CITIZEN SCIENCE:
THEORY AND PRACTICE

# The OPEN17 Challenge: Online Coaching of Young Innovators to Tackle the Sustainable Development Goals with Citizen Science and Open Data

COLLECTION:
CONTRIBUTIONS OF CITIZEN SCIENCE TO THE UN SDGS

METHOD

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## ABSTRACT

In this article, we introduce the Open17 Challenge, an online coaching programme, inspired by the 17 United Nations (UN) Sustainable Development Goals (SDGs). This challenge has occurred roughly once a year since 2015, when the UN launched the SDGs. It lasts five weeks and involves five two-hour online coaching sessions as well as homework for the participants between sessions. The objective of the challenge is to coach a team of students about how to apply citizen science tools and methodologies to generate open data relevant to the SDGs. The goal of the coaching is to help each team develop their idea to the stage where they can make a compelling pitch that involves crowdsourcing of citizen-generated data. The format of the challenge has evolved as the organizing institutions have learned from each edition and improved iteratively. The purpose of this article is to describe the evolving methodology of the Open17 Challenge in the context of challenge-based learning (CBL) and more specifically discuss its relevance to e-learning. In particular, we analyse the potential of this methodology to generate new citizen science projects on issues relevant to the SDGs, with a view to enabling other organizations to adapt and apply this approach to specific SDG-related challenges.

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## INTRODUCTION

As the world approaches the United Nations (UN) Agenda 2030 deadline (UN 2015), there is a growing urgency to actively engage the younger generations and help them develop the knowledge and skills necessary to contribute effectively to the global effort towards sustainable development. To this aim, the 17 UN Sustainable Development Goals (SDGs) can be used as an effective reference framework to identify challenges that need sustainable and innovative solutions. When addressed to students and young innovators, such challenges encourage social engagement as well as active and multidisciplinary learning (Johnson et al. 2009; Gallagher and Savage 2020).

In this article, we present the Open17 Challenge, a challenge-based learning experience involving young innovators from across the world. It brings together UN agencies and other international organizations that are tackling specific SDGs and facing issues in the field, with students and young innovators who have ideas and ambitions to make a difference locally or globally. At its core are concrete challenges that experts in international organizations help to define. The purpose of the article is to share the methodological approach that has evolved iteratively over several years, so that others can benefit from lessons learned and adapt the methodology to specific SDG challenges according to their needs.

The Open17 Challenge was launched in 2015 by Citizen Cyberlab, a partnership between the UN Institute for Training and Research, the European research organization CERN, and the University of Geneva (Flückiger and Seth 2016). Initially a collaboration with the Governance Lab (GovLab) at New York University, the Open17 Challenge has partnered, over time, with several other organizations, notably the Competence Center—Citizen Science in Zurich (CC-CS 2017). The Center is a joint initiative of the University of Zurich and ETH Zurich and is aimed at mainstreaming citizen science as a research methodology. Since 2020, the Open17 Challenge has been supported as part of the EU Crowd4SDG project (Crowd4SDG 2020), and recently UNICEF is collaborating through a programme on "learning to earning" called Yoma (Yoma 2022).

The original format and the methodology of the Open17 Challenge were strongly influenced by online coaching for social innovation developed by the GovLab Academy (Noveck 2021). The Academy provides open source web-based training modules ("canvases") that help solve contemporary problems with digital technology, data, and the collective wisdom of citizens.

Over the years, the format of the Open17 Challenge has remained relatively constant. During a five-week interactive online coaching programme, multidisciplinary teams of students from all over the world develop their solutions to address challenges related to specific SDGs. At the same time, they follow short training modules that provide them with context for the issue, understanding of the specific challenges, as well as an introduction to useful concepts and methodologies of innovation. Particular emphasis is given to easily implementable crowdsourcing methodologies.

Key methodological elements include a focus on themes of global importance, concrete challenges, international teamwork, self-directed learning, multidisciplinarity, and the use of open technologies. These naturally reflect and integrate the defining components of the Challenge Based Learning (CBL) approach (Nichols and Cator 2008; Yang et al. 2018; Gallagher and Savage 2020). However, the Open17 Challenge uniquely combines learning about the SDGs with learning about citizen science, and uses both in a hands-on and team-based way to tackle challenges that affect participants and their own communities.

