Public libraries embrace citizen science: strengths and challenges

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ABSTRACT

Can public libraries become hubs for citizen science? We answer this question collaboratively, in line with citizen science principles. Two hands-on activities for librarians of the Barcelona Network of Public Libraries were ideated and implemented. One was a training course for 30 librarians from 24 libraries. The training empowered the librarians and allowed them to envisage citizen science tailormade implementation in each library. The second activity consisted of the co-creation of a citizen social science project. 40 library users, 7 librarians from 3 different cities, and professional scientists, were involved. Before, during and after the activities, we listened to librarians and users with participant observation, surveys, and a focus group to identify strengths and challenges. The potential of citizen science at public libraries, and especially its co-created citizen social science format, lays within a more social dimension that allows to strengthen social bonds among participants and acquire better knowledge of the environment. However, the potential may be hindered by the complexity of collaboration, the uncertainty of research co-creation and by participant retention strategies. The results overall suggest that public libraries can offer leadership in the promotion and implementation of citizen science initiatives, contributing to the debate over the public libraries' mission as local community hubs.

Introduction

Citizen science (CS) broadly refers to the active engagement of the general public in scientific research tasks that are traditionally implemented by scientists[1,2]. Although not new in the history of science[3] there is increasing awareness about its current, and potential, social and political impacts[4–6]. The democratic promise that characterizes the more inclusive CS narrative[3] builds on the idea that scientific knowledge is socially constructed[7] and that CS enables citizens to direct research towards societal needs[8]. This civic facet of CS is often associated with co-design, collaborative inquiry, community-based or participatory action research, civic science or extreme citizen science[9–12]. It can eventually be framed as 'citizen social science'[13,14], understood as a research co-designed and driven by groups sharing a social concern[15].

Almost in parallel to this vivid form of understanding CS, public libraries are reconsidering their core mission. The shift towards a knowledge-based society[16] has challenged the role and social value of the public library as an institution in society[17,18]. Much analysis and debates about the changing nature of the public library, however, has focused on the implications and needs emerged as a consequence of the digital revolution[19,20]. A recent large-scale survey on citizens perceptions and support for public libraries identified differences between the services offered and those requested by library users[21]. The study suggests that public libraries and their uses are to be redesigned so that, as well as being quiet places with books and Internet connection, they can also be shaped into community hubs in which library professionals should take on active roles[21]. Yet, libraries are more than infrastructures and contents: they are socially meaningful institutions with a higher role and calling, as transcultural and transgenerational knowledge spaces created beyond traditional disciplinary boundaries.

These two lines of discourse, emerging CS practices and redefinition of public libraries' core mission, share similar visions. Made few and limited discussions in the context of European and American research libraries[22–25] [1], there is no empirical evidence of whether the most open and participatory ways that CS puts forward can converge with and be nurtured by the essence of public libraries. Also, the roles of librarians and users in the 'next generation public library' have been under-developed.

We herein present the analysis of the one-year project (2018-2019) Citizen Science in Action promoted by the Barcelona Network of Public Libraries (Catalunya - Spain), that coordinates 225 libraries and 2,7M users. The project we implemented was part of the Bibliolab programme [2] whose broad aim is to experiment new forms of open and creative collaborations with citizenry. The project has tested and then analyzed the capacity of assimilation of CS practices in public libraries. It included the ambition to collect evidence and, jointly with librarians and users, reflect on strengths and challenges of embracing

co-created CS in public libraries.

Research context

The project was structured along two interdependent and hands-on activities offered to librarians as part of their life-long training. These activities were: the Citizen Science Lab, and the Science and Citizen Action.

The Citizen Science Lab consisted of an introductory course of 5 two-hours capacitation sessions about CS addressed to 30 librarians from 24 different libraries (see Figure 1). Based on both theoretical and practical activities, the librarians learned about CS practices, they tested and eventually implemented existing CS projects at their library. Throughout this effort they collectively discussed the opportunities and challenges that CS could offer to library users, and the aspects that are to be addressed when implementing a CS project at the library. As a result, the librarians' recommendation took the form of a collective toolkit for library users and other librarians on how to turn on citizen science projects at libraries[26]. Librarians selected 10 CS projects to be implemented in their libraries, and proposed a series of parallel activities for their own libraries.
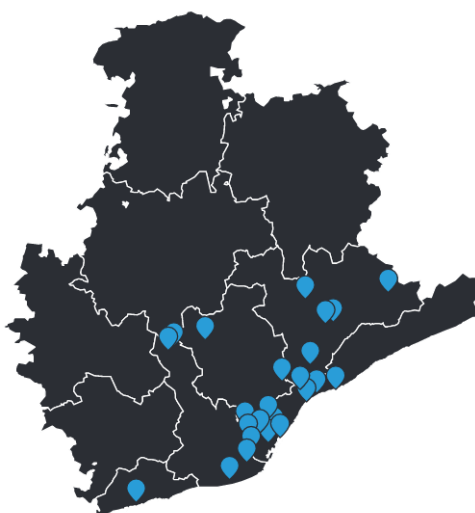

