Academia permeating society through Citizen Science: recommendations for Higher Education Institutions

Author	**Katerina Zourou, Angeliki Tseliou**
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Contributor(s):	**Evangelia Triantafyllou, Aalborg University** **Antoine Blanchard, Sébastien Peyrard, University of Bordeaux** **Külli Kori, Kai Pata, Tallinn University** **Giulia Torresin, Angeliki Tseliou, Katerina Zourou, Web2Learn** **Karoliina Hautala, Essi Vuopala, Oulu University** **Friedel Grant, Vasso Kalaitzi, Athina Papadopoulou, LIBER**
Reviewer(s):	**Vasso Kalaitzi, LIBER**
Approved by:	**All Partners**
Abstract:	**The document corresponds to activity 3 of Output 1 (Field analysis: Positioning HEIs in open and citizen science for open knowledge and innovation). It contains actionable guidelines with the aim to raise awareness in open and citizen science inside and outside HEIs and thus develop practices and routines for implementing and sustaining open and citizen science, and through this mechanism better connect to society.**
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Consortium

	Name	Short Name	Country
1	**Aalborg University**	AAU	Denmark
2	**Tallinn University**	TU	Estonia
3	**Web2Learn**	W2L	Greece
4	**University of Oulu**	UO	Finland
5	**University of Bordeaux**	UBx	Fance
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List of Abbreviations

Abbreviations	Description
HE	Higher Education
HEI	Higher Education Institution
CS	Citizen science
OS	Open science
SDG	Sustainable Development Goals adopted by all United Nations Member States in 2015

Summary

This publication addresses citizen science (CS), a key component of Open Science (OS), and the role(s) that universities currently play in it or can possibly play in the future. It is the result of the study entitled *Academia permeating society through citizen science: use cases of engagement in Higher Education* conducted within the framework of the INOS project from September to December 2019. The study was an analysis of more than 80 citizen science projects from the perspective of involvement of Higher Education Institutions (HEIs) in citizen enhanced open science, and is fully accessible online at the project website.

The current publication completes the study by translating its key messages into Recommendations. Therefore, the analysis that follows comprises a set of actionable guidelines aiming to raise awareness about open and citizen science and to upgrade the higher education contribution to citizen science projects and engage in a more sustained interaction with society.

The stakeholder group it addresses in particular is staff at universities and at institutions cooperating with universities (public and private sector, international organizations, NGOs, etc.). As university staff collaborate more and more frequently with stakeholders outside the university in a citizen science approach, non-academic staff are very suitable as a target audience for this study.

Introduction

Recent studies elaborating on perspectives of science in years to come, emphasize the role of Open Science in broadening horizons for science and society. Open Science, among other definitions, can be understood as "the practice of science in such a way that others can collaborate and contribute, where research data, lab notes and other research processes are freely available, under terms that enable reuse, redistribution and reproduction of the research and its underlying data and methods" (FOSTER, 2016[1]). Due to the transparency and accessibility to knowledge that Open Science conveys, it is expected to offer opportunities to HEIs to break up with a more traditional image of knowledge creation and to genuinely connect with various social groups.

Universities are identified as institutions situated in a broader social context and as incubators of the next generation of citizens active in society. Due to their key role in the production and circulation of scientific outcomes, universities have the potential to act as catalysts, forging better connections between science and society, and citizen science is one of the possible ways. Citizen science is a broad term, "covering that part of Open Science in which citizens can participate in the scientific research process in different possible ways: as observers, as funders, in identifying images or analysing data, or providing data themselves. This allows for the democratisation of science and is also linked to stakeholders' engagement and public participation." (European Commission, nd[2]). Citizen science is one of the eight pillars of Open Science (Open Science Policy Platform, 2018[3]).

The involvement of volunteers in research opens new perspectives in academia-society cooperation. Very few publications have explored this relationship, but these include the Advice paper "Citizen Science at Universities" released in 2016 by the League of European Research Universities (LERU, 2016)[4] and an INOS publication (Teo, 2020)[5] which highlight the need to further commit to this objective.

Audience

The study is open for consultation by any interested individual. The stakeholder group it addresses in particular is staff at universities and at institutions cooperating with universities (public and private sector, international organizations, NGOs, etc.). As university staff collaborate more and more frequently with stakeholders outside the university in a citizen Science approach, non-academic staff are

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[1] FOSTER. (nd). Retrieved from: https://www.fosteropenscience.eu/

[2] European Commission (nd). Citizen Science https://ec.europa.eu/digital-single-market/en/citizen-science

[3] Open Science Policy Platform (OSPP). (2018, April 22). Recommendations. Retrieved from: https://ec.europa.eu/research/openscience/pdf/integrated_advice_opspp_recommendations.pdf#view=fit&pagemode=none

[4] League of European Research Universities (LERU). (2016, October). *Citizen science at universities: trends, guidelines and recommendations*. Advice paper. Retrieved from: https://www.leru.org/publications/citizen-science-at-universities-trends-guidelines-and-recommendations

[5] Teo, E. A. (2020, in press). *State-of-the-art analysis of the pedagogical underpinnings in open science, citizen science and open innovation activities*. E. Triantafyllou (Ed.). INOS Consortium. Retrieved from: https://inos-project.eu/

very suitable as a target audience for this study. Finally, with regards to university staff, any type of staff can find an interest in this study with respect to their position, because the Recommendations engage HE staff at different levels: library staff, researchers, technical staff, administrative staff and decision makers regarding openness to society and internationalization.

