Unleashing the Potential of Citizen Science as an Educational Tool towards the Sustainable Development Goals (SDGs)

Quality Education for an empowered society

Corresponding author:

- **Imane Baïz**, European Project Manager, Paris Descartes University
  imane.baiz@gmail.com
  +33(0)6 78 09 95 36
  8bis rue Charles V, 75004 Paris, FRANCE

Co-authors:

- Tonino Rizzo, Pedagogical Engineer, Paris Descartes University
- Gina Maskell, Student Assistant, European Citizen Science Association

Executive Summary

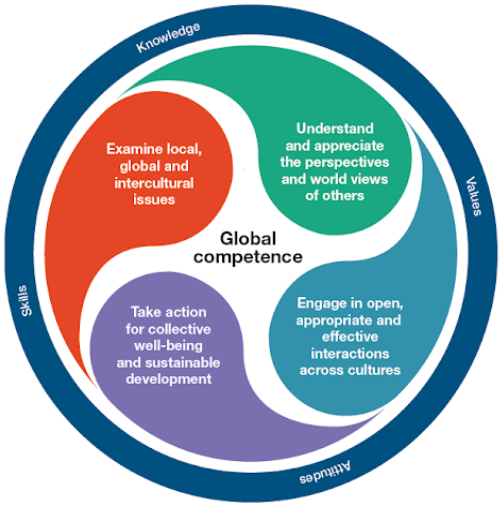
This policy brief assesses the potential and challenges of citizen science (CS) as an educational tool and how it can contribute to achieving the Sustainable Development Goals (SDGs). While CS can address specific challenges across almost all of the 17 SDGs, this policy brief focuses on direct contributions to SDG 4, Quality Education. It asks: 'How can citizen science equip learners with life-long skills, knowledge and attitudes that foster change-making, using a blend of non-traditional pedagogies?' We demonstrate the roles that educational practices developed around citizen science can have, by presenting a selection of inspiring initiatives currently taking place throughout Europe. Citizen-science-based education does not provide learners solely with an understanding of science and scientific methodology, but it also develops social skills used to communicate, take part in or coordinate multi-stakeholder projects. In this way, this policy brief aims to support decision makers in education and science policy, including the European Commission, national and state ministries and other stakeholders in integrating these non-traditional educational practices into existing funding schemes, education policy and curricula, towards more meaningful, transformative learning and teaching.

Toward the SDGs as a universal framework for all

The United Nations' (UN) Sustainable Development Goals (SDGs; **1**) are a common framework to address the 21st century challenges, created to set an agenda for the change-makers around the globe. This "blueprint for peace and prosperity" has been adopted by member state governments, soon joined by industries and institutions. It is also an important matter to invite citizens worldwide to participate as they represent a powerful driving force.

Unleashing the potential of the world population requires equipping every individual with knowledge, skills, values and attitudes to promote sustainable development (**2**) such as the "multi-dimensional, lifelong learning for sustainability" laid out in OECD reports; **3** ; **Box 1**)

Box 1: *Dimensions of Global Competence, from the PISA Handbook on Global Competence, 2018*



Preparing our youth for an inclusive and sustainable world - The OECD PISA global competence framework. OECD, (2018). Available at:
http://www.oecd.org/pisa/Handbook-PISA-2018-Global-Competence.pdf

Addressing the SDGs through Citizen Science

In this brief we will consider citizen science (**4**) as a method to collectively address questions and issues, using the scientific tools at our disposal (be that DIY tools or support from academic researchers or other professionals). In this effort, CS works side by side with the Do-it-Yourself community and the Open Source movement (**5 ; 6**). While each CS project has its specific contributions to the SDGs according to its focus (**case study 1, 2 and 3**), all CS projects have a learning component inherent in them **(7 ; 8).** They also have the potential, when integrated properly in the curriculum, to contribute to SDG 4 (Quality Education), ensuring "that all learners acquire the knowledge and skills needed to promote sustainable development" (SDG target 4.7 and associated indicator 4.7.1[1]).

SDG4 and rethinking how science is taught

Recent research-based reports (such as those from the OECD) about science education worldwide focus on the need to rethink national curriculum standards and the way science is taught (**9 ; 3**). National programmes tend to be very dense, with the need to cover a wide range of topics, resulting in a shallow coverage (**10**) and strains on teachers in the classrooms. CS could be an interesting pedagogical tool, with the potential to integrate many non-traditional and complementary approaches, moving into deeper, holistic, more experiential learning. Pedagogies engaged by CS and their benefits are listed in the table below (**9, 11**):