Figure 1. Map of the Barcelona Metropolitan Area indicating in blue the 24 public libraries participating in the Citizen Science Lab: Biblioteca Mercè Rodoreda (Sant Joan Despí), Biblioteca Ramon Fernàndez Jurado (Castelldefels), Biblioteca Antonio Martin (El Prat de Llobregat), Biblioteca Joan Coromines (Masnou), Biblioteca bd5 (Terrassa), Biblioteca Can Casacuberta (Badalona), Biblioteca de Viladecans (Viladecans), Biblioteca Santa Oliva (Olesa de Montserrat), Biblioteca L'Ateneu (Esparreguera), Biblioteca Sagrada Família - Josep M. Ainaud de Lasarte (Barcelona), Biblioteca Fort Pienc (Barcelona), Biblioteca de Bigues i Riells (Bigues i Riells), Biblioteca Can Pedrals (Granollers), Biblioteca Roca Umbert (Granollers), Biblioteca Ernest Lluch i Martin (Vilassar de Mar), Biblioteca Municipal (Cervelló), Biblioteca La Grua (Montmeló), Biblioteca Central (Cerdanyola del Vallès), Biblioteca Volpelleres - Sant Miquel Batllori (Sant Cugat), Biblioteca Josep Janés (L'Hospitalet de Llobregat), Biblioteca El Molí (Molins de Rei), Biblioteca Montserrat Roig (Sant Feliu de Llobregat), Biblioteca de Sant Antoni de Vilamajor (Sant Antoni de Vilamajor), Biblioteca Joan Oliva i Milà (Vilanova i la Geltrú).

At a higher level of engagement, the activity Science and Citizen Action involved 7 library professionals also participating in the Citizen Science Lab, from three municipalities of the Barcelona Metropolitan Area (Fort Pienc - Barcelona, Granollers and Olesa de Montserrat), ranging from 24,000 to 1.5M inhabitants. After being specifically trained and in close collaboration with professional researchers, a community generated ad-hoc for the project co-created and ran a public behavioral experiment[27] [3]. Groups formed by library users and local associations were created, according to diversity and inclusion principles. The activity was based on co-creation methodologies to align scientific goals and citizen social concerns. The librarians were trained on co-creation and dynamic learning[28] following the methodology developed in Senabre et al.[9] through 4 two-hours sessions: how to agree on the research focus, how to formulate the research question, how to plan the experiment, and how to interpret the results. After each session, the librarians were asked to put the knowledge into practice by replicating the session within their community. In these sessions, they took the role of facilitators, with the support of researchers. Each following session, the librarians discussed the output of their community's work with other librarians. By the end of the third session, they together came up with a unique research design agreed for all three municipalities that addressed a common social concern: access

to housing. A related public behavioral experiment was run in the public space to bring libraries and librarians to the streets with 358 participants. Framed as 'citizen social science'[13–15], the activity was thus putting the accent on the civic facet of CS practices. Behavioral data was collected by means of simulations of the housing market implemented on the Citizen Social Lab platform[29] and following a game theoretical paradigm on strategic decision-making[30].

Methodology

Research on engagement in CS builds on a variety of socio-psychological models, including experiential, transformative and situated learning theories[31–34], or self-determination and social movement theory[35], among others. We drew on the Theory of Planned Behaviour (TPB)[36] to explore the dynamics of participation. According to the theory, the intention to keep engaged in CS activities is best predicted by positive views towards CS (attitudes), favorable opinions of influential others towards CS (subjective norms), and by individual perceived ability to engage in CS (perceived behavioral control)[36]. The data were collected in different phases of the project and the analysis builds on a mixed-method approach.

Citizen Science Lab
For the activity Citizen Science Lab, the data were collected through paper-based questionnaires (see Figure 2). The closed-ended questions covered librarians familiarity with CS, their expectations regarding users engagement, their perceived efficacy to recommend a CS project and to implement it at their library, the perceived impact of the activity and their overall satisfaction. Overall, we collected 25 responses in the first paper-based questionnaire, and 22 responses at the end of the course. The majority of librarians (60%, n=15) had been working at the library for 11 to 20 years and only 4% (n=1) had a scientific background. Further details are provided in the Supplementary Information document.

Science and Citizen Action
For the activity Science and Citizen Action, data on librarians engagement with CS was collected through a focus group at the end of the project. The focus group addressed each element of the TPB model. To uncover attitudes, the librarians were asked about what they considered to be positive and negative outcomes of participating in the activity. Subjective norms were identified by asking questions about the returns for users and participants after taking part in the activity. Self-efficacy came from questions regarding librarians perceived ability to lead the activity. Behavioral intention was explored by asking librarians about their intention to keep engaged with CS and implement a CS project the following year. Overall, 7 librarians participated in the focus group, all but one were women, one was director and the others were library technicians.

To complement librarians perspectives, we further collected data on library users' perceptions in three phases: at the beginning, after the third session, and after the fourth session (see Figure 3) through paper-based questionnaires. The questions covered library users' motivation to participate, their perception of the library, their perceived ability to contribute to different scientific tasks, the perceived impact of the activity, and their overall satisfaction and motivation to keep engaged with CS. Overall, we collected 54 users' answers to the first paper-based questionnaire and 23 valid answers to the last paper-based questionnaire. On average, 40 library users, across libraries, participated in each of the 4 sessions. The majority of participants were women, in the age range 36-55 years old, and were part or representatives of local community associations. Further details are provided in the Supplementary Information.

Responses to closed-ended survey questions were analyzed at a descriptive level because the reduced sample size did not allow for statistical significance testing. The qualitative feedback from the focus group and the open-ended survey question on motivations was subjected to a thematic analysis[37]. This is a widely used method for identifying, analyzing, and reporting patterns (or themes) within data inductively.
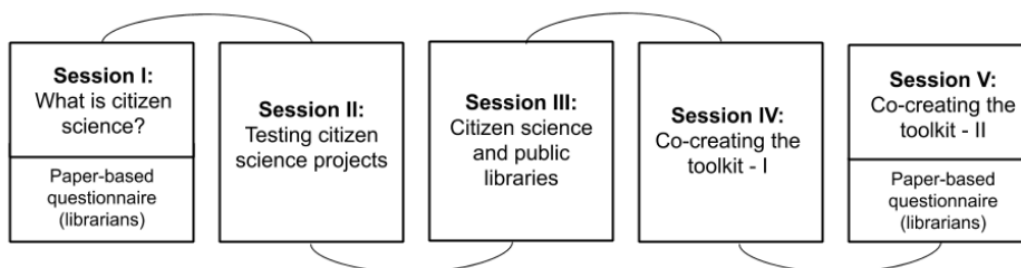