Methodology

The present set of recommendations result from a study carried out by the INOS team between September and December 2019[6]. This study served to collect citizen science initiatives, including open innovation ones, and analyze them through the lens of involvement of HEIs (and academic libraries) in them.

85 initiatives were identified, of which 20 were selected based on the role of Higher Education actively played in them. To be able to specify what "HE involvement in citizen science" means, we identified some criteria that allowed us to understand its various dimensions, and to proceed with a cross-institutional comparison, across the identified cases. We thus agreed on a typology to analyze all cases against them, consisting of the following items:

1. Website
2. Outline
3. Main organisers
4. Types of activity
5. Format
6. HE roles
7. HE staff investment and their profile
8. Type of HE investment
9. Quality and impact of the achieved activity
10. Ethical and legal considerations, data management
11. Sustainability considerations
12. Citizen science approach

Following the analysis of these 20 emblematic citizen science projects against the aforementioned typology, the role of universities was identified and transformed into actionable points, which is the subject of the current study. Therefore, this set of recommendations is rooted in current practice that was identified through the analysis of 20 citizen science projects, and as a way to overcome identified obstacles in the widening the citizen science landscape.

Moreover, each recommendation is connected to one or more concrete examples of citizen science projects, allowing the reader not only to be inspired by the recommendations, but also to be able to deepen their understanding of the reality of citizen science and ways of successful implementation. Finally, this study is an invitation to the community (consisting of HE academic and library staff and staff of public and private sector institutions cooperating with universities), to accelerate efforts to contribute

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[6]Zourou, K. 2020. *Academia permeating society through citizen science: use cases of engagement in Higher Education*. INOS consortium. Retrieved from: https://inos-project.eu/

to the understanding and reshaping of the role of HEIs in open and citizen science. This would certainly offer a new dimension of their position to the knowledge base of science with and for society.

Structure of the Recommendations

Each recommendation consists of the following components:

- Background: the current situation with regard to a specific, identified need

- Action: measures to be taken by HEIs in order to address a specific need.

- Examples: case studies based upon the 20 initiatives selected as examples of the suggested recommendation.

Recommendations table

Recommendation	Underlying concept	Relevant case
1. Strengthen the engagement of university students to meet ambitious social objectives	Whereas university staff may be involved in citizen science projects, university students are much less involved.	Aalborg University's Megaprojects & Climathon
2. Adopt innovative approaches in academic engagement for civil society	There is a need to go beyond mainstream solutions to reach out to new, ground-breaking initiatives.	Project Discovery with Eve Online & Smartfin
3. Not mere observers: engage academic staff in the design and implementation of citizen science	HEIs can adopt more diversified roles and at various stages of citizen science projects, beyond the role of scientific validation or external evaluation.	Citizen science activities organised by Tartu University Natural Science Museum & Helsinki Central Park
4. Develop curricula that embrace citizen science and public participation in shaping science	HEIs should include a citizen science dimension in their curricula as a means to mainstream it in university learning and teaching practice.	Tallinn University LIFE projects & Ocean i3
5. Support local communities seeking scientific advice	Efficient collaboration between scientists and citizens is of the highest importance in environmental justice and public health advocacy.	The Flint Water Study
6. Open up to the various types of stakeholders a CS project can involve	A multi-stakeholder collaboration is needed to tackle social issues.	MosquitoAlert & AirCitizen
7. Build trust and sustainability by including citizens	Universities should anticipate sustainability beyond the end of a citizen science project, by taking sustainability measures, strengthening community uptake and building trust with volunteers.	Open Seventeen & DigiEduHack
8. Leverage the role of universities in financial transparency initiatives	Social movements asking for more financial transparency on national & global levels should be supported by universities through citizen science.	#DataOnTheStreets Rally & The Better Budget Dataquest
9. Engage in open innovation	Universities are expected to commit to the creation of new knowledge, and thus become a key source of innovation in society.	Epidemium & Open Source Electric Vehicle

Recommendation #1 | Strengthen the engagement of university students to meet ambitious social objectives

Background

HEIs are actively involved in a number of citizen science initiatives, playing a role in their design, implementation and assessment phases. While university scholars are generally included as the initiators, teachers or coordinators of such projects, students are often left behind. The limited number of students involved presents two disadvantages. First, the citizen science cycle becomes narrowed down due to the low number of contributors, and, second, academia loses a unique opportunity to shape the skills and competences of the new generation of researchers with an open science mindset, namely as students/citizens with a developed sense of the contribution of academia in society.