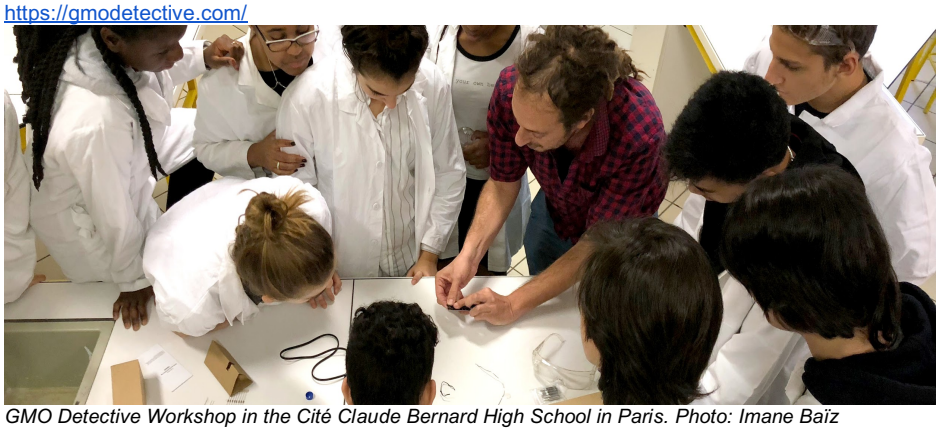
Aspects of CS	**What students learn from it**	**Related pedagogy**
Based on the scientific methodology	■ Working with hypotheses and experiment design ■ Gathering Data ■ Extracting conclusions from observations and/or data ■ Criticise and discuss	■ Evidence -based pedagogy ■ Learning through research ■ Theoretical learning
Project structure	■ Managing a project and its resources (i.e. time, money,	■ Project-based education

[1] United Nation (2016). Sustainable Development Goal 4 - Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. Available at: https://sustainabledevelopment.un.org/sdg4

	actors).	
Community-based: involving various actors	■ Interacting, connecting and coordinating with various actors ■ Benefiting from the experience of others ■ Practicing inclusivity, patience and other key social skills from intergenerational learning	■ Community-based learning
Engagement - centered	■ Get into action ■ Find motivation and self-confidence	■ Action-oriented pedagogy ■ Hands-on learning
"Real-world" implications and applicability	■ Using theoretical knowledge in reality ■ Solving concrete-case problems.	■ Authentic situation pedagogy ■ Learning-by-doing ■ Challenged-based education
Based on sharing culture	■ Practicing openness and sharing culture	

All the above-mentioned benefits can be observed in **Case Study 1, "GMO Detective".** However, to lay the foundations for these non-traditional teaching and learning pillars, teachers at the forefront need to be supported in terms of planning time, flexibility in curriculum implementation and access to resources (such as lesson plans and also connections to practitioners and scientists).

Case Study 1: GMO Detective, France
https://gmodetective.com/



GMO Detective Workshop in the Cité Claude Bernard High School in Paris. Photo: Imane Baïz

GMO Detective is a project developed by a PhD student from CRI, dealing with the democratisation of genetic marker detection. The project allows people to detect GMO DNA in a food. The project protocol and materials are all openly available, and replicable by anyone interested. Also, the results from gene testing are all shared in an open access database, allowing for the transparent mapping of foods containing GMOs. The project deals with SDG 3, "Good Health and Well-being" and SDG 12, "Responsible Consumption and Production," filling a data gap on these topics. A workshop for high schools was conceived out of this project, cross-linking genetics knowledge, DIY technology, basic lab skills and citizen science. The main focus of the workshop was to explore GMOs, critically and with an interdisciplinary approach, questioning what they are and how are they used, through experimentation, imagination and research skills. Students were given the task to test out food sample for GMOs, practising scientific neutrality. Students were then invited to take part in a role-playing debate. They were assigned roles as politicians, citizens, medical professionals or agronomists. This pushed students to consider the real-world applications of the science they were undertaking. They used internet research to find facts and build opinions around them. During the workshop, students also benefited from the presence of a researcher who, in their everyday life, uses science to address an actual, authentic, worldwide concern.

Why should CS-based education be integrated as a long-term project into school curricula?

It has been demonstrated that project-specific factual knowledge is acquired through participating in citizen science projects **(7 ; 8)**. However, many CS projects currently existing in or connected to schools, occur as one-off events and do not induce the longevity or repetition needed to foster the internalisation of broader social and

scientific learning goals. Implementing CS programmes systematically in curricula **(7 ; 12 ; 13)** would allow the possibility of transmitting deeper notions of science and promoting many of the attitudes and skills necessary to foster "sustainability changemakers."(**2, Box 1**). An example of a citizen science integration in the curriculum is elaborated in **Case Study 2 "Far Out."**

Case study 2: Far Out, Finland
http://www.syke.fi/en-US

Experiential learning and wondering at nature provide pupils with positive experiences of nature. Photo: Mervi Aineslahti.