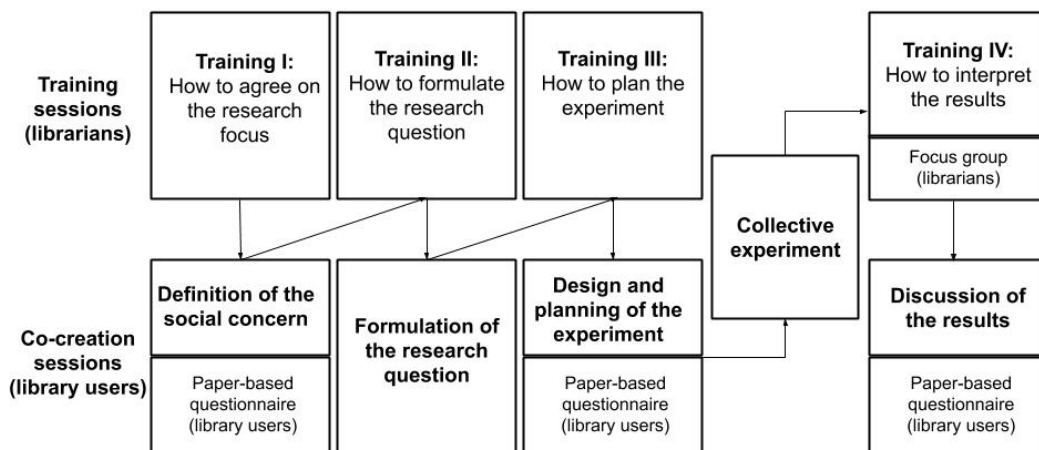**Figure 2.** The Citizen Science Lab timeline.

Figure 3. The Science and Action timeline.

Results

Surveys

The answers to the questionnaire administered at the end of the first session of the Citizen Science Lab show that the majority (56%, n = 14) already knew about CS, and that there was a strong consensus that library users could effectively participate in a CS project (96%, n = 24). There were however still some reservations about their degree of commitment: both at the beginning (75%, n = 18) and at the end of the activity (79%, n = 15) the majority imagined a moderate level of user involvement. The main concerns raised by librarians regarding user engagement had to do with user commitment (n=5), unawareness namely lack of familiarity with CS (n=4), and lack of time (n=3).

Out of the 26 projects that the librarians initially selected and tested themselves or in some cases with library users, the majority (n=19) were indeed of 'crowdsourcing' type, namely projects where participation is limited to the data collection process with minimal cognitive involvement[12]. Many of the projects selected counted on the use of a mobile app (n=11) or a web platform (n=11) for data collection, and were based on outdoor activities (n=22). Some librarians imagined an informative talk with scientists to explain how the project and app works and to promote its use, others planned to organize a one-day outdoor session in the surrounding of the library facilitated by scientists to collect data[26]. Further details are provided in the Supplementary Information document.

Overall, librarians expressed a high level of satisfaction. Librarians declared that they were completely or vastly satisfied with their initial expectations (70%, n=17). The most relevant fact is that, although their low former participation in CS projects (only 8% reported a previous participation) and their lack of scientific background (only 4% reported a scientific background), they expressed in the end a significantly higher (or total) confidence in relation to their ability to be involved or implement CS projects. At the beginning of the Citizen Science Lab, only 32% (n = 8) of librarians initially did see themselves capable of providing their users with content related to CS. However, by the end, everyone (100%, n = 22) self declared able to recommend and explain some CS projects to library users and felt motivated to be more engaged in CS projects (82%, n=18). Yet, concerning librarians' perceived capacity to start on their own a citizen science project, almost twice more declared to be 'totally' or 'largely' confident at the end of the project (44%, n=8) than at the beginning (21%, n=5). Librarians saw in CS above all an opportunity to create new connections (mean=1.68, sem=1.32, where -2 refers to 'strongly disagree' and 2 refers to 'strongly agree'), improve local knowledge (mean=1.58, sem=1.22), and a fun activity (mean=1.47, sem=1.08) that boosted social cohesion (mean=1.47, sem=1.20) (see Figure 4).

As for the co-creation frame of Science and Citizen Action, users were mainly motivated to participate by personal motives, social networks, advocacy and socialization, instead of being interested in citizen science (94% of users declared at the beginning that they had never participated in CS projects before). Although since the very beginning of the activity the majority very much agreed that their library is close and attentive to the needs of the community (57%, n=31) and agreed to a great extent that their library is able to face local challenges based on the active participation of its users (89%, n=48), the majority