Action

We would encourage HE staff to involve students depending on the link to their university degree in their citizen science projects and invest in the students' participatory and scientific skills in order to broaden a project's scientific perspective and enrich its outcomes. To do so, teaching and research staff of universities are advised to:

- Connect students' curricula and degrees to citizen science projects as a means to rethink the knowledge production and circulation models inside and outside the university.
- Include students in the design phase of such projects as an active learning approach and an in-person experience in the shaping of tomorrow's science.
- Invest in in-house training to raise awareness and build capacity for students' participation in projects for society.
- Engage students in group projects that are not only beneficial for their degree but also have a real-life, societal impact.
- Reward students' performance as participants of citizen science projects with awards and extra academic excellence points.

"[University] students were interested in the assignment and the collection of citizen science data beyond the classroom, and around 80% agreed that participation in [the project] increased their environmental engagement".

Mitchell N., Triska M., Liberatore A., Ashcroft L., Weatherill R., Longnecker, N. (2017) *Benefits and challenges of incorporating citizen science into university education.* PLoS ONE 12(11): e0186285. https://doi.org/10.1371/journal.pone.0186285

Insights into examples

Both initiatives outlined below are examples of ways universities engage their students in group work leading to certification within the university and have a societal impact – namely their connection to the United Nations Sustainable Development Goals (SDGs). Impact is thus systemic, inside and outside the university, with students having a leading role.

Aalborg University's Megaprojects & Climathon

Megaprojects[1] at Aalborg University (AAU) concern solving the world's grand challenges related to the United Nations SDGs, through the engagement of university staff and students. Megaprojects are regular semester projects where groups of students from across semesters and educational backgrounds meet and inspire each other on the solution to a big societal challenge. Across disciplines and degree programmes, AAU students get ready to tackle the challenging, yet exciting, task of assisting local communities (i.e. the municipality and its business community) in creating sustainable development in a wide range of sectors. This is all part of the new initiative on Megaprojects, developed by AAU under the vision: "Grand challenges must be addressed across disciplinary boundaries as well as across degree programmes and semesters."

Climathon[2] is a year-round programme, with a solutions-hackathon at its core, translating climate action solutions into tangible projects, supporting climate-positive businesses and start-ups and addressing local policy changes. It is initiated by the European Institute of Innovation and Technology (EIT) and several challenges, such as the circular economy, waste management, extreme weather, energy, etc., are identified and tackled by Climathons. Recently a Young Climathon was initiated to host a one- to two-day climate hackathon where students work on a real climate challenge from an industry sector, city, company or school. Furthermore, in 2019 the Climathon Global Awards were introduced, to award citizens and cities for local climate innovation and to offer exposure and support to scale the selected solutions' impact.

[1] https://www.megaprojects.aau.dk/ ; https://megaprojects.moodle.aau.dk/

[2] https://climathon.climate-kic.org/

Recommendation #2 | Adopt innovative approaches in academic engagement for civil society

Background

It is often highlighted in citizen science literature, that citizens are confined in the role of (mere) data collection and annotation, while researchers cover the whole range of scientific activities required in an experimentation (LERU, 2016). In contrast, there is a range of citizen science activities that open up new ways of engagement, where the data collection and aggregation activities are better aligned with a leisure dimension, and citizens can be engaged in unpredicted and fun activities, which at the same time are fully scientifically valid. "Innovation" in science should also cover creative, unpredictable situations where data collection by citizens is natural and fun.

Action

HE staff are encouraged to go beyond mainstream solutions to reach out to new, ground-breaking initiatives. Whereas decision makers at HEIs can pave the way towards this objective through policies and also incentives to encourage staff to engage in this type of initiative, HE staff with teaching and/or research profile can be engaged in innovative citizen science projects for society. More specifically, they are advised to:

- Locate where massive numbers of users are active, as is the case with players of massively multiplayer online role-playing games (MMORPGs).
- Engage them in science through innovative formats that participants can identify with (e.g. immersive online games).
- Reach out to and team up with experts in the field to ensure high quality of the selected format (e.g. online gaming companies).
- Also think of citizen science in terms of fun, creativity and unpredictability for the participants.

"(…) When designing a citizen science (…) project, researchers should plan for substantial and sustained investment in outreach and community management, to ensure adequate numbers and diversity in the citizen science community."

