PROCEEDINGS OF SCIENCE

Co-creation in citizen science (CS) for the development of climate adaptation measurements — Which success factors promote and which barriers hinder a fruitful collaboration and co-creation process between scientists and volunteers?

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Biodiversity loss, insect mortality, periods of drought and heat, or insect-caused forest dieback are just a few of the climate change impacts we are already facing today. Only a few projects address adaptation to the consequences of climate change. The aim of the project Participatory Early Warning Systems to Address Local Climate Change Impacts Through Citizen Science Activities in Environmental Informatics (ParKli) is to make the consequences of climate change on local natural and living spaces tangible through citizen science (CS) activities and to (further) develop local early warning systems for climate protection together with citizens. In this paper we presented the results of our workshop at the Engaging Citizen Science Conference 2022, where we discussed the topic of co-creation in citizen science (CS) for the development of climate adaptation measurements—Which success factors promote and which barriers hinder a fruitful collaboration and co-creation process between scientists and volunteers? Under consideration were the social, motivational, technical/technological and legal factors. Our findings suggest that a clear communication strategy of goals and how citizen scientists can contribute to the project are important. In addition, citizen scientists have to feel that they are included in the project and that their contribution makes a difference.

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1. Background

Biodiversity loss, insect mortality, periods of drought and heat, and insect-caused forest dieback are just a few of the climate change impacts we are already facing today. Through its Sustainable Development Agenda, the United Nations has set ambitious goals for cities, climate protection, clean energy and water, health and food security to put the world on a sustainable and resilient path until 2030 [1]. The recurring negative headlines about climate change are often very frightening and demotivating. Many citizens want to get involved but do not know how. There are a large number of climate change mitigation projects, for instance, CO2 reduction, climate-friendly behavior, etc. Only a few projects address adaptation to the consequences of climate change, especially those we are already feeling today. The aim of the project Participatory Early Warning Systems to Address Local Climate Change Impacts through Citizen Science Activities in Environmental Informatics (ParKli) is to make the consequences of climate change on local natural and living spaces tangible through citizen science (CS) activities and to (further) develop local early warning systems for climate protection together with citizens. Based on the results, a toolbox of best practices (technologies, measures, processes, etc.) for early warning systems for climate protection will be developed to help citizens and other stakeholders independently implement and use local early warning systems. Through an active exchange with citizens, we want to identify specific applications and technologies that can be easily used and integrated into the everyday life of citizens.

Table 1 shows the four topics identified in ParKli: biodiversity, water, city and soil, the corresponding sample questions, apps and possible scenarios. The questions are intended to generate interest among citizens. In addition, the questions help to sharpen the scientists' focus to actively involve citizens in the process of problem definition and solution development. The currently applied apps in the project—INaturalist [2], EyeOnWater [3], CrowdWater app [4] and Greenspace Hack [5]— are used to collect data through citizen science activities. In the next section an outlook of possible scenarios for climate adaptation early warning systems is given. In this paper we present the results of our workshop at the Engaging Citizen Science Conference 2022 with the topic/research question: Co-creation in CS for the development of climate adaption measurements—Which success factors promote and which barriers hinder a fruitful collaboration and co-creation process between scientists and volunteers?

2. Co-creation methodology

ParKli is designed as a citizen science project, focusing on the active participation of citizens along the entire research process. In the sense of the "co-creation of knowledge and sustainable solutions approach", we want to develop the concrete problems and questions together with central actors. The aim is to address practical issues and to scientifically accompany the transformation processes to achieve the climate protection goals. The underlining research design is based on the process steps of a living lab: co-design, co-production and co-evaluation [2].

Co-design: A project design is jointly developed in workshops. This is followed by a joint problem definition, thematic and spatial delimitation, system analysis and the generation of specific questions and ideas for case studies.

Co-production: In the development of the case studies, transdisciplinary teams work on the implementation of the ideas collected in the co-design phase, which are reflected and adapted in an iterative process.