agreed to a great extent that the public behavioral experiment had positively changed their perception of the library (70%, n=16), being first very motivated to run the experiment (58%, n=18), and then very satisfied with the experiment (70%, n=16). The latter result is aligned to the high or moderately high motivation to run the experiment by the librarians (100%, n=7). When asked about their capacity to participate in CS, namely contributing to different scientific tasks, both at the beginning and at the end of the activity library users were slightly most likely to report feeling confident about translating evidence into action based on the evidence gathered (0.63, sem=0.03 and 0.64, sem=0.05, respectively) rather than formulating the research question, collecting, or analyzing the data (see Table 1)). Library users indicated that participating in the project mainly increased their willingness to learn (mean=0.96, sem=0.84); it was a fun activity (mean=0.83, sem=0.70) and that. similarly to librarians' views, it increased social cohesion among engaged participants (mean=0.74, sem=0.65). See Figure 4.
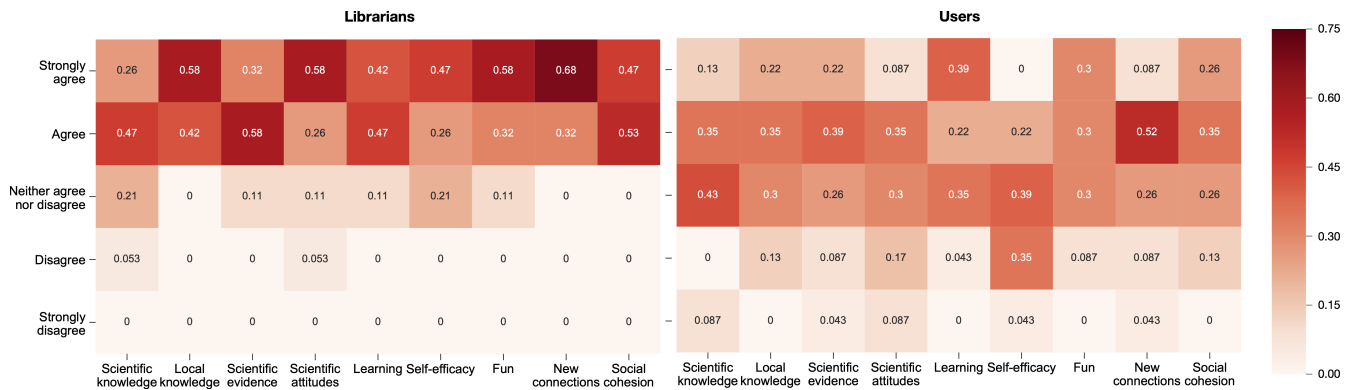

Figure 4. The heatmap shows the frequency of rankings to different dimensions of perceived impact of CS according to librarians (n=19) and users (n=23) at the end of the project. The dimensions are: increased knowledge of the scientific process (scientific knowledge); increased knowledge of the local community (local knowledge); scientific evidence over a common concern (scientific evidence); improved attitudes towards science (improved science attitudes); heightened willingness to learn (learning); improved self-efficacy to contribute to science (self-efficacy); fun (fun); new social connections between co-researchers (new connections); and social cohesion (social cohesion).

	Research question formulation μ (SEM)	Data collection μ (SEM)	Data analysis μ (SEM)	Evidence translation μ (SEM)	NA
Beginning of Science and Citizen Action (n=54)	0.66 (0.03)	0.62 (0.03)	0.59 (0.03)	0.63 (0.03)	n=1
End of Science and Citizen Action (n=23)	0.58 (0.05)	0.55 (0.05)	0.53 (0.06)	0.64 (0.05)	-

Table 1. Basic statistics of user's confidence to perform scientific tasks. Mean and standard error of the mean (SEM) of the normalized score of users confidence to perform different scientific tasks (where 0 refers to 'not at all', 1 refers to 'totally').

Focus group

Most relevant challenges and further insights about the engagement of librarians in CS emerged from the focus group with the librarians at the end of the co-creation of the public behavioral experiments (see Table 2 for a summary of the main themes). When asked about their views regarding co-created CS, the librarians pointed to the opportunity that CS may provide to engage people with different viewpoints to generate knowledge together, beyond traditional disciplinary fields. According to librarians, the activity also attracted new library users and created new local connections. They agreed that the collaborative method helped to integrate the participants' local concerns in the research. The librarians further pointed to the emancipatory potential of co-created CS. They described a sense of awareness for the proximate environment that can be prompted by CS and can, in turn, facilitate relationship building.

When asked about the returns for users after participating in the activity, concerns emerged regarding users' commitment and

the activity's inclusivity. According to librarians, the open nature of the collaborative activity was seen with certain skepticism by users. Continuous adaptive planning of the calendar was also highlighted as a potential barrier to user's commitment. The librarians further pointed to the hardship involved in ensuring an equity-driven recruitment of participants, with special reference to the reading comprehension of co-design material and data collection tools which was sometimes hard to understand for participants. They observed the high level of abstraction required which made evident the necessary adaptation of the materials and mechanisms in order to guarantee inclusivity. The activity provided new resources for the library and promoted critical thinking among participants while enhancing social networks within the community.

When asked about their perceived ability to engage in co-created CS, the librarians remarked the opportunity that the activity gave them to learn new practices and the fact that interacting with professional scientists changed librarians' understanding of science. Yet, they expressed a certain unease regarding the complexity of collaboration. The uncertainty associated with the co-creation dynamics was related to the difficulty in sustaining participation overtime. The librarians also observed the different and even conflicting stakes at odds in the research process. If, on the one hand, librarians aimed at attracting new publics, on the other hand professional scientists were concerned with scientific results.

These two streams made them unclear the role of each participant. The librarians further highlighted the workload it implied, the need for training and the importance of practical experience. The librarians found it difficult to implement and lead the activity, although they agreed that it was a dynamic process and difficulties were reduced by the end. The workload was perceived as mainly related to participant recruitment and retention, and to the fact of moving out of one's comfort zone. The librarians also stressed the fact that without the support of professional researchers they would not have been able to manage it within their community. They agreed on the need for training to be able to lead and implement such activities, both in terms of facilitation, communication, group management, and participation. The librarians indeed remarked the importance of practical experience in participatory and group dynamics which could then facilitate project implementation: administering the group, allowing for uncertainty adaptability, and that the methodology used could be transferred to other library initiatives and processes.

Overall, when asked about their intention to keep engaged with CS and implement a project the following year, all librarians agreed positively and confirmed that motivation was considerably higher compared to the beginning.