Figure 1 shows an example of the recruitment banner for the Open17 Challenge on climate justice.

An initial call for project pitches, in the form of 1-minute videos, was open for two months in August and September 2022 on the social network for youth, Goodwall (Goodwall 2014). The authors of the 50 most promising ideas were selected for a five-week online coaching programme which is the core of the Open17 Challenge.

## THEORETICAL BACKGROUND

### UNITED NATIONS CONTEXT

In 2015, the UN General Assembly adopted the 2030 Agenda for Sustainable Development (UN 2015). At its core are 17 SDGs, which aim at securing a sustainable, peaceful, prosperous, and equitable life on earth for everyone.

According to the United Nations Educational, Scientific and Cultural Organization (UNESCO), to achieve the goals, individuals need the knowledge, skills, values and attitudes that empower them to contribute to sustainable development (UNESCO 2017). In addition, the SDGs can be used as a reference framework to promote innovation while supporting active and multidisciplinary learning (Martínez-Acosta, Membrillo-Hernández, and Cabañas-Izquierdo 2022), and be an effective vehicle to generate challenges that need sustainable and innovative solutions.

### CHALLENGE-BASED LEARNING

By addressing these challenges, CBL is a way to contribute to educational innovation and to actively engage

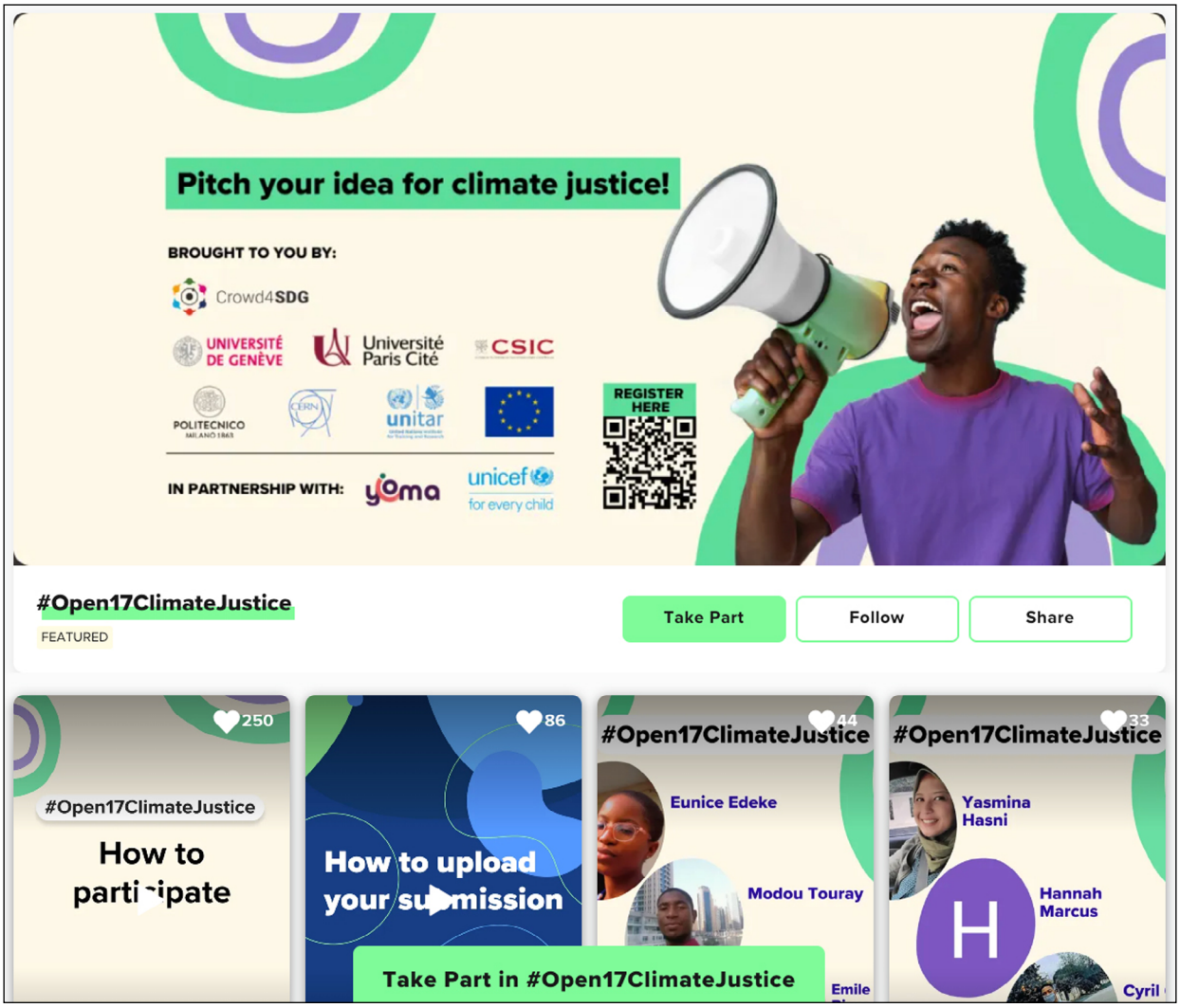


**Figure 1** Recruitment banner for the Open17 Challenge on climate justice, open for two-months on the social network for youth, Goodwall.

students in relevant real-world problems that exist in their environments (Lozano et al. 2019). CBL is a multidisciplinary, collaborative, and hands-on approach to teaching and learning. It has been promoted as a means for students to align the acquisition of knowledge with the development of transversal competencies (Nichols and Cator 2008). CBL incorporates teamwork, self-directed learning, and the use of technology to find solutions to real problems that extend from the classroom to the community (Yang et al. 2018).