League of European Research Universities (LERU) (2016). *Citizen science at universities: Trends, guidelines and recommendations study.* Retrieved from: https://www.leru.org/publications/citizen-science-at-universities-trends-guidelines-and-recommendations

Insights into examples

The following initiatives succeed in collecting valuable data to complement scientific research by reaching out to uncommon pools of citizens and developing innovative tools and attractive formats to engage them in science.

Project Discovery with Eve Online & Smartfin

Project Discovery, which leverages massively multiplayer online role-playing games (MMRPG) to engage citizens in cutting-edge scientific research, uses Eve Online[1], a space-based, persistent world MMRPG, to invite players to analyse graphs for variations in a star's luminosity, possibly indicating the transit of an exoplanet. The game contains a total of 7,800 star systems that can be visited. Players can participate in a number of in-game professions and activities and are provided with the luminosity curves of stars. Identifying a change in a star's brightness nets them an in-game reward while also potentially indicating to scientists that an undiscovered planet has passed in front of the star. From late 2017, a first analysis of 44.4 million classifications provided by 77,709 players has been underway. Around 4 million samples are analysed every month, or 135 thousand per day. So far, users have collected more than 200 million annotations on exoplanets, a massive feat and perhaps an all-time record in citizen science. Eve Online is a collaboration between CCP Games and Massively Multiplayer Online Science (MMOS) with the Universities of Reykjavík and Geneva.

The **Smartfin** Project [2] addresses the lack of understanding of climate change in our coastal zones due to the high biodiversity and the increasing rate of human activities hosted there. As it becomes challenging and expensive to measure the trends and effects of climate change in these areas, Smartfin aims to unite the surfing community and the research community to fill in this gap. It offers research-grade, data-collecting surfboard fins ("Smartfins") to its ocean-engaged members and encourages them to surf or SUP with the fins regularly to transfer useful nearshore data to the open cloud for oceanographic scientists to use in their research. Smartfin is partnered with researchers at the Scripps Institution of Oceanography, a department of UC San Diego and one of the world's leading institutions for oceanographic research.

[1] https://www.eveonline.com/discovery
[2] https://smartfin.org/

Recommendation #3 | Not mere observers: engage HE staff in more sustained interaction with citizens

Background

In the majority of citizen science projects, citizens carry out clearly defined tasks, in a pre-organised manner. This may affect citizens' opinions about the utility or reason for their engagement, as they lack the full picture. There is thus room for improvement to make citizen science a more holistic experience, engaging citizens in onsite and online experimentations, and in several locations, allowing them to discover more than one stage of a scientific project.

Action

Actively participating in citizen science projects can offer universities a broad spectrum of benefits: from non-automated large data analysis and distributed observations in large geographical areas to the reinforcement of the universities' engagement with society and the formulation of new research questions, citizen science can enhance the universities' performance in terms of academic productivity and social contribution.

Academic institutions are encouraged to:

- Identify areas of scientific research which could largely benefit from such an approach.
- Connect to civil society to detect possible trends, needs and possibilities related to their scientific focus.
- Engage citizens in the design and implementation phases – not merely in low-level tasks such as data observation or annotation of a research project.
- Involve citizens in onsite and online experimentations, allowing them to discover more than one stage of a scientific project.

"We have identified three areas in which citizen science might enhance undergraduate education: data collection, research opportunities, and class projects. In all cases, students are engaged in inquiry-based learning."

Oberhauser, K., & LeBuhn, G. (2012). Insects and plants: Engaging undergraduates in authentic research through citizen science. *Frontiers in Ecology and the Environment*, *10*(6), 318–320.https://esajournals.onlinelibrary.wiley.com/doi/pdf/10.1890/110274

Insights into examples

In both the cases below citizen science is perceived as an integral part of the universities' scientific activities and HEIs were active in all phases. Citizens (including students) are involved in onsite observations and online participation.

Citizen Science activities organized by Tartu University Natural Science Museum & Helsinki's Central Park

Initiated by Tartu University Natural Science Museum, **eElurikkus**[1] is a portal for the taxa found in Estonia, hosting data on 29,266 species and more than 4 million records. The aim of the portal is to provide a comprehensive resource on Estonian biodiversity by bringing together scientific, monitoring, and citizen science datasets. The portal provides public access to a wide variety of taxa occurrence types including specimens in scientific collections, observations, sounds, images, videos, references in literature and DNA-based observations. Data contributors are collecting institutions, individual collectors and community groups. In this framework, the National Science Museum has organised several citizen science activities, such as data collection of fungi Mushroom Foray, a marathon of nature observations with BioBlitz format, and a project of plant herbarium collection also engaging school students.

