted educational programs. Through BESPOC, libraries can offer specialized training sessions, workshops, and resources designed to enhance the understanding of citizen science principles and practices. This tailored education can benefit librarians by equipping them with the expertise needed to effectively support and guide citizen science initiatives.

Engaging in citizen science initiatives enables libraries to cultivate partnerships both within their organizational structure (internal) and with external entities. Internally, libraries can forge collaborations among different departments or teams within the library, fostering a multidisciplinary approach to citizen science projects. Externally, libraries can establish partnerships with external organizations, research institutions, community groups, or other stakeholders involved in citizen science. Kaarsted et al. recommend that (research) libraries actively pursue partnerships by engaging with established working groups, organizations, networks, or project consortia. Alternatively, they can take the initiative to create new collaborations. The suggested partners encompass universities, civil society, government entities, the education sector, the private sector, etc. [25]. These collaborative efforts contribute to the library's ability to support and enhance citizen science activities, broaden its network, and create a more robust ecosystem of shared knowledge and resources.

By actively participating in citizen science initiatives, libraries have the potential to draw in and attract new users. Citizen science projects often involve the community in scientific research, creating an opportunity for individuals who may not traditionally use library services to engage with the library. The appeal of citizen science, which encourages active participation in scientific activities, can serve as a gateway for people to discover and utilize the resources and services offered by the library. In this way, libraries can broaden their user base and reach individuals who are interested in both scientific exploration and the diverse offerings provided by the library.

Citizen science initiatives can contribute to gaining recognition from the media for libraries. When libraries actively participate in citizen science projects, they engage in collaborative and impactful activities that are often of interest to the broader community. The media may find these initiatives noteworthy, leading to coverage and visibility for the library's involvement in citizen science. This recognition can take the form of news articles, interviews, or features that highlight the library's role in supporting scientific research and community engagement. By leveraging citizen science projects, libraries have the potential to enhance their visibility in the media, thereby strengthening their public image and raising awareness about the valuable contributions they make to scientific endeavors and community involvement.

Citizen science participation can contribute to the enrichment of a library's existing collections and services. Through citizen science projects, libraries often involve the community in activities that generate new knowledge, materials, or resources. The outcomes of these projects, such as data, research findings, or tangible artefacts, can be incorporated into the library's collections, enhancing the diversity and relevance of available materials. Moreover, citizen science engagement may inspire the development of new services that align with the interests and needs of the community involved in these projects. Citizen science serves as a means for libraries to actively augment their collections and adapt their services to better reflect the evolving interests and contributions of the community they serve.

In their research, Kaarsted et al. identified the acknowledgment of transferable skills that are well-suited for citizen enhanced open science. Research libraries have the opportunity to assess the existing skill set and concentrate on enhancing competencies in areas that may be lacking [25]. Leveraging existing competences is a significant benefit when integrating citizen science into library initiatives. Libraries inherently possess a diverse pool of skills and competences among their staff, ranging from information management to community engagement. By aligning these existing competences with the collaborative nature of citizen science, libraries can efficiently contribute to scientific projects while maximizing the utilization of their internal expertise.

The involvement of library employees in citizen science can yield positive effects on their personal and professional development. Engaging in citizen science projects offers employees opportunities to develop and enhance a variety of skills, such as project coordination, project management, evaluation, and research data management. These experiences contribute to the enrichment of their professional skill set and may lead to increased competence in handling diverse aspects of library work. Additionally, participating in citizen science can broaden the horizons of library staff, exposing them to new challenges and fostering a deeper understanding of the collaborative nature of scientific inquiry. This exposure not only contributes to their professional growth but also adds a valuable dimension to their personal development by fostering a sense of accomplishment and engagement with meaningful, community-oriented work. Overall, citizen science initiatives in libraries provide a platform for continuous learning and development for library employees.