The CBL experience starts with a real-world challenge rooted in themes of global importance (Gallagher and Savage 2020). Teams of students, often international and multidisciplinary, are tasked to find a solution to the problem. The solution should be environmentally, socially, and economically sustainable. The learning takes place through the collaborative identification, analysis, and design of the solution (Malmqvist, Rådberg, and Lundqvist 2015). Several benefits of CBL have emerged from the literature, including fostering a global mindset, developing transversal competencies, raising awareness of sociotechnical problems, and accelerating the use of technology. It also promotes collaboration between academic and extra-academic actors (Nichols and Cator 2008; Gallagher and Savage 2020). At the same time, an analysis of the existing literature (Gallagher and Savage 2020; Colombelli et al. 2022) reveals how different educational approaches use the term CBL in different ways. This creates methodological difficulties for researchers wanting to assess its effectiveness, and practical problems for educational practitioners seeking to understand and implement CBL. In addition, tackling global and ambitious challenges puts further requirements on educators and mentors. On top of disciplinary knowledge and basic professional skills, CBL requires skills related to working in multidisciplinary environments, with different (social) actors, and with a variety of technologies (Malmqvist, Rådberg, and Lundqvist 2015; Portuguez Castro and Gomez Zermeño 2020).

## CHALLENGE BASED LEARNING FOR SOCIAL ENTREPRENEURSHIP

CBL introduces all the ingredients that entrepreneurship needs, including dealing with real problems, finding innovative solutions, interacting personally with stakeholders, studying feasibility, and analysing the validity of the solution from the perspective of the recipients (Martínez and Crusat 2020). Results of such programmes have shown a positive and significant effect on the entrepreneurial mindset of participants. They also acquire skills such as financial literacy, creativity, and planning (Colombelli et al. 2022). The European Commission recognizes entrepreneurship as one of the eight key competences for citizens. Such competences are needed to promote personal and social development, to ease entrance into the job market, and to create new ventures or scale existing ones (Bacigalupo et al. 2016).

In the Open17 Challenge, combining CBL with the SDGs encourages translating global issues into local problems that need sustainable and innovative solutions. Focusing on real-world issues, the programme gives students a chance to work on important problems, get their voices heard, and make a positive difference in their communities (Laurence 2009).