Far Out, a Finnish two-year basic education programme, aims to bring together project-based and multidisciplinary learning, citizen science skills, mobile technology literacy, and other 21st century skills to basic education in Finland. The programme introduces these skills through two environmental themes: (i) carbon neutrality, and (ii) researching and improving the state of waterways (aligned with SDG 13, "Climate Action" and SDG 14 "Life under Water"). In a transdisciplinary partnership between schools and environmental scientists at the Finnish Environmental Institute, pupils collect water samples, analyse the findings and feed the information to nation-wide, open-access environmental databases. The Far Out programme encourages learning in the authentic environment, by the lakes, rivers or sea, as well as learning-through-playing via simulations through a mobile game. The Far Out programme also contextualizes students' learning to their home and schools by investigating energy use in terms of carbon neutrality.

Citizen Science based Education as a Springboard for Action

Actions spurred by a citizen science investigation can take many different forms and scales. Examples include (1) using CS data as evidence for an awareness raising campaign, or influencing policy (such as many of the projects lead by Mapping for Change, **Case Study 3**; (2) using personal and scientific lessons learnt to write to local, or national, policy makers to create a media buzz; (3) taking local actions such as planting trees, litter clean-ups, or the creation of microhabitats in an urban setting. Involving students in such actions teaches them how to enact change. It also stirs up curiosity, reinforcing or even potentially uncovering new intrinsic self-determination, an interest for a cause or field, and all of them catalysing engagement (**14**).

Case study 3: Mapping for Change, UK
http://mappingforchange.org.uk/

Participatory Mapping Workshop. Photo: Mapping for Change.

Mapping for Change is a London-based organisation that supports local communities in creating the necessary tools for enacting the change they wish to see in their neighbourhoods, using citizen science and participatory mapping. One of their projects, "Citizen Science Used to Map Community Air Quality", which drew from both CS and DIY science, provided low-tech diffusion tubes for measuring nitrogen dioxide (NO_2) levels in communities in London. In three of the participating neighbourhoods, Putney, the City of London and Highbury, data indicated levels along the main road networks were up to 75% above EU limits. The results were fed into community meetings, attended by neighbourhood authorities and London political candidates, and eventually the results were part of Transport for London's decision to deploy hybrid electric buses in Putney earlier than planned. Air quality became a key issue at local elections in the City of London, which in turn led to a number of measures being piloted around the Barbican Estate as part of a Low Emission Neighbourhood. They are also the first neighbourhood in London to pilot an ultra-low emission street, contributing to London's part of achieving SDG 11 "Sustainable Communities and Cities". The project inspired and was then adapted in Barcelona, engaging

high school students in the setting-up of the diffusion tubes in the neighbourhood of Poblenou, and is now being replicated in 20 schools across Kampala, Uganda. This cross-pollination of ideas and advocacy demonstrates how citizen science projects can spark, spread and scale.

Current Status & Future Challenges

SDG4 “Quality education” is an important key to unlock progress on all the other SDGs. There is the political will today to change education, but a large-scale transition from one practice to another demands time and resources. Many communities, among them citizen scientists, are willing to collaborate with stakeholders that belong to the education system. This collaboration has already proven to be very beneficial and it continues to be advantageous to systematically integrate the non-traditional pillars of CS education into curricula at all ages and for everyone.

Moving forwards, the ***following challenges*** are central:

Rethinking the educational system

- Allocating specific time for ambitious projects in schools.
- Training educators to set up project-based pedagogy.
- Breaking away from “True/False” knowledge evaluation.
- Developing evaluation tools for skills and curiosity.
- Supporting local actors to develop pedagogical content and projects in tandem with educators.
- Fostering partnerships between local actors and the school system.

Funding

- Dedicated funding for CS-in-schools projects, teacher training on CS-based pedagogy, the development of teacher networks, and other support initiatives

Infrastructure

- Dedicated physical and online spaces for change-makers (also outside the school space) such as:
    - Labs allocated specifically to citizens’ concerns
    - Co-working spaces for change-makers
    - Biohacker spaces
    - Fablabs
    - Stakeholders’ / teachers’ networks
    - Dedicated online platforms

Equality

- Despite its cost, quality education should be provided to everyone, regardless of his or her social background.
- Gender equality in career projection and tasks.

Conclusion

The UN SDGs offer a framework to channel efforts worldwide towards common goals. Achieving such an ambition requires empowering societies by giving individuals conceptual tools, knowledge and resources. We argue that using Citizen Science as an educational tool embedded in the curriculum can directly address SDG 4 on “Quality Education”. CS offers projects that combine non-traditional pedagogies with more comprehensive learning, and equip learners with the skills and knowledge they need to address all SDGs, placing every one of us at the centre of tomorrow’s actions.

Recommendations

1. Ease pressures and constraints on teachers' time and resources through funding dedicated to infrastructure and opportunities for knowledge sharing, such as networks, open courses and curriculum platforms.
2. Finance and incentivise non-school citizen science actors to coordinate workshops or projects with[in] schools, universities, and other educational institutions.
3. Develop infrastructure in which empowered citizens can practice and develop CS projects once they leave the education system. Such structures could be libraries, fablabs or new centres of research dedicated to citizen action in which specialists would mainly have a mentorship focus to help citizens carry out their own projects.

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Colophon

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