Project Title

From top-down to bottom up: Peer production as a means to citizen science throughout the research cycle.

Introduction and background

The Universal Declaration of Human Rights describes a broad human right to access science as a whole, implying a right to participate in all aspects of the scientific enterprise [1]. While *Citizen/Community Science* (CCS) involves community contributors in the research process, involvement is typically limited to data collection or processing. Much of these efforts have focused on the natural sciences, like natural resource management, environmental monitoring/protection, and astrophysics [2]. In many cases volunteers crowdsource the collection of data, e.g. by performing fieldwork or through the deployment of sensors. Alternatively, participation may merely involve microtasks, such as classifying images or generating protein-structure foldings. Non-researchers are far from participating in all aspects of research [3], resulting in concerning power asymmetries – especially in health and human subjects research [4].

CCS shares many of the characteristics of commons-based peer production (CBPP) systems [5] and key aspects of CBPP (sharing, intrinsic positive motivation, openness, collaboration, bottom-up innovation, community accountability) [6] seem well-aligned with the goals of CCS. Alas, a fundamental question remains: if there is a commons, what is the commonly managed resource in a CCS framework? While the collected data or microtask results can be viewed as resources in a traditional digital/knowledge commons [5], another key resource for citizen science is the pool of volunteer contributors itself. This, admittedly cynical, view of volunteers as a resource that is to be managed describes the power imbalance between academic researchers and community contributors [3]. By viewing volunteer contributors as a resource to be exploited, traditional CCS can fall short of being a genuine commons-based peer production process.

A set of design principles has been found as the hallmark of successfully managing stable common pool resource institutions. A central design principle are the collective-choice arrangements, meaning that those individuals affected by the operational rules can participate in modifying those [6,7]. For that reason, successful peer production systems such as Wikipedia are based on a lack of hierarchical control and authority. Instead they are based on communal validation and negotiated coordination, as quality control is community-driven and conflicts are resolved through ongoing mediated dialogue [8]. Most CCS projects on the other hand lack such community-driven decision making aspects. Instead of being run through a community of peers, academic researchers take the lead, set up the rules and enforce them.

Given the rising popularity of CCS and its potential benefit to research it is timely to investigate if and how CBPP can lead to more equitable and more efficient CCS [9]. This is especially the case for biomedical CCS, which often involves patients themselves along with their personal data [4]. While individual, patient-led initiatives, such as the Type-1-Diabetes community, are already implementing their own projects independent of academic leadership, so far there are no systematic studies of the limitations and benefits of such communities compared to traditional CCS.

Research question and hypothesis

We hypothesize that the introduction of CBPP features increases the involvement of community contributors in more phases of the research cycle. Projects modeled after CBPP systems should lead to new learning and innovation opportunities as well as more egalitarian approaches to those projects.

To test this hypothesis we aim to create an experimental social CBPP environment, exploring if and how the different aspects of peer-production influence how the CBPP elements interrelate to the CCS aspects of the projects carried out. Specifically we want to investigate whether a CBPP approach is viable for CCS projects and what the limitations and barriers of such approaches are. Furthermore, we want to uncover which factors are important for increasing the ability of community/patient stakeholders to learn, innovate and contribute to inform further CCS projects.

Detailed project description

To comprehensively investigate the potential of a commons-based peer production (CBPP) system for citizen science we will employ a three-pronged approach for our project:

1. **Mapping the citizen science ecosystem into a CBPP-framework**
2. **Implementing an experimental, CBPP-based citizen science platform**
3. **Monitoring the effects of the CBPP approach on citizen science approaches**

As an exemplary case, we wish to investigate implementing CBPP within health and human subjects research, where research necessarily involves contributions from participants – and where CBPP features may supplement traditional ethics review to counter potentially exploitative relationships with participants.

Mapping the citizen science ecosystem into a CBPP-framework
While there has been various work exploring the characteristics of CBPP [10], so far there has been little work done to transfer these into a CCS framework [11]. To get a fuller picture into if and how CBPP can be mapped onto citizen science efforts, we will identify what the key aspects of a CBPP system are and how they relate to existing CCS efforts.

By conducting a systematic literature & community survey of CBPP and CCS projects we will generate an understanding of how CCS is already aligned with CBPP aspects and identify points where those approaches might fall short of being peer-production systems. The results will help us gain a fuller understanding of how citizen science relates to CBPP ecosystems, and will inform the further design of CBPP-enabling CCS platforms.

Implementing an experimental, CBPP-based citizen science platform
We will use the insight gained from the CCS/CBPP survey to create a citizen science platform that implements a CBPP model, by building upon the existing prototype of the *Open Humans* citizen science platform. In its current iteration, *Open Humans* largely targets top-down CCS efforts that focus around collecting personal data (e.g. from wearables, social media or personal genetic tests) and sharing those data with academic researchers working in health-related disciplines. This existing open source platform along with a budding community of over 6,000 members offer ideal conditions for observing how a CBPP approach affects CCS.