Table 1: ParKli Overview

Topic	Biodiversity	Water	City	Soil
Example question	*"How can citizens support to protect the local biodiversity?"*	*"How can citizens support to protect our local waters from the impacts of climate change?"*	*"How can citizens support to keep our city livable despite climatic changes?"*	*"How can citizens support to adapt soils to climate change?"*
App(s)	**iNaturalist** Monitoring of the condition of local biodiversity.	***EyeOnWater-App*** Measurement of water quality of bodies of water with the help of water color. ***CrowdWater-App*** Measurement of various data: Water level, soil moisture, dynamics of drying rivers, plastic pollution.	***Greenspace Hack App*** Using surveys, information about urban green spaces will be collected.	-
Example scenarios	• An early detection of the occurrence of invasive species • Combining Greenspace Hack and iNaturalist to develop a biodiversity index to increase the resilience of green spaces in cities.	• Sensors for measuring temperature, turbidity, oxygen content, water level, etc. • Early warning systems and adaptation measures to prevent lake overturning.	• Identification, monitoring or preservation of green spaces • Combining Greenspace Hack and iNaturalist to develop a biodiversity index to increase the resilience of green spaces in cities.	• Monitoring and adaptation measures to protect soil from erosion, humus loss and other climate-related risks.

Co-evaluation: The ideas and solutions developed in the co-production phase are evaluated together with the various actors. Relevant ideas are selected and tested in practical applications. The aim is to further develop the ideas and optimize them in terms of their usefulness and user-friendliness. In the process, best-practice features of applications should be derived that can be transferred to other applications.

3. Workshop

The topic and research question for our workshop were: Co-creation in citizen science (CS) for the development of climate adaptation measurements—Which success factors promote, and which barriers hinder a fruitful collaboration and co-creation process between scientists and volunteers? Social, motivational, technical/technological, and legal factors were considered. First, we introduced the ParKli project to the participants of the workshop in a short 15-minute presentation. Thereby, we presented to the participants of the workshop our volunteer group with the name “climate detectives”.

The climate detectives are a group of interested citizens who want to contribute actively to climate change adaptation. They are using three different apps, INaturalist, EyeOnWater and GreenspaceHack to collect data in the areas of cities, water, and biodiversity. The recruitment was mainly done through online volunteer platforms. At the workshop, we presented user stories, to give the participants of the workshop an overview of the background of the climate detectives. We also described the current problems we are having with our climate detectives, which is that

we are having problems keeping them engaged. The number of climate detectives has been decreasing. In January and February, we registered 15 to 20 participants at our monthly meeting. In the meetings in March and April, we registered a decrease in the number of participants of over 60%. All the meetings took place at 6 p.m., which should have been a convenient time for the climate detectives. Due to the Corona pandemic, no face-to-face events were held.

Based on this situation, the participants of the workshop discussed the topic in a 50 minute session at 5 tables. Afterwards one participant from each table gave a short summary of their results. In the following, we describe the results of the workshop with respect to each factor.

3.1 Social factors that promote vs. hinder co-creation

The workshop participants mentioned that the citizen scientists involved in a project must identify with the main topic of the project and project goals. As a result, clear communication of the project topic and goals is necessary. The workshop participants also pointed out that the establishment of personal relationships between scientists and citizen scientists is important. This is also addressed in the scientific literature. [8] describes the relationships between scientists and citizen scientists as important. The workshop participants added that it is much easier to build a personal relationship between scientists and citizen scientists when meeting in person. One workshop participant pointed out that the composition of our volunteer group of climate detectives should be representative of the larger society. The workshop participants also discussed the value of communication of results, as citizen scientists are interested in learning something new. Additionally, the workshop participants mentioned the issue of the ownership of the collected data. They said that every development during a project should be Open Source.

3.2 Motivational factors that promote vs. hinder co-creation

To attract and retain participants in a project, it is important to understand what drives them to participate and why they stay with or leave a project. A key factor mentioned by the workshop participants, and described in the literature, is the way goals, tasks, and recruitment messages are communicated. Also, the workshop participants pointed out that clearly communicating the different ways participants can contribute to a project is important. [7] describes that it is crucial to develop a communication strategy based on the targeted audience, and the communication strategy should address diverse groups of participants regardless of their skill level, education level, age, gender, ethnicity, and socio-economic status [9]. The workshop participants and several scholars describe the importance of making sure participants are aware of how they can make a difference through citizen science by doing something interesting, feasible, and achievable for them [7, 8, 9]. Another factor mentioned was the importance of appreciation, reward, and the perception that there are benefits to participating in the project [7]. These aspects were also pointed out by the workshop participants in the context of our project. The workshop participants also talked about the presentation of results. Citizen scientists expect that the data they gathered is useful [7, 8], and the presentation of results is important for keeping citizen scientists engaged [7]. [7] also describes that an inefficient flow of collected data can demotivate participants. The workshop participants mentioned that time is a limiting factor for participation. This is also mentioned in the scientific literature [7, 8, 9]. It is important to give participants the opportunity to contribute when they are able to, for instance, on the weekend. In the context of our citizen science project, the workshop participants felt that that we are addressing too many different topics,