Construct	Theme	Code
Attitudes	Learning and socialization	New resources Social connections Emancipation
	Complexity of collaboration	Openness Retention Diverging interests
Subjective norms	Commitment	Skepticism Planning
	Inclusivity	Reading comprehension Material adaptation
Perceived behavioral control	Workload	Recruitment Comfort zone
	Training	External support Communication Group management Practical experience

Table 2. Code map of the most commonly reported codes (and associated themes and subthemes) under each construct of the TPB model.

Discussion

The study represents a novel empirical effort at contributing to the evolving debate around what role CS may play in reimagining public libraries as community hubs to adapt to the changing societal landscape[19, 21, 22, 25]. After the training received, results show that library professionals felt confident over their ability to recommend CS projects to their users. The librarians envisaged both indoor and outdoor activities, mainly of crowdsourcing type[12] which do not require significant investment in technical expertise or infrastructure, but rather depend on online resources, low-cost tools or personal smartphones[38, 39].

We have explored whether co-created citizen social science projects can be successfully implemented in public libraries. Beyond STEM knowledge and skills gain[34, 40–43], the potential of CS, especially in its co-created dimension[9, 44], may lay within a

more social and playful dimension, in line with the mission of public libraries. According to the perception of librarians and users participating in the activity, co-created citizen social science allows to strengthen social bonds among the participants, better knowledge of the environment and improved perceptions of the social value of the library and its surroundings. Doing science with and for the participants pushes CS beyond the scope of knowledge and skill development, leveraging individual sense and critical connection to place[45–47]. Co-created projects indeed invite genuine participation through trust, creativity and transparency[9] and critical engagement[44]. This encourages library users to take an active role in addressing common concerns, alongside scientists, around science-based community issues[4]. Co-created citizen social science may further constitute an opportunity for public libraries to reinforce their role as powerful community networks that promote civic engagement and cultural opportunities[48], acting as what Kranich[49] called agents of civic learning.

Nevertheless, the librarians expressed a certain unease with the complexity of collaboration, which is to be taken into account during the planning of the participatory dynamics. Some of the main challenges identified are the uncertainty of the open nature of a co-created inquiry[9], the conflicting stakes at odds in the research process between of citizens, librarians and scientists interests[50], and the hardship involved in ensuring an equity-driven recruitment and retention of participants during the whole process[51]. Co-created practices indeed modify the relationship between librarians and users towards a more participatory and horizontal interaction. As pointed out by the librarians, possessing 'soft skills' (e.g. facilitation, management, communication, participation) is crucial for libraries to engage with CS more fully[25]. Soft skills are needed for the transformative use of means and resources, the strengthening of social cooperation, and the resolution of cognitive and social challenges[17–19].

Overall, the study suggests that public libraries may indeed offer leadership in the promotion and implementation of CS initiatives[22–25]. Engaging public libraries in CS may enable alternative learning experiences that, coupled with increased social cohesion, generate new perspectives about public libraries where knowledge is not only shared but also built in a horizontal and collective way[9]. Libraries are transcultural and transgenerational meeting spaces where knowledge is shared and communicated beyond disciplinary boundaries, and may facilitate social changes through curiosity, knowledge, culture and science. They can then be conceived as spaces where people, groups and communities practice CS to build community and citizenship.

Limitations

The exploratory nature of the analysis, the small sample size, and the self selected sample of librarians and users may hinder the generalizability of the findings and their representativeness on the grounds of age, gender or socio-cultural background.

Notes

1. collaboration between the citizen science platform SciStarter, the Arizona State University and the Arizona State Library
2. https://www.diba.cat/web/biblioteques/bibliolab
3. A public behavioral experiment takes the form of a "physical, light, very flexible, highly adaptable, reproducible, transportable, tuneable, collective, participatory and public experimental set-up for behavioral experiments in urban contexts".

Funding agency

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SUPPLEMENTARY INFORMATION

	Pre (n=25)*	Post (n=22)*
How long have you been working at the library?		
2 or less	4% (n=1)	4.5% (n=1)
3 to 5 years	4% (n=1)	9.1% (n=2)
6 to 10 years	12% (n=3)	13.6% (n=3)
11 to 20 years	60% (n=15)	63.6% (n=14)
more than 20 years	20% (n=5)	9.1% (n=2)
Do you have a scientific background?		
yes	4% (n=1)	14.3% (n=3)
Have you heard already about citizen science?		
yes	56% (n=14)	-
Have you already participated in a citizen science project?		
yes	8% (n=2)	-

*valid answers.

Table 3. Sociodemographics of librarians participating to the Citizen Science Lab.

	Pre (n=54)	Mid (n=32)	Post (n=23)
Gender			
Woman	61% (n=33)	56% (n=18)	70% (n=16)
NA	5% (n=3)	3% (n=1)	-
Age			
18-25	9% (n=5)	9% (n=3)	9% (n=2)
26-35	11% (n=6)	7% (n=2)	22%(n=5)
36-45	26% (n=14)	25% (n=8)	39% (n=9)
46-55	22% (n=12)	31% (n=10)	26% (n=6)
56-65	15% (n=8)	9% (n=3)	-
66+	17% (n=9)	19% (n=6)	4% (n=1)
NA	-	-	-
Profile			
Library user or technician	30% (n=16)	28% (n=9)	26% (n=6)
Local association	50% (n=27)	66% (n=21)	43% (n=10)
Public administration	14% (n=7)	6% (n=2)	18% (n=4)
Private sector	4% (n=2)	-	13% (n=3)
NA	4% (n=2)	-	-

Table 4. Sociodemographics of users participating to the Science and Citizens Action activity.