In a research project[2] conducted by the City of Helsinki and Silviya Korpilo, researcher at the University of Helsinki, the aim was to further the planning of the **Helsinki's Central Park** in an increasingly sustainable direction. A total of 230 volunteers using the park gathered information concerning forest usage and development needs. The information was gathered employing volunteers' smartphones and GPS data. As they moved about in the forest, exercise applications on their phones collected data on their movements. The more data entered into the site, the more accurate the view of Korpilo and the City of Helsinki became concerning forest usage and development needs. The initiative served as the pilot study for MyDynamic Forest, an ongoing research project and collaboration of the University of Helsinki, Aalto University, the City of Helsinki and citizens to map recreational use and movement in Helsinki's urban forests.

[1] https://elurikkus.ee/en
[2] https://www.hel.fi/uutiset/en/helsinki/central-park-citizen-science

Recommendation #4 | Develop curricula that embrace citizen science and public participation in shaping science

Background

The importance of universities in supporting and promoting citizen science is highlighted in several EU policies. Whereas HEIs are engaged in citizen science projects and thus reshape their role and contribution to society, the value of citizen science in terms of teaching has not been fully deployed. Students would benefit a great deal from upgraded university curricula that discuss the advantages (and disadvantages) of such an approach while embracing the openness of citizen science in teaching and learning resources.

Action

We claim that HEIs need to break up with a more traditional image of knowledge creation and incorporate a citizen science dimension in the core of their educational approach and implementation, in order to become incubators of future open science researchers' generations. To reach this goal, university staff with a teaching profile and administrative staff are encouraged to:

- Develop curricula with a strong citizen science aspect for all levels of studies.
- Include courses which elaborate on the advantages (and disadvantages) of it.
- Match current trends in Open Education and Open Educational Resources with Citizen Science, thus to develop a systematically broader approach to open knowledge.
- Adopt an interdisciplinary, across-degree approach in order to assist local communities in finding solutions for real-life challenges.

"If the use of citizen science platforms becomes an increasingly common feature in participatory-learning-focused university coursework assignments, then a mechanism to notify project science teams and track which are student assignment-based classifications would be highly advisable. This would permit subsequent analysis that may control for the effects, if found to be necessary."

Phillips, T. B., Ballard, H. L., Lewenstein, B. V., & Bonney, R. (2019). Engagement in science through citizen science: Moving beyond data collection. *Science Education*, *103*(3), 665-690.

Insights into examples

Both initiatives below display a high rate of incorporating citizen science into their curricula with a strong interdisciplinary approach. Furthermore, Tallinn University offers students a relatively high level of initiative by offering them the option to participate as project initiators.

Tallinn University LIFE projects & Ocean i3

LIFE (ELU in Estonian)[1] initiated by Tallinn University is a university-wide project-based course, compulsory for Bachelor's and Master's level students. The main objective of LIFE is to support the development of interdisciplinary problem-solving skills. Students from different study areas are invited to collaborate with academics to carry out projects focusing on problems of their own interest. To do so, the course encourages the development of thinking and argumentative skills, metacognitive skills and critical thinking as well as self-management, application of knowledge and lifelong learning skills. The initiator of a LIFE project idea can be a lecturer, a student or a partner from outside the university (entrepreneurs, NGOs, organisations, etc.).

Ocean i3[2] led by the University of the Basque Country (Spain) and the University of Bordeaux (France), in the framework of Bordeaux-Euskampus Campus partnership, is a teaching project with a mission to contribute to the reduction of plastic pollution on the Basque-Aquitaine transboundary coast. The project invites students from various disciplines, such as business administration, law, teaching, nursing, engineering, criminology and sports management, to collaborate with teachers to promote an interdisciplinary approach in order to understand and respond to this challenge and its complexity.

[1] https://www.tlu.ee/en/elu & https://elu.tlu.ee/
[2] https://euskampus.eus/en/programmes-en/euskampus-bordeaux/ocean-i3

Recommendation #5 | Support local communities seeking scientific advice

Background

Citizens play a prominent role in every citizen science project. For some of them, namely environmental justice or public health advocacy case initiatives, observations by citizens become paramount in terms of observing and improving the everyday life of citizens and documenting change though scholarly work (data and publications). In several environmental justice projects, the triggering event comes from the citizens' side. Therefore, there is a unique opportunity for close collaboration between citizens and scientists. Sustaining collaboration between scientists and volunteers is of the highest importance for the achievements of these citizen science projects.

Action

When environmental justice and public health are at stake, academic institutions can help by bringing their expertise and further engaging citizens in research design and implementation. More specifically HE scholars are encouraged to:

- Establish an open communication strategy to interact with citizens and stay vigilant towards their claims.
- Once invited to assist, reach out to the broader local community with awareness campaigns, which are both comprehensive and scientifically sound.
- Engage in close collaboration with local civil society representatives to co-create an appropriate format for the citizens' contribution.
- Follow-up with the community and continue to contribute to the cause until the issue is solved.

"Increasing coordination and collaboration between citizen science practitioners from different fields (…) leads to sharing procedures and best practices, and to the creation of networks and associations."