Why is it important to talk about the benefits of citizen science for libraries? Firstly, it sheds light on the valuable contributions that libraries can make to scientific endeavors through citizen science initiatives. This recognition is crucial in highlighting the evolving role of libraries beyond traditional information repositories. Secondly, emphasizing these

benefits serves to inspire and encourage other libraries to engage in citizen science. By showcasing the positive outcomes, such as increased visibility, enriched collections, and community engagement, it encourages a broader adoption of citizen science practices within the library community. Furthermore, discussing these benefits contributes to a broader understanding of the societal impact of libraries. It underscores their role not only as information providers but as active participants in community-driven scientific activities. This can enhance the public perception of libraries, positioning them as dynamic institutions that contribute actively to the advancement of knowledge and community well-being.

5. Conclusions

Today, the concept of citizen science is positioned within the broader field of open science, and citizen science is recognized as a grounded and valid approach to scientific research [45]. Participation in citizen science activities presents a multifaceted opportunity for libraries, transcending their conventional roles as repositories of knowledge. Engaging in citizen science not only positions public and research libraries as active contributors to scientific endeavors but also fosters dynamic partnerships across diverse fields.

This literature review, which explored the benefits of citizen science for public and research libraries, identified the following advantages: recognition as partners in various fields of science, advocacy, teaching citizen science, developing partnerships, attracting new library users, media recognition, enriching existing library collections and developing new services, utilizing existing competences and personal and professional development of employees. Those benefits are divided into two groups: external and internal.

Through active participation in citizen science initiatives, libraries position themselves as valuable contributors and supporters, engaging with diverse scientific fields and fostering collaborative efforts. This recognition stems from their role in providing access to research materials, contributing to data management practices, and advocating for open access principles. By aligning with these activities, libraries strengthen their position as essential partners in advancing scientific knowledge across various domains. To leverage the potential of being recognized as partners in various scientific fields, libraries should actively promote their involvement in citizen science projects. Additionally, they need to continue supporting open access to research materials and develop initiatives that enhance collaboration with the research community. Educating stakeholders about the benefits of their role in citizen science projects could also contribute to increasing the recognition of libraries as key players in scientific research.

By actively advocating for citizen science, libraries endorse the notion that the public can play a crucial role in scientific research. This advocacy encourages active citizen involvement in research, leading to not only enhanced data accessibility but also the cultivation of shared responsibility for scientific endeavors. With advocacy, libraries position themselves as advocates for inclusivity in knowledge creation, thereby strengthening their role as pertinent and forward-thinking institutions in society. Encouraging community involvement and fostering partnerships with educational institutions can further promote the inclusivity of citizen science initiatives. Additionally, libraries can collaborate with policymakers to integrate citizen science principles into broader scientific strategies, emphasizing the importance of diverse perspectives in shaping the future of research.

The engagement of libraries in citizen science presents a valuable opportunity for education within the library setting. Actively participating in citizen science initiatives allows libraries to contribute to the education of librarians, scientists, and citizen-scientists alike. The establishment of a dedicated unit, such as BESPOC, within the library framework serves as a central hub for organizing and delivering targeted educational programs. Through BESPOC, libraries can provide specialized training sessions, workshops, and resources designed to enhance the understanding of citizen science principles and practices. This tailored education is advantageous for librarians, equipping them with the expertise needed to effectively support and guide citizen science initiatives. Collaborating

with educational institutions and citizen science organizations can broaden the reach of these programs.

Engaging in citizen science initiatives empowers libraries to develop partnerships both internally and externally. Internally, libraries can foster collaborations among different departments or teams, encouraging a multidisciplinary approach to citizen science projects. Externally, libraries can establish partnerships with organizations, research institutions, community groups, and other stakeholders involved in citizen science. They can also partner with working groups, organizations, networks, project consortia, civil society, government entities, etc. To further develop partnerships, libraries should proactively engage with diverse internal departments and teams to promote a collaborative approach to citizen science initiatives. External partnerships can be expanded by actively participating in established networks and seeking out potential collaborators in universities, government entities, and the private sector. Additionally, documenting and sharing successful partnership models can inspire other libraries to pursue similar collaborations.