## CHALLENGE BASED LEARNING IN INFORMAL SETTINGS

Learning in informal settings refers to the opportunities for learning that exist beyond traditional or formal schooling. It is characterized by the freedom to follow one's own interests, by the nature of the facilitation, and by the context in which the experience occurs (King and Dillon 2012). An important difference with learning in formal settings is that learners actively choose to engage with the learning, sometimes paying for the opportunity. The freedom to select and engage with content depending on personal interest is believed to engender deeper learning (Csikszentmihalyi and Hermanson 1995).

Students and young innovators apply to join the Open17 from all over world, choosing to join it as an optional, extracurricular course to add to their normal students' duties. Owing to the geographical coverage and different time zones, they also choose to endure several occurrences of early morning or late-night trainings and teamwork sessions.

## CHALLENGE BASED LEARNING IN E-LEARNING

According to a study carried out in Spain and the United States (Racovita-Szilagyi, Carbonero Muñoz, and Diaconu 2018), the opportunity to use e-learning modalities for CBL is perceived to increase accessibility for students in rural areas. It also allows students to learn at their own pace with an online mentor. A study in Portugal finds that education in sustainability through e-learning can be highly relevant for sustainable development. e-Learning can contribute to the transition to sustainable societal patterns by providing an alternative to face-to-face training, and by allowing students to pursue their studies while holding part- or full-time jobs (Azeiteiro et al. 2015).

Portuguez Castro and Gomez Zermeño (2020) run a study in a university in Mexico and found that the e-learning mode facilitated collaborative work and interactions among the participants at different times and places, and offered the opportunity to integrate various flexible and inexpensive technological solutions. It also provided easy access to the resources and knowledge to help students solve their challenge. For technology, and in particular software development, combining an active methodology such as CBL along with an engaging virtual environment can foster and improve software development learning (Chanin et al. 2018).

## CROWDSOURCING AND OPEN DATA FOR SUSTAINABLE DEVELOPMENT GOALS

According to the Organisation for Economic Co-operation and Development (OECD), wherever possible, the solutions to today's challenges need to come from, and be led by, the public. Solutions need to involve a wide range of actors and draw across several disciplines (OECD 2011). Success depends on being able to assess the current status and to monitor the progresses towards the achievement of the SDGs. Official statistics alone cannot produce information on the necessary scale, and the framework currently suffers from significant data gaps (Fritz et al. 2019; US SDG data tracker https://sdg-tracker.org). Innovative solutions are needed for generating, gathering, and analysing meaningful and reliable data that can help fill the gaps.

Citizen science refers to the engagement of the general public in a range of scientific activities such as monitoring and reporting about the state of the environment. As a form of crowdsourcing, it adheres to well-defined quality criteria developed by an international community of citizen science practitioners and researchers (Robinson et al. 2018). In the context of the SDGs, citizen science projects are considered a "non-traditional source of data." Together with other forms of crowdsourced data collection and analysis, citizen science can help fill the gaps by complementing official statistics with nontraditional data, such as satellite and mobile phone data (Fritz et al. 2019). Citizen science is already contributing to the effort by monitoring 5 SDG indicators, while having clear potential to contribute to an additional 76 indicators (Fraisl et al. 2020).

The need for innovative solutions includes new ideas for the use of Open Data. The World Bank encourages UN

member states to draw on Open Data from governments to help achieve the SDGs and to measure progress in meeting them. Open Data can help achieve the SDGs by providing critical information on natural resources, public services, population demographics, urban planning, agriculture, and many other areas. For monitoring, Open Data can help ensure evidence-based plans and measurable outcomes. These insights can inform national priorities and effective paths for action at both the national and local levels (Petrov, Gurin, and Manley 2016).

## METHODOLOGY AND COMPONENTS

The Open17 Challenge implementation involves several steps: definition of the challenges; call for ideas; selection of participants; coaching; and selection of the most promising projects for further development.

### THE CHALLENGES

The challenges at the core of the Open17 Challenge are developed in close collaboration with all involved partners, including the host institution, other interested academic organizations, and representatives of UN agencies and international organizations in Geneva. For each edition of the Challenge, the composition of the partnership varies depending on the specific challenge, except for the organizing team at University of Geneva.