League of European Research Universities (LERU) (2016). *Citizen science at universities: Trends, guidelines and recommendations study*, p.3. Retrieved from :
https://www.leru.org/publications/citizen-science-at-universities-trends-guidelines-and-recommendations

Insights into examples

An environmental cause of action, introduced by members of the community, triggers a scientific investigation procedure which includes and follows-up with the public. Persistent collaboration between scientists and civil society resulted in beneficial outcomes for citizens.

The Flint Water Study

In 2014, the city of Flint, Michigan, switched its water supply to the Flint River in an effort to save money. From this moment on, citizens complained about the smell, taste, and appearance of the water, but their complaints were ignored by experts and local politicians. The **Flint Water Study**[1] was initiated by students and researchers at Virginia Tech University at the end of summer 2015, in order to prove the high water risk. To reach their goal, Virginia Tech University teamed up with civil society and advocacy associates as collaborators and information sources. Residents were sent a sample kit and an accompanying instruction sheet. They were required to proceed with water sampling according to the accompanying instructions and return the samples to Virginia Tech University. A total of 300 sample kits were sent out on August 14th and reached Flint on August 19th 2015. The tests that followed detected extremely high levels of lead and copper contamination. Based on these facts, the state and the federal government finally took action and President Obama signed an emergency declaration. The overall initiative peaked in 2015 and 2016 and is still ongoing through the updates on the Flint Water Study website.

[1] http://flintwaterstudy.org/

Recommendation #6 | Open up to the various types of stakeholders a citizen science project may involve

Background

The term "citizens" often disguises the variety of roles and the range of expertise that lies within non-professional scientists. Due to this wealth of skills that various volunteers bring, citizen science projects leverage the opportunities for engagement in tasks more in line with volunteers' expertise. This also leads to a greater diversity in the achievement of complex tasks, which calls for a multi-stakeholder participation.

Another feature of the multi-stakeholder participation is the need to open up citizen science projects in types of partners engaged in a cooperation scheme that supplies expertise from various backgrounds. This is the case of citizen science projects grounded on cooperation between the private and public sector institutions along with universities and civil society associations or communities, to tackle societal issues together.

Action

In order to be successful in reaching a complex citizen science project's full potential, academic institutions should keep an open mind approaching and identifying key stakeholders. The role of decision makers at HEIs can be the catalyst in enabling a more direct connection between universities and the surrounding world, through policies and incentives for HE staff. Academic institutions are encouraged to:

- Go beyond the identification of traditional stakeholders or stakeholders that most often cooperate with HEIs, to reach out the most relevant ones for a citizen science collaboration.
- Collaborate with a variety of stakeholders (from different industries in the public and private sectors and in civil society) with relevant and high-quality expertise in the specific topics tackled by the project to ensure a multitude of scientific perspectives and enrich content and research.
- Select partners from the public and private sectors as well as from civil society, so that they can create a mix of joint interests for a social purpose.

Insights into examples

Both initiatives presented below have adopted an inclusive approach in terms of the data collection and sharing of the findings: Mosquito Alert invites civil society to complement their scientific work while sharing valuable information with health managers from the public sector; in the Air Citizen initiative, the private and public sectors, civil society and academia have joined their forces to fight for an environmental cause.

Mosquito Alert & AirCitizen

Mosquito Alert[1] is a cooperative citizen science observatory coordinated by various public research institutions. Its main objective is to fight against the tiger mosquito and the yellow fever mosquito expansions, two invasive species vectors of global diseases such as zika, dengue and chikungunya. The information collected complements the scientific work and allows public health managers to use this information to monitor and control the spread of mosquitoes in neighbourhoods and cities. The software used in the Mosquito Alert application is free and open source.

The **AirCitizen**[2] project is a collaboration between business and public sector institutions (research centres, universities, regional policymakers). It aims at giving citizens the ability to actively probe their close environment and the air they breathe, through: a) making mobile environmental stations in FabLabs that include several low-cost sensors (i.e. temperature, relative humidity, pressure, NOx, ozone or fine particles PM10 and PM2.5); b) performing in situ measurements to evidence the spatial and temporal variability of the environmental parameters – in mobile measurement campaigns, for instance, with the help of climatologist-geographers, and in various places with a variety of environmental contexts – and; c) contributing to the improvement of environmental knowledge by sharing the measurements in a database, thus allowing an online cartography of air pollution. Within the AirCitizen project, workshops are held, offering the opportunity to researchers, hackers and citizens to meet, discuss and exchange information.

[1] http://www.mosquitoalert.com/en
[2] http://aircitizen.org/

Recommendation #7 | Build trust and sustainability by including citizens

Background

Long-term sustainability is particularly important for citizen science projects that aim to pursue their activity after the initiation stage. In reality, many citizen science projects are of short scale, fragmented, with low reproducibility possibilities, and with a lack of sustainable measures allowing their continuation for the long-term. This situation calls for more careful planning of all stages of the citizen science project, with special attention paid to the period after the specific citizen science task(s) are completed.