and this could discourage potential participants from taking part in the project. The workshopparticipants also mentioned seasonality, which can have a huge impact on the motivation of a citizen scientist. For example, the participation in outdoor activities is higher during the warm season. In addition, the workshop participants brought up gamification as a way of increasing the motivation of citizen scientists. Finally, the workshop participants suggested that we should tap into the existing networks of our participants in the project to raise the efficiency of acquiring additional participants.

3.3 Organizational factors that promote vs. hinder co-creation

The workshop participants pointed out that it was important for scientists and citizen scientists to establish a cooperative relationship based upon a foundation of trust. Moreover, transparency regarding who is funding the project is needed. In addition, workshop participants considered it important that the organization carrying out the project be regarded as highly trustworthy. In the context of our project, workshop participants pointed out that there are a large number of different topics, so we need to identify tasks that fit the skill level, interests and time availability of the citizen scientists. This could reduce the complexity of the project for everyone. The workshop participants also noted that a good methodological competence in co-creation methods is necessary. Interactive, regular communication between citizens and scientists was addressed by the workshop participants and is also described by [7]. Another aspect which was mentioned by the workshop participants is having a clear time frame and milestones for the project. Project meetings or other events must be oriented towards the needs of the citizen scientists. Since the citizen scientists are participating during their leisure time, the question arises whether activities should be on weekdays or weekends. This was pointed out by workshop participants and is also described by [7, 8].

3.4 Technical/technological factors that promote vs. hinder co-creation

The workshop participants mentioned that it is important to obtain funding for the development of technical solutions, and the technology needs to be maintained over a certain period of time. Moreover, it should be possible to support citizen scientists when using the applied technology in the project. For instance, guidelines for smartphone apps could be provided. Project organizers need to consider the expected skill level of the target group when the project involves the use of applied technology. Furthermore, workshop participants recommended that efforts should be made to minimize the use of technology in the context of our project. The workshop participants suggested conducting regular surveys or feedback session to gather information about the technologies used. The existing infrastructure must also be considered when selecting a technical solution for instance whether Internet service is available.

3.5 Legal factors that promote vs. hinder co-creation

The workshop participants pointed out that current General Data Protection Regulation must be considered for data collection. One of the participations reported from a project in which the collected data could not be used because they did not have an agreement with the citizen scientist. During the workshop, participants discussed the matter of privacy issues with respect to the individual participants of a citizen science project, and it was noted that these must be addressed. Clarification of the use of the collected data can counteract the problems of privacy issues. The workshop participants pointed out that copyright issues can stop possible releases and these too must be addressed.

4. Conclusion

In this paper we presented the results of the workshop with the topic: Co-creation in citizen science (CS) for the development of climate adaptation measurements—Which success factors promote and which barriers hinder a fruitful collaboration and co-creation between scientists and volunteers? Insights from the workshop have been discussed according to the factors underlined in the scientific literature. Under consideration were the social, motivational, technical/technological and legal factors. Our findings suggest that a clear communication strategy of goals and how citizen scientists can contribute to the project are important. In addition, citizen scientists have to feel that they are included in the project and that their contribution makes a difference. To achieve this, it is critical to present the results to the citizen scientists. Also, the relationship between scientist(s) and citizen scientists is essential for keeping citizen scientists engaged. Notification of meetings and events needs to be made well in advance and should be scheduled during the attendees' leisure time. The citizen scientists should be especially supported regarding technical questions. Following these steps will result in the citizen scientists feeling appreciated and remaining part of the project. Regarding legal factors, the current General Data Protection Regulation was considered important by the participants of the workshop. In further research, we will aim to address these points by first of all improving our communication with the citizen scientists about the project goals and how the citizen scientists can contribute to the project. In addition, we will aim to be better at sharing the achieved results.

References

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