To make this transition, we will engage in an iterative design process with the CCS community already using *Open Humans*. Through survey and usage data, collected from existing and new projects, we will investigate project needs to identify CBPP features relevant to projects operating in this platform. Amongst others, existing collaborations through *Open Humans* include

- community-driven bottom-up approaches that are driven by patients, for example inside the Type-1-Diabetes community of *OpenAPS*,
- hybrid approaches which combine traditional academic research designs with further input from the volunteer data collectors like the ovulatory cycle tracking project *QCycle*, which is a collaboration between the *Quantified Self* community and researchers at *UC Berkeley*
- traditional citizen science approaches such as the *Personal Genomics Human Computer Interaction* project which is run by the Wellesley College

Covering this broad spectrum of projects will allow us to identify whether these different approaches have common needs, and where they differ. From this, we can identify general requirements and limiting factors needed in a CBPP-based platform and adapt the *Open Humans* infrastructure to implement these.

Monitoring the effects of the CBPP approach on citizen science approaches
Iteratively transforming *Open Humans* from a traditional CCS platform into a CBPP-centered infrastructure we will have a set of features and interventions, allowing us to compare project outcomes under different CBPP models. Through this we will be able to track usage of these features and gather longitudinal data about how both bottom-up as well as top-down projects fare after individual changes. By following up with the individual CCS projects run through *Open Humans* we will be able to gain insights on a variety of metrics to gauge the impact of the CBPP intervention. Amongst other metrics we will track:

- Are more or less projects started after the changes?
- Are they different to previously started projects?
- Do they attract more/less users?
- Which aspects of CBPP are actually being used by the community

- Does the implementation of CBPP principles affect user satisfaction of
  - the citizen science project leads
  - the volunteers

Additionally, we will perform surveys and structured interviews with participants to gain insight into the user behaviour and satisfaction. Based on these results we will evaluate how a CBPP-informed citizen science ecosystem differs from the traditional top-down approaches, and infer abstract general principles and rules of how CBPP methods may impact CCS projects.

Speculation

Our main hypothesis is that it is feasible to generate citizen science projects that follow the ideals of commons-based peer production, thus empowering people to take more responsibility and gain more from the projects they contribute to. On the one hand, such empowerment helps CCS participants to gain more domain knowledge and to demystify the manifold aspects of doing research. On the other hand it also teaches universal skills (such as project organisation, working in interdisciplinary teams, negotiations etc.), which participants can apply outside the respective CCS projects. Furthermore, these CBPP methods have the potential to increase research efficiency as well as enabling new kinds of research which traditional CCS methods would not be able to support.

References

[1] Vayena, E. & Tasioulas, J. "We the Scientists": a Human Right to Citizen Science. Philos. Technol. 28: 479, 2015, https://doi.org/10.1007/s13347-015-0204-0

[2] Greshake Tzovaras B., Arvai K., Dulaney M., Estrada-Galinanes V., Gunderson B., Head T., Lewis D., Nov O., Shaer O., Bobe J., Price Ball M. Open Humans: A platform for participant-centered research and personal data exploration. bioRxiv, 469189; doi: https://doi.org/10.1101/469189

[3] Resnik DB., Elliott KC., Miller AK. A framework for addressing ethical issues in citizen science. Environmental Science & Policy, vol. 54:475-481, 2015, https://doi.org/10.1016/j.envsci.2015.05.008.

[4] Woolley JP., McGowan ML., Teare HJA., Coathup V., Fishman JR., Settersten Jr. RA., Sterckx S., Kaye J., Juengst ET. Citizen science or scientific citizenship? Disentangling the uses of public engagement rhetoric in national research initiatives BMC Medical Ethics 17:33, 2016 https://doi.org/10.1186/s12910-016-0117-1

[5] Madison, MJ. Commons at the Intersection of Peer Production, Citizen Science, and Big Data: Galaxy Zoo. Published in Governing Knowledge Commons, Brett M. Frischmann, Michael J. Madison and Katherine J. Strandburg, eds., Oxford University Press, 2014 https://ssrn.com/abstract=2495404

[6] Ostrom, E. Governing the commons : the evolution of institutions for collective action. Cambridge University Press, 1990.

[7] Ostrom, E. How Types of Goods and Property Rights Jointly Affect Collective Action. Journal of Theoretical Politics, 15(3), 239–270, 2003 https://doi.org/10.1177/0951692803015003002

[8] Kostakis, V., Niaros, V., & Giotitsas, C. Production and governance in hackerspaces: A manifestation of Commons-based peer production in the physical realm? International Journal of Cultural Studies, 18(5), 555–573, 2015. https://doi.org/10.1177/1367877913519310

[9] Benkler Y. The wealth of networks: How social production transforms markets and freedom. Yale University Press, 2006.

[10] Benkler, Y. and Nissenbaum, H. Commons-based Peer Production and Virtue*. Journal of Political Philosophy, 14: 394-419, 2006. doi:10.1111/j.1467-9760.2006.00235.x

[11] Curtis V. Motivation for Participation: From General Volunteerism to Online Citizen Science. In: Online Citizen Science and the Widening of Academia. Palgrave Studies in Alternative Education. Palgrave Macmillan, Cham, 2018

[12] Greshake B., Bayer PE., Rausch H., Reda J. openSNP–A Crowdsourced Web Resource for Personal Genomics. PLOS ONE 9(3): e89204, 2014. https://doi.org/10.1371/journal.pone.0089204

[13] Gershman SJ, Greshake Tzovaras, B. Dopaminergic genes are associated with both directed and random exploration. Neuropsychologia 120:97-104, 2018.