Active engagement in citizen science initiatives positions libraries to draw in and attract new users. Citizen science projects, involving the community in scientific research, provide an opportunity for individuals who may not typically use library services to interact with the library. The allure of citizen science, promoting active participation in scientific activities, acts as a gateway for people to discover and utilize the resources and services offered by the library. In this manner, libraries can expand their user base, reaching individuals interested in both scientific exploration and the diverse offerings provided by the library. To further attract new users, libraries should actively promote their involvement in citizen science projects through targeted outreach and marketing efforts. Collaborating with community organizations, schools, and local media can enhance visibility and awareness of library initiatives. Libraries can also consider tailoring specific programs and services to cater to the interests of the diverse audience engaged through citizen science projects.

Participating in citizen science initiatives provides libraries with an avenue to gain recognition from the media. When libraries actively engage in collaborative and impactful citizen science projects, these activities often capture the interest of the broader community. The media may find such initiatives noteworthy, resulting in coverage and visibility for the library's involvement in citizen science. This recognition can manifest through news articles, interviews, or features that highlight the library's role in supporting scientific research and community engagement. To continue gaining media recognition, libraries should proactively share information about their citizen science projects through press releases, social media, and other communication channels. Building relationships with local journalists and media outlets can facilitate coverage of library initiatives. Regularly assessing the media coverage and adapting communication strategies accordingly will further contribute to sustaining and expanding the library's presence in the public eye.

Citizen science participation plays a crucial role in enriching a library's existing collections and fostering the development of new services. This not only contributes to the diversity of content within the library but also highlights the community's ability to participate in shaping and expanding the cultural heritage preserved by the library. Furthermore, citizen science engagement has the potential to inspire the creation of new services that align with the interests and needs of the community involved in these projects. To continue enriching collections and developing services through citizen science, libraries should actively seek out projects that align with the diverse interests of their community. Libraries can also explore innovative approaches, such as virtual resources or interactive platforms, to make citizen science outcomes more accessible to the community and seamlessly integrate them into their collections and services.

Utilizing existing competences of library employees emerges as a significant advantage for libraries when integrating citizen science into their initiatives. Libraries have a diverse pool of skills and competences among their staff, spanning from information management to community engagement. By aligning these competences with the collaborative nature of

citizen science, libraries can efficiently contribute to scientific projects while maximizing the utilization of their internal expertise. To further leverage existing competences, libraries should conduct a thorough assessment of the skills within their staff and identify areas for enhancement. Establishing interdisciplinary teams within the library can facilitate the collaborative utilization of diverse competences.

The involvement of library employees in citizen science projects yields positive effects on both their personal and professional development. Engaging in these initiatives offers employees opportunities to develop and enhance various skills, including project coordination, project management, evaluation, and research data management. These experiences contribute to the enrichment of their professional skill set, potentially leading to increased competence in handling diverse aspects of library work. Additionally, participating in citizen science broadens the horizons of library staff, exposing them to new challenges and fostering a deeper understanding of the collaborative nature of scientific inquiry. Providing opportunities for skill-building workshops, training sessions, and mentoring programs can enhance the capabilities of library staff. Recognizing and celebrating the achievements of employees involved in citizen science initiatives can foster a positive and supportive organizational culture.

Future research endeavors can delve into the specific benefits derived from individual citizen science projects within the context of libraries. Examining the outcomes and impacts of particular initiatives can provide nuanced insights into the effectiveness of citizen science engagement at the project level. Researchers may explore how different types of projects contribute to community empowerment, scientific knowledge advancement, and the overall mission of libraries.

Author Contributions: Conceptualization, D.M. and A.M.; methodology, D.M.; validation, D.M. and A.M.; formal analysis, D.M.; data curation, A.M.; writing—original draft preparation, D.M.; writing—review and editing, A.M.; visualization, D.M. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.

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