Action

In order to ensure the longevity of their projects, academic institutions are advised to develop a sustainability plan at the beginning of the project that includes a strategy for the pooling of human and material resources throughout its duration and after its end. More specifically, they are encouraged to secure funding, involve participants more actively and empower them to become citizen scientists qualified for the continuation of a project. Suggestions for implementing this strategy include, among others:

- to involve citizens in the three main stages of a project (design, implementation and assessment), as a mechanism ensuring trust and ownership;
- to develop open source tools and to train participants to effectively use and/or upgrade them;
- to make all research findings available in open formats to ensure accessibility, interoperability and reusability of the data.

"A (…) [current] trend [in citizen science] is that professional scientists (…) and other universities are inviting citizens to play an increasingly sophisticated and central role in the citizen science projects they develop."

League of European Research Universities (LERU) (2016). *Citizen science at universities: Trends, guidelines and recommendations study,* p. 9. Retrieved from:
https://www.leru.org/publications/citizen-science-at-universities-trends-guidelines-and-recommendations

Insights into examples

Both initiatives outlined below are successful in shaping citizen scientists who will be qualified to sustain citizen science projects, by including them as much as possible at all stages. To reach their goal, they offer a competition format, in which training can be complemented by open source solutions (as is the case with Open Seventeen's SDG Solution Kit).

Open Seventeen & DigiEduHack

Open Seventeen (O17)[1] is a challenge-based, online interactive coaching programme that supports and rewards teams developing innovative and implementable solutions for the 17 UN Sustainable Development Goals (SDGs). An O17 coaching cycle starts with a call for projects to solve concrete challenges inspired by experts from UN agencies, international organisations and NGOs targeting one or more of the SDGs. The call might have a specific target audience, such as students, or be open to anyone. In the currently running 3rd edition of O17, the challenge targets plastic pollution, and it is run in collaboration with UN Environment (UNEP). On successful completion, the most promising solutions will be offered travel grants to Geneva (Switzerland) to attend international events such as WSIS Forum 2020 and AI for Good. O17 participants are encouraged to use the SDG Solution Kit, comprising tools adapted from existing open source solutions, that can support a wide range of crowdsourcing projects for the SDGs, ranging from crowd-based data collection and classification to distributed volunteer computing to project design and community mapping tools.

DigiEduHack[2] is an initiative by EIT, the European Institute of Innovation and Technology, under the European Commission's Digital Education Action Plan, led by EIT Climate-KIC and coordinated by Aalto University. The aim is to empower people to articulate and engage, participate and shape the future using digital technologies and education. Organisations willing to register as DigiEduHack hosts from all over the globe invite students, entrepreneurs, teachers, researchers and education professionals to co-create solutions to a specific digitalisation and learning challenge in a 24-hour hackathon. The DigiEduHack 2019 version took place simultaneously in 21 countries, with more than 1,700 participants solving 60 challenges. The result is hundreds of innovative solutions reinventing the future of education, which were submitted for online voting.

[1] http://openseventeen.org/plastic/

[2] https://digieduhack.com/en/

Recommendation #8 | Consolidate the role of universities in financial transparency initiatives

Background

Citizen science initiatives often reflect strong societal needs and accountability in public spending is one of the most recurrent ones. In a number of cases, attempts by global networks for financial transparency to connect the governmental bodies in charge with their efforts were welcomed and a growing trend of governments providing open information and data regarding budget execution is now observed. Our study claims that the active involvement of academic institutions is a requisite for an integrated validation of such initiatives; however, a relatively low response rate from academic institutions was recorded.

Action

We would encourage universities to strengthen their involvement in initiatives tackling accountability in public spending in the following ways:

- Join the financial transparency networks as advisors at local and international levels.
- Engage in advocacy for openness, by providing scientific background information on the utility of transparency and civil society contribution.
- Team up with their affiliated institutions and individual scientists to form scientific consortia responsible for validating methodology and optimizing outcomes of the network's activity.
- Provide the citizen science teams with tools and know-how to facilitate reaching their goals.
- Exchange with the governmental bodies involved to optimize the usability of their datasets and platforms.

Insights into examples

Both cases presented below aim at generating a more informed, participatory and involved society and have a strong research focus. However, the academic participation rate is rather low: in Better Budget Dataquest, university involvement is limited in their role as co-conveners in the local events (in the cases of Costa Rica, Indonesia and South Africa) while in #DataOnTheStreets Rally it is not mentioned at all.