Original statement	Translation	Code
"Temps, implicació continuada"	"Time, continuous commitment"	time
"Falta de motivació, desconeixement"	"Lack of motivation, unawareness"	motivation, unawareness
"Compatibilitat de la vida familiar/laboral amb el projecte, pensar que això de la ciència no és per la gent d'apeu"	"Consonance of family/work life with the project, note that science is not for ordinary people"	understanding of science, time
"Com qualsevol activitat a la biblioteca: l'assistència"	"As whatever library activity: assistance"	commitment
"La implicació segons temàtica. Dificultat per vincular la gent en continuïtat"	"Commitment varying with the project scope. Hardship involved in retaining people overtime"	commitment, retention
"La manca d'implicació de la majoria de gent en projectes col·lectius (societat molt individualista...)"	"Lack of commitment by the majority of people around collective projects (individualistic society..)"	commitment
"Als usuaris adults els costa més participar. Hem de busca projectes motivadors"	"For adult users it is harder to get involved. We are to find motivating projects"	motivation
"Que els arribi bé en què consisteix i que el tema proposat els engresqui"	"That they understand clearly what it is about, and that the attractivity of the project scope"	communication, motivation
"Falta de recolzament institucional (Ajuntament)"	"Lack of institutional support (local administration)"	lack of institutional support
"Poca participació en general en activitats i propostes diverses"	"Little participation in general, and heterogeneity of activities offered"	commitment, activity abundance
"Desconèixer matèria, inversió temps d'oci"	"Unawareness, leisure time investment"	unawareness, time
"Hi ha molta oferta d'activitats al municipi"	"There's abundance of activities offered in the municipality"	activity abundance
"La falta de coneixement dels projectes de ciència ciutadana"	"Unawareness of citizen science projects"	unawareness
"Desconeixement, falta de compromís en processos de disseny cocreatiu"	"Unawareness, lack of commitment in processes of cocreation design"	unawareness, commitment

Table 5. Librarians statements and coding on the barriers to users engagement.

Code	n
Commitment	5
Unawareness	4
Time	3
Motivation	3
Activity abundance	2
Communication	1
Lack of institutional support	1
Retention	1
Understanding of science	1

Table 6. Code frequency of librarians statements (n=21, valid answers) regarding barriers to user's engagement.

Project name	Research field	Level of participation (Haklay 2013)	Digital infrastructure	Site
Eyewire	Neuroscience	Distributed intelligence	Web platform	Indoor
300.000km/s	Urban planning	Crowdsourcing	Mobile App	Outdoor
Ancient Lives	History	Distributed Intelligence	Web platform	Outdoor
Battling Birds	Ornithology	Distributed Intelligence	Web platform	Indoor
Mosquito Alert	Epidemiology	Crowdsourcing	Mobile App	Outdoor
Old Weather	History	Distributed Intelligence	Web platform	Indoor
Public Lab	Environmental Science	Extreme Citizen Science	DIY sensor	Outdoor
Openlittermap	Environmental Science	Crowdsourcing	Mobile App	Outdoor
Beepath	Human Mobility	Participatory Science	Mobile App	Outdoor
Cadáveres Inmobiliarios	Urban Planning	Crowdsourcing	Web Platform	Outdoor
Citi-Sense-BCN	Air Quality	Crowdsourcing	Sensor	Outdoor
Milmots	Linguistics	Crowdsourcing	Web platform	Indoor
MonuMai	Architecture	Crowdsourcing	Mobile App	Outdoor
Arbres Monumentals de Catalunya	Environmental Sciences	Crowdsourcing	Mobile App	Outdoor
Bioblitz	Environmental Sciences	Crowdsourcing	Mobile App	Outdoor
Catalan Butterfly Monitoring Scheme	Environmental Sciences	Crowdsourcing	Web Platform	Outdoor
Observatori ciutadà de la biodiversitat de papallones a la ciutat	Environmental Sciences	Crowdsourcing	Web Platform	Outdoor

Project name	Research field	Level of participation (Haklay 2013)	Digital infrastructure	Site
Jocs pel Canvi Social	human behavior	Participatory Science	Electronic tablet	Outdoor
Liquencity	Environmental Sciences	Crowdsourcing	Mobile App	Outdoor
Natusfera	Environmental Sciences	Crowdsourcing	Mobile App	Outdoor
Observadors del Mar	Marine Biology	Crowdsourcing	Web Platform	Outdoor
Ocells dels Jardins	Environmental Sciences	Crowdsourcing	Web Platform	Outdoor
Plant·tes	Environmental Sciences	Crowdsourcing	Mobile App	Outdoor
Riu.Net	Hydrology	Crowdsourcing	Mobile App	Outdoor
Pluviómetros Ciudadanos	Hydrology	Crowdsourcing	Sensor	Outdoor
Ground Truth 2.0	Environmental Sciences	Crowdsourcing	Web Platform	Outdoor

Table 7. Clustering of the projects selected by librarians participating to the Citizen Science Lab.

	Distributed Intelligence	Crowdsourcing	Participatory Science	Extreme Citizen Science
Indoor	3	1	-	-
Outdoor	1	18	2	1

Table 8. Clustering of the projects selected by librarians participating in the Citizen Science Lab according to Haklay's categories (2013) project's site. The set of projects was manually clustered through the web analysis of projects' description.

Do you feel able to recommend and explain citizen science projects to library users?	Yes	No
Beginning of Citizen Science Lab (n=25)	68% (n=17)	32% (n=8)
End of Citizen Science Lab (n=22)	100% (n=22)	-

Table 9. Perceived ability of librarians to recommend citizen science projects to their users at the beginning and at the end of the Citizen Science Lab.

Do you feel able to recommend and explain citizen science projects to library users?	Totally	To a large extent	To a little extent	Not at all	NA
Beginning of Citizen Science Lab (n=25)	8% (n=2)	8% (n=2)	64% (n=16)	12% (n=3)	8% (n=2)
End of Citizen Science Lab (n=22)	4% (n=1)	32% (n=7)	50% (n=11)	-	14% (n=3)

Table 10. Perceived ability of librarians to implement citizen science projects at the library, at the beginning and at the end of the Citizen Science Lab.