The subject of the challenges reflects current and authentic needs that the organizations are facing in the field when trying to "tackle the SDGs," that is, assessing situations, monitoring evolutions, and supporting sustainable change at the local and global levels. The challenge definition needs to strike the right balance between specificity and breadth. Specificity implies a challenge narrow enough in its formulation to generate targeted solutions to a very specific need, at the risk of limiting out-of-the-box thinking. Breadth denotes a challenge generic enough to allow freedom and innovation, at the risk of producing ideas that are powerful but not dedicated to the specific need.

For a typical edition of the Open17 Challenge, as illustrated in Figure 2, there is an umbrella topic (e.g., "Mobile health solutions for noncommunicable diseases") and a set of specific sub-challenges (e.g., Monitor and Encourage Use of Road Helmets) to incentivize addressing specific pre-identified needs.


**Figure 2** Six specific challenges developed for the Open17 Challenge on health, in collaboration with the World Health Organization and International Telecommunication Union, as part of the Be Healthy Be Mobile initiative (as displayed on the website openseventeen.org).

## SELECTION OF PARTICIPANTS AND PROJECTS

The Open17 Challenge targets young innovators anywhere in the world. Depending on the challenge, these may include a combination of high school, undergraduate, and master's students. In many cases, they are young professionals. Applicants can be individuals or teams, and applications must be in English. Participants should have a good command of written and spoken English to benefit fully from the online coaching. Individual applicants are included in teams at the beginning of the coaching phase. Applications come in the form of pitches of the original idea, currently in the form of short (1-minute) video pitches uploaded to an online platform (GoodWall).

The overall aim is to encourage participants to develop innovative and implementable solutions that enable and leverage grassroots public participation through citizen science. The use of available open data sets and open digital tools for crowdsourcing are also emphasized in the call. At submission, though, the ideas need only to show true potential for leveraging such technologies and methodologies, as often applicants have only superficial knowledge of these concepts. Submissions are evaluated based on four general criteria: novelty, relevance to the topic, feasibility, and potential to involve citizens and communities in the implementation (crowdsourcing). The evaluation committee includes representatives of all organizations involved. Out of all applications, 8–10 projects are selected, and students are grouped into multidisciplinary teams of 3–5 participants with a balance of academic background and experience.

## COACHING FORMAT

The Open17 Challenge is carried out virtually as a series of five weekly two-hour online sessions. The last one is dedicated to final pitches by all teams in front of an online jury of experts. Each of the four previous coaching sessions is split into two parts (see Figure 3). The first part consists of expert presentations on the challenge context (30 min) and tools and methods (30 min) and involves experts and mentors.