#dataonthestreets Rally & the Better Budget Dataquest

On Open Data Day, GIFT, a global network that facilitates dialogue between governments, civil society organisations, international financial institutions and other stakeholders to find and share solutions to challenges in fiscal transparency and participation, invites citizens to participate in two main data collection events:

a) In the **#DataOnTheStreets Rally**[1], citizens use publicly accessible data generated by the government regarding investment projects, as well as the respective transparency platforms, to follow up on the public construction.

b) Based on the SDGs, the **Better Budget Dataquest** for Sustainable Development (BBD)[2], organised for the first time in 2019, focuses on gender, inequality and environment. Citizens are invited to explore the open data of public expenditures and relate them with additional data and contextual information to present findings on the implications of the allocation and execution of the budget.

The initiatives take place in Mexico, Chile, Colombia (the #DataOnTheStreets Rally) and Argentina, Chile, Colombia, Costa Rica, Indonesia, Mexico, South Africa and Uruguay (the Better Budget Dataquest). Both are initiatives focusing on generating a more informed, participatory and involved society and were both successful in proving that the results generated can lead to more specific observations that allow improvements to the design of government programmes and the structure of spending. In both types of activities, the need to improve the publication of government data was palpable.

[1] http://www.fiscaltransparency.net/use/dataonthestreets-international-rally/

[2] http://www.fiscaltransparency.net/use/better-budget-dataquest-for-sustainable-development/

Recommendation #9 │ Engage in open innovation

Background

The central idea behind open innovation is that, in a world of widely distributed knowledge, companies rely on crowdsourcing to expand and improve research and development. Citizen science as a form of crowdsourcing can act as a means to connect universities with the private sector in view of more open products for the market, and ensure that ethical considerations are taken into account, including recognition and data re-use. Universities on the other hand are expected to be committed to the creation of new knowledge, and thus become a key source of innovation in society. At present, there are very few universities engaged in open innovation, with universities showing some lack of agility or speed to adjust. As the lack of agility does not mean lack of scientific rigor, this situation is hoped to change in the future.

Action

Academic institutions are invited to play an important role in open innovation projects, in order to ensure that they meet high quality and Responsible Research & Innovation (RRI) standards. Therefore, they are encouraged to:

- Initiate or join existing open innovation consortia.
- Provide open data to support further research.
- Ensure that legal and ethical considerations on user generated data are carried out with respect to individual contributors.
- Be more agile and responsive to needs in skills and research and development driven by the private sector.
- Contribute with their expertise to secure quality standards are applied in all project open innovation project stages.

Insights into examples

Open innovation mostly takes place outside academia; the business sector employs crowdsourcing as a means to accelerate time-to-market and to benefit from the potential of volunteer contributions. Involvement of HEIs in open innovation projects is non-existent (first case: Open Source Electric Vehicle) or marginal (second case: Epidemium) which should be seen as an opportunity for HE deployment.

Epidemium & Open Source Electric Vehicle TABBY EVO

Epidemium[1] is an open and collaborative scientific research project that aims to study the epidemiology of cancers through the exploitation of open data, based on the implication of a community of volunteers who develop projects in teams. Three types of challenge have been set: 1. See Cancers, 2. Foresee Cancers, and 3. Cancer Mortality Prediction. Epidemium supports each team in its research until publication. To reach this, a 5-step plan has been developed. This plan includes the review of each step by experts and a mid-challenge presentation to the jury. At the end of the challenge, each selected team will present their results, including a scientific poster and a publication paper draft. As openness is one of the programme's core values, every contribution, database, content and piece of code used or produced within a project will be released under open licences.
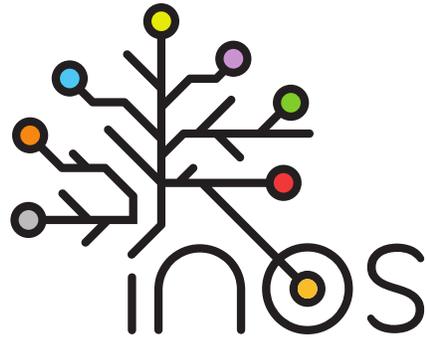
TABBY EVO[2] is an open source, ready-to-use, completely modular framework for the creation of complete electric vehicles, designed and engineered by OS Vehicle (currently Open Motors). According to its founders, it can be used to bootstrap businesses (electric vehicle (EV) start-ups), to create one's own vehicle, for education purposes, and much more besides. Compared to previous versions before 2015, EVO is claimed to be better, faster and stronger version of the platform. All the plans and blueprints can be downloaded from the Open Motors website's download section. Users are encouraged to improve the designs, work on them, and upload them to share their ideas with the community through the Open Motors forum.

[1] http://epidemium.cc/
[2] https://www.openmotors.co/tabbyevo/

INTEGRATING OPEN AND CITIZEN SCIENCE INTO
ACTIVE LEARNING APPROACHES IN HIGHER EDUCATION

https://inos-project.eu