Theme	% (n)	Text content	Quote
Personal motives	42.9 (30)	curiosity personal interest concern science	"The curiosity to discover a new way of doing, and willingness to engage in a collective project" "They proposed and it seemed of interest to me" "To find answers to my concerns and to have them recognized" "mainly for its connection with science which is one of my passions"
Social networks	24.3 (17)	invitation library trust	"The library engagement" "I've been asked by the librarians and I fully trust whatever initiative they carry out"
Advocacy	18.6 (13)	neighborhood try change	"Get more involved in the neighborhood and try to do something that can improve life quality" "The willingness to study a social issue and try to develop proposals for social transformation" "What pushed me to participate was the idea of collectively exploring and analyzing a common problem and try to change it" "The idea of contributing to social cohesion and a more proactive city"
Socialization	12.9 (9)	meet know collaborate	"The opportunity to meet other people in the city who come from different areas with a common objective" "Listening and knowing other's experiences" "Engage and collaborate with community activities"

Table 11. Main themes, associated text content and quotes from users statements on motivations to participate in the Science and Action activity.

	Totally	To a great extent	To a little extent	Not at all	NA
Library responsiveness (n=54)	57% (n=31)	35% (n=12)	2% (n=1)	2% (n=1)	4% (n=2)

Table 12. Users perceptions of the library's responsiveness to community needs at the beginning of the Science in Action activity.

	Totally	To a great extent	Nor agree or disagree	To a little extent	Not at all	NA
Library ability to innovate (n=54)	31% (n=17)	57% (n=31)	6% (n=3)	4% (n=2)	-	2% (n=1)

Table 13. Users perceptions of the library's ability to face local challenges through the active participation of its users at the beginning of the Science in Action activity. at the beginning of the Science in Action activity.

	Totally	To a great extent	Nor agree or disagree	To a little extent	Not at all	NA
Positive effect of the experiment on library perception (n=23)	26% (n=6)	35% (n=8)	26% (n=6)	9% (n=2)	-	4% (n=1)

Table 14. Users rating of the positive effect of the public behavioral experiment on their perception of the library after the co-creation process and after the experiment in the Science in Action activity.

Attitudes		
	"Avui en dia la ciència té molts camps, des de les humanitats i tal, i tot s'integra. I això és molt xulo. El vostre grup és molt integrador. Hi ha gent de diferents perfils que no tenen res a veure i que s'integren en un equip. Això és veritat, es complementen els perfils. cada perfil té unes coses bones i uns tal i...es van complementant. Llavors és això que fem interdisciplinar tot"	"Today science presents many fields, from the humanities and so on, and everything is complementary. And that's really cool. Your [research] group is very complementary. There are people from different profiles which have nothing to do with each other and that are integrated into a team. That's true, such profiles complement each other. Each profile has some good things and so on, they complement each other. That's what we are doing, making it interdisciplinary"
Learning and socialization	"Ens va arribar molta gent nova. Una oportunitat doncs de atreure a nous usuaris i noves aliances a nivell municipal. Perquè a vegades coneixes altra gent que ja veus que tenen predisposició per activitats socials i que sempre estan a totes, però que no coneixem mai a nivell de projecte. I això és una oportunitat per engrescar"	"We met many new people. [It was] an opportunity to attract new users and to create new alliances at the municipal level. Because sometimes you know people that you see they might be willing to engage in social activities because they are always there. But you never really get to know them within a given activity. And this is an opportunity to get to know each other "
	"També per les grands ciutats hi ha una solitud no volguda..I el tema de fer ciència ciutadana pero de la banda social [...] permet que [...] puguis conèixer, tenir uns moments que hi ha altra gent, i puguis fer altres contactes. És lo més important. La ciència ciutadana pot ser una bona excusa també, perquè la gent realment li preocupa el barri on viu des d'aquest vessant social"	"Within big cities people are unwillingly lonely. And the fact of doing citizen science, in its social focus, allows you to get to know each other, share a few moments with other people, and make new contacts. That's the most important. Citizen science can be a good excuse, because people really care about the neighborhood where they live, from this social point of view. "
Complexity of collaboration	"És molt participatiu però sí que és veritat que s'ha d'encarrilar. Perquè vosaltres ho sabeu molt bé quin son els interessos del grup de recerca i tal.. I l'heu d'encaminar, encara que sigui molt participatiu. I bueno sí que es notaba que de moments a moments s'havia d'encarrilar, i ho encarrilaveu vosaltres. Pero bueno es que molts actors han participat: la universitat, els municipis, Opensystems.. Llavors clar tot això s'ha de tenir en compte"	"It's very participatory. Yet, it's true that you have to get on track. Because you know very well what the interests of the research group are, and so on. And you have to direct it, even if it is to be participatory. And well, you could notice that, from time to time, you had to redirect it, and put it on track again. But it's good that many actors participated: the university, municipalities, Opensystems. So, of course, you have to take it all into account"
	"I el tema al final és un cost-benefici. I suposo que això també [...] He vist que, clar, sis mesos! Es que en sis mesos en tu vida pasan muchas cosas! Clar..Al gener vam fer una, després fins al març..I després l'altra, clar ja a la segona ens va faltar gent..I l'altra…"	"The point, at the end, lies in the cost-benefit balance. Part of the cost benefit is time, I think. I've seen that, of course, six months! It's just that in six months many things happen in your life! Of course..In January we did one, then until March..And then the other, of course in the second we lacked people..And the other… "
	"Sisi ha sortit. Ha sortit de la bases no? Perquè al final surt de les bases, lo que pasa es que si al final ja surt d'entrada amb unes bases potser es mes facil. Perquè no ho has de reconduir. Lo primer: xino. Buuff. Lo intentamos. Pero dices: esto, no, no se puede"	"It simply came to our notice then. It's out of the basics right? Because in the end it leaves the bases, what happens is that if in the end it already leaves with some bases it is perhaps easier. Because you don't have to redirect it. The first: Chinese. Buuff. We tried. But you say, this, no, you can't "