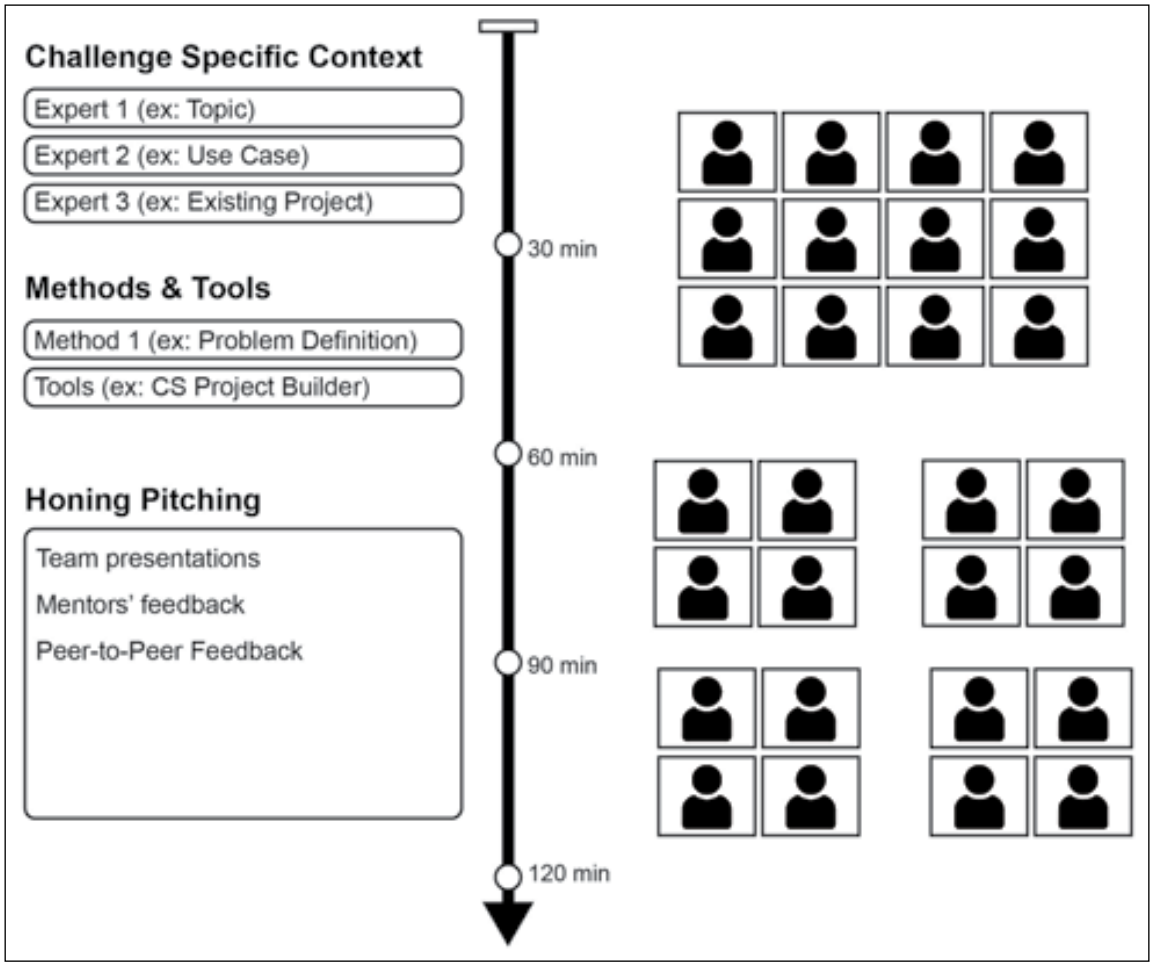


**Figure 3** Overview of a typical coaching sessions. A first part consists of expert presentations on the challenge context (30 min) and tools and methods (30 min). A second part, in breakout sessions, focuses on honing pitching skills and applying the tools and methods learned to the projects.

Experts come from academic, technical, and business backgrounds. Some of them are specialists in the particular topic of the challenge, and others in innovation concepts and methodologies transversal to all topics (theory of change, open data, etc.) Mentors are mainly from the organizations that promoted the challenge. Their role is to closely follow the teams, monitor their progress, and provide advice and guidance. The second part of a session focuses on honing pitching skills, and it is run in breakout sessions hosted by master's and PhD students familiar with the methodology. After each pitch, students receive immediate feedback, both from their peers and from the breakout hosts, and they benefit from hearing the feedback that other teams receive. The goal is to encourage participants to rapidly iterate on innovative and implementable solutions.

At the end of the coaching, the last session is fully dedicated to final pitches and evaluation, which results in the selection of one or more top teams. Each team has 5 minutes of pitching time followed by a 3-minute question-and-answer session.

A jury, including representatives of the organizations involved in the challenge and the mentors, is tasked to evaluate the projects on their final pitch. The evaluation criteria include the ones for the initial selection (novelty, feasibility, relevance, crowdsourcing), the quality of the pitch, and additional criteria related to the team engagement, cohesion, the evolution over the 5 weeks, and the quality of the intra-session homework.

The in-person sessions are held in a virtual smart learning environment that includes multiple tools (Zoom, digital canvases, shared folders), which provide a modern infrastructure for collaboration and innovation processes.

### CURRICULUM

The 5 weeks of coaching (effectively, ten hours in person plus time spent by participants to prepare for each session) help students to analyse and develop the key aspects of their idea. They demonstrate its validity and structure it into a viable and scalable project that can be pitched to potential implementers. By the end of the coaching programme, students should have developed:

- a clear understanding of the problem they are tackling and its underlying causes;
- a compelling theory of change that supports their solution, narrowly tailored to fit the given problem;
- a crowdsourcing approach that incorporates citizen science tools and methodologies, and strategy to engage with people and data; and
- a clear and persuading pitch for potential implementer organizations.

The learning outcomes include problem identification and formulation skills, teamwork and project management, elements of design thinking, as well as public communication and project pitching skills.

During the coaching, alongside the weekly presentations, teams track the evolution of their thinking and activities by filling in and constantly updating a "Public Problem Solving Canvas" specifically developed to support the progress of a public interest project (Noveck 2021). A canvas includes twenty questions designed to help refine the understanding of a problem and those whom it affects, generate a big idea, and turn that idea into an actionable strategy.

### INCENTIVES AND PRIZES

The Open17 Challenge is framed as a competition, a recognized variant of the challenge-based learning experience that has been shown to incentivizes students to address issues with visionary, bold approaches while still aiming towards implementable solutions (Malmqvist, Rådberg, and Lundqvist 2015).

An incentive for all participants, regardless of whether their project progresses or not, is the awarding of a certificate from the host organization or a partnering UN institution.

A further and more competitive incentive, or prize, comes from access to a follow-on event that will give students and their project international visibility and the opportunity for further development. Examples of such rewards include funded participation to the SDG Summer School organized by University of Geneva, funded participation in the UNLEASH event for SDG innovators (Junqueira Burallitiago et al. 2018), an opportunity to pitch at the AI for Good Summit at ITU in Geneva (Butler 2017). Selected projects may also get additional entrepreneurial training and mentorship to further develop their projects.

## SOCIETAL IMPACT

The primary motivation of the Open17 Challenge is educational, with participants learning in a hands-on manner a set of soft skills related to innovation. However, the competitive nature of the challenge and the prizes offered emphasize a progression towards deployment of some solutions in the field.

This is an ambitious goal, in particular because the participants are typically joining Open17 in their spare time and have their school or university studies to pursue afterwards. Sometimes they are already employed or running a social venture. Nevertheless, there have been several success stories documented where the Open17

Challenge enabled a project to achieve some measurable societal impact.

A few examples are: 1) enabling a participant to develop a crowdsourcing solution for her existing social venture called Safe City, which is mapping cases of sexual violence against women in India; 2) enabling a high-school student in California to launch a project on tracking floods using crowdsourcing and AI analysis of traffic light CCTV camera data, now supported by her city and developing in a local incubator 3) developing an existing open source app for menstrual cycle tracking, widely used in Argentina, so that it can gather data relevant to health issues such as early-stage cervical cancer detection.

Although, in the latter case, the team is no longer active, data gathered thanks to their innovation related to Covid has recently been published in a top gynaecology journal (Velasco-Regulez et al. 2022) and has attracted a high level of media interest.

## DISCUSSION

The Open17 Challenge has been and continues to be an experimental platform for CBL, enabling testing ideas about how to use challenges to spark and nurture youth-led projects to tackle the SDGs. There have been several lessons learned by the organizers, which can be summed up as three experiential and qualitative rules of thumb. They are based partly on informal surveys of participants carried out at the end of each edition:

1. *Choose a well-defined and reasonably narrow topic.*
   The topic should be related to just one or two SDGs. This makes it possible to locate a few experts in that field available to provide mentorship and participate in the jury. The first Open17 Challenge, open to ideas for all SDGs, led to a huge diversity of projects with minimal overlapping interests. This made providing expert advice challenging and reduced the benefits of peer-to-peer learning in the coaching sessions.
2. *Focus on a reasonably homogenous age group.*
   Again, various options have been tested, and some participants have been professionals with established social venture activities such as NGOs (e.g., SafeCity). However, targeting youth has several advantages from a pedagogical perspective, not least because they generally obtain the full benefit of the coaching on innovation. More mature participants may view this part of the programme as superfluous to their needs.
3. *Invest effort in team formation prior to starting the coaching.*
   Participants may come as teams, but most often are individuals. Both cases represent challenges. Should all team members of an existing team follow the coaching? Is it ok for a participant to follow the course alone if they find no one amongst the other participants to team up with? Several ad hoc team formation processes have been tested. Currently, the Open17 challenge is using an AI-based approach based on short surveys of participants about their interests, skills, and personalities. The algorithm matches teams with tasks, on the basis of the similarity between the competencies required by the tasks and the competencies offered by teams (Georgara, Rodríguez-Aguilar, and Sierra 2021). The impact of this approach on team performance and learning outcomes is still being analysed, but anecdotal evidence suggests that it improves the interpersonal and cross-cultural experiences in the teams.