Subjective norms		
Commitment	"Bueno i perquè la gent ara encara no està habituada a trobar-se en aquests processos. Ara comencen, et sonen..Cada procés també és diferent..Però quan estàs ficat es: "Ah pues no m'ho imaginava així.." Algú ho comentava del nostre grup. Sembla que tot sigui molt lliure. Però després.."	"Well, because people are not yet used to being in these processes. Now they start, they sound to you..Each process is also different..But when you're stuck it is: "Oh well I didn't imagine it that way .." Someone commented on it from our group. It seems like everything is very free. But then .. "
	"I planificar això fa que hi hagi un compromís, que la gent es compromet, i sap a què es compromet, i sap que l'implicarà d'hores, per exemple. A nivell per exemple de saber: la sessió durarà dues hores. Si ho haguessim sapigut podríem haver iniciat abans de les 7, doncs quedant abans. I clar aquesta incertesa fa que no vulguis quedar malament o tampoc que et sap greu que la gent passada una certa hora et planta mala cara"	"And planning this makes for a commitment, for people to commit, and they know what they are committed to, and they know it will involve them for hours, for example. At the level of for example knowing: the session will last two hours. If we had known we could have started before 7, so staying ahead. And of course this uncertainty makes you not want to look bad or that you are sorry that people after a certain time put a bad face on you "
Inclusivity	"La comprensió lectora...Es una mica difícil per segons quin perfil..T'havies de posar molt amb la manera de pensar. I llavors és veritat que hi havia gent que directament no ho entenia...Nosaltres teníem gent que no entenia directament. També és veritat això"	"Reading comprehension ... It's a bit difficult depending on which profile ... You had to put a lot of effort into your way of thinking. And then it is true that there were people who did not directly understand ... We had people who did not understand directly. This is also true. "
Perceived behavioral control		
Workload	"hi havien moltes coses d'aquella ja que se'ns escapaven i que tampoc venien de nosaltres de la biblioteca...Que ja venia marcat i llavors era com...a més, si...era més complicada."	"There were a lot of things like that because they escaped us and they didn't come from us from the library either ... It was already marked and then it was like ... besides, yes ... it was more complicated."
	"ens ha comportat moltíssima feina. Un esforç, un esforç personal gran, dins i fora de la biblioteca"	"It simply came to our notice then. An effort, a great personal effort, inside and outside the library"
	"I a nivell de biblio crec també que és la forma que nosaltres ens omplim la boca amb que la biblio ideal és la que surt al carrer, i en el fons abans ens costa sortir de la nostra zona de confort. I fa molta ràbia. Però aquesta activitat o coses que fem habitualment no arriben al 90 per cent dels usuaris.. I potser no ho comuniquen bé perquè són autònoms o simplement la fan servir com un lloc on trobar llibres i preguntar coses...Però està bé aquesta implicació més gran amb la comunitat"	"And at the level of a bible, I also think that this is the way we fill our mouths with the fact that the ideal bible is the one that goes out on the street, and deep down it is difficult for us to get out of our comfort zone. And it makes me very angry. But this activity or things we do usually do not reach 90 percent of users .. And maybe they do not communicate well because they are autonomous or just use it as a place to find books and ask things ... But it is good this involvement more great with the community "

Training and support	"Vull dir, no sé si hi hauria una forma per simplificar-ho per un futur o algo... Vull dir si estem amb el vostre suport està clar que això funciona, però...o mes o menys ha funcionat. Però jo crec que sense el vostre suport aixi darrera, no.. crec que és impossible."	"I mean, I don't know if there would be a way to simplify it for the future or something ... I mean if we're with your support it's clear that this works, but ... or more or less it has worked. But I think without your support like that, no ... I think it's impossible. "
	"i que es faci més formació si això..De fet també la formació que rebem moltes vegades es una mica més obsoleta i que no va cap a el estavem dient de ser mes...de tenir més habilitats comunicativas...Encara que et comuniques bé, saber cap a on vas no? De fer mes eines..De saber parlar també lo que deiem amb la tele, amb els mitjans...perquè al final. Dius el que et sembla i... I ja està. Però clar.. No tenim més guió.."	"And that more training is done if this..In fact also the training that we receive many times is a little more obsolete and that does not go towards it we were saying to be more ... to have more communicative abilities ... Although you communicate well, know where you are going right? To make more tools..To know how to speak also what we say with the TV, with the media..because in the end. You say what you think and ... And that's it. But of course .. We don't have any more script .. "
	"Però això ells que.. perquè saben, i perquè tenen experiència. Perquè clar, ja quan has portat no sé quants grups ja sé per on...Sino clar, lo que deia ella...podem estar aquí fins…"	"But that's because ... they know, and because they have experience. Because of course, when you brought it I don't know how many groups I know where ... But of course, what she said ... we can be here until… "
	"Això ho sabem que ho podem fer. I que tindrem doncs tot aque… llistat d'aplicacions, i podem fer cosetes..més senzilles. Pero d'aquesta la cosa guapa de juntar gent, i..sí que ens podem portar a Joan Solé a fer fotos de plantes..Pero repetir una cosa així jo penso que serà difícil"	"It simply came to our notice then. And then we will have all that list of applications, and we can do things .. simpler. But that's the nice thing about bringing people together, and..if we can get Joan Solé to take pictures of plants..But to repeat something like that I think will be difficult "

Table 15. Quotes of librarians from the focus group at the end of the Science and Citizens Action activity.