As part of the Crowd4SDG project, research is ongoing to establish in a more quantitative fashion the range of learning outcomes and the innovation potential of the approach. The same is true for the interpersonal skills learned by online team collaboration. These results will be published in due course. What is clear already, from some of the interviews with teams, is that for many participants, the experience is transformative. For participants from the Global South in particular, putting youth at the center of the innovation process is something they have often never met before.

Even for participants from North America and Europe, the approach is highly inspiring. In the case mentioned above of the high-school student from California, she became first author on a poster about her project in a major international conference on disaster management. Her project was accepted in a local incubator, and won several other prizes—all before she turned 18.

## CONCLUSIONS

The Open17 Challenge has coached a total of more than 400 young innovators from more than 50 countries. It has proved a successful lightweight and online format for CBL, which condenses a wide range of learning outcomes into just 10 hours of in-person coaching and some homework.

It confirms the effectiveness of CBL as a powerful learning methodology in which students deal with global challenges and real problems for which they propose multidisciplinary, crowdsourced, and open solutions.

Research is ongoing on how to generalize the methodology and share it in an open-source way. Educational practitioners can then run their own challenges,

overcoming some of the constraints mentioned above. This would enable institutions to run Open17 challenges adapted to regional challenges, in local languages, and possibly collaborating with existing citizen science initiatives.

The potential for citizen science applications is being furthered by Crowd4SDG with the development of the GEAR (gather, evaluate, accelerate, and refine) cycle. The first two phases of the cycle, gather and evaluate, are based on the two phases of the Open17 Challenge: the initial video pitches on the Goodwall platform, and the 10-hour online coaching programme. The accelerate phase goes beyond project definition and focuses on prototyping a solution. The refine phase aims to move the most promising projects from prototype to deployment, including locating partners and funders.

A main limitation of the Open17 Challenge is that, although it is managed by academic institutions, it does not yet offer standard credit, such as the European Credit Transfer System (ECTS), for participation. This may dissuade some students, especially in the Global North, from applying. Indeed, most of the applicants tend to be from the Global South. However, awarding certificates of participation from a UN partner is motivational for many participants, as is the global nature of collaboration and teams. Nevertheless, we recommend exploring ways to give academic credits, based on the recently established European approach to micro-credentials (Council of the European Union 2022).

A further limitation that the Open17 Challenge shares with many youth-based challenges is the lack of tangible impact of most of the projects proposed. From a pedagogical perspective, this is not crucial: The purpose is to learn about challenge-based innovation, not necessarily to innovate. But given the context of the SDGs and the focus on youth who are motivated to solve global challenges, the question of impact needs to be considered carefully. In future editions, we recommend setting a realistic target for a rate of transformation of ideas into impactful projects. This target can be used as part of the process of improving the Open17 Challenge and embedding it in more ambitious innovation schemes, like the GEAR cycle.

Finally, we note that the Open17 Challenge has benefitted for the last seven years from various forms of subsidy, including philanthropic and EU research and innovation grants. Therefore, the coaching could be offered for free. The cost of running an Open17 Challenge is estimated at up to $50k per edition. This is about $1k per participant, depending on how the often pro-bono contributions of mentors are costed. Costs are minimized by recruiting student assistants and training them to manage much of the logistics and contribute to the coaching. Ways of streamlining the process could help to reduce costs and enable easy re-use of the methodology. Still, a detailed cost-benefit analysis has yet to be made. High costs are a challenge common to many CBL approaches, which tend to be relatively expensive compared with traditional classroom approaches. This is due to their focus on hands-on activities and intensive one-on-one mentoring and coaching of participants.

In conclusion, at just 10 hours of in-person instruction and coaching, the Open17 Challenge is a highly efficient and easily reproducible and adaptable format for stimulating youth-led innovation around citizen science and the SDGs. To achieve societal impact for the most promising projects though, follow-up support and coaching is required.

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## COMPETING INTERESTS

The authors have no competing interests to declare.

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