PROCEEDINGS OF SCIENCE

Design of a platform to measure the impact of citizen science

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Citizen science has long been used as an approach across different disciplines, both in terms of the science produced and the democratisation of the process to involve all stakeholders that have a vested interest. However, whilst citizen science's potential to contribute towards such concerns is well documented, limitations exist when measuring the impact that citizen science has made. Despite multiple attempts across the literature, there remains no formal process by which to assess a citizen science project's impact and to accurately compare that impact with other projects, traditional science, or the status quo. The MICS (Measuring the Impact of Citizen Science) project has developed an online platform and toolbox that citizen-science project coordinators can use to assess the impact of their activities, whilst generating comparable results across the citizen science landscape. MICS considers impact across five domains (environment, society, economy, governance, and science and technology), and consists of approximately 200 indicators—implemented in the form of questions—designed to find out as much information as is possible about a project's intended or achieved impact across these domains. These 200 indicators have been generated and refined through a combination of literature reviews, workshops and iterative interviews to capture as much information about impact as possible. The MICS platform and assessment-approach have been demonstrated to a number of project coordinators from a range of projects. In this work, we present the design of the platform, and demonstrate its relevance to citizen science, and suitability for measuring its impact.

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1. Introduction

Citizen science allows the professional scientific community from a range of disciplines to both provide and receive information from amateurs [1], who many see as volunteer participants in research. The advent of digital technologies has allowed the practice to challenge traditional forms of science activity through permitting collective participation, the sharing of results and the potential co-production of knowledge [2]. As such, citizen science has the potential to have impact across a range of domains (including the environment, economy, science, society and governance) and contribute towards associated progress-tracking frameworks (the United Nations' Sustainable Development Goals (SDGs), for instance) [3]. However, whilst the potential of citizen science to contribute to such concerns is well-documented, limitations exist regarding the measurement of the impact citizen-science activities have made. Despite multiple attempts by past research, no singular, formal process by which to assess the impact of a citizen science project exists, preventing impact comparisons to be made with other citizen science activities, traditional science or the status quo. This has resulted in a self-reflection regarding the impact assessment field of citizen science, considering its own approaches [4]. It has been found that issues exist when considering the impact towards broader, global contexts, which are often beyond the project goals and the timescales of the project lifecycle [5].

In response to these issues, research has begun to consider the best ways to link citizen science with their potential impact, including the MICS project (Measuring the Impact of Citizen Science) [6]. MICS aims to create a citizen-science impact assessment approach that is flexible yet standardised, with which citizen-science projects can consider their impact and compare their actions to other similar practices. Access to the MICS assessment approach and its associated tools will be through the MICS platform. The platform represents the gateway through which end-users, be they citizen science practitioners, participants, reviewers, policy makers or other stakeholders, will be able to access the MICS toolbox, to better understand the strengths and weaknesses of their project in terms of impact. It provides a space to review project attributes, understand the process when assessing impact, and review outputs to help realise impact in the future. The platform incorporates approximately 200 indicators, presented to the user in the form of questions, covering a range of topics across the aforementioned domains. The indicators have been derived and refined through a combination of literature reviews [7], workshops and interviews [8] to ensure they are relevant, intuitive and answerable when presented as questions on the platform.

The MICS platform and associated assessment approach have been tested by a number of citizen-science project coordinators, from a range of disciplines. These projects have been chosen to represent the vast range of citizen science activities that exist. This is to ensure that the platform is usable, intuitive and functional, whilst also producing impact assessment and guidance that is both relevant and suitable to the project being measured. As a continuation of this process, the platform was demonstrated at the Engaging Citizen Science Conference 2022, in Aarhus, Denmark, to a range of citizen-science stakeholders. The demonstration included the design of the interface, and a discussion of its relevance and suitability to different citizen science approaches.

2. Platform design

Core to the principles of the MICS project is accessibility and the sharing of resources. The structure of the MICS platform is no exception, with open-source repositories, servers and development frameworks being utilised for both the front and back-end of the system. The following technologies have been used for the prototype MICS platform:

- **Apache**: free and open-source cross-platform web server software. Apache is developed and maintained by an open community of developers [9].
- **MariaDB**: a community-developed, commercially supported fork of the MySQL relational database management system, intended to remain free and open-source software under the GNU General Public License [10].
- **Laravel**: a free, open-source PHP web framework, intended for the development of web applications following the model–view–controller architectural pattern [11].
- **Vue**: an open-source model–view–viewmodel (MVVM) JavaScript framework for building user interfaces and single-page applications [12].
- **D3**: a JavaScript library for producing dynamic, interactive data visualizations in web browsers. It makes use of Scalable Vector Graphics, HTML5, and Cascading Style Sheets standards [13].
- **Greensock**: an industry-standard JavaScript animation library that lets you craft high-performance animations that work in every major browser [14].

The prototype MICS platform has been separated into three user interfaces for design purposes: (i) **The project space**, where users can sign-up, create a project, add general details and access the MICS tools; (ii) **The impact assessment interface**, where users can input data regarding their projects' impact associated with the five domains of environment, economy, society, science and governance; and (iii) **The impact assessment output**, where users can access a report of their projects' impact, strengths, weaknesses and suggested actions. In order to ensure that these interfaces are accessible, intuitive and easy to use, Nielsen's ten general principles for interaction design have been followed, which provide a broad rule of thumb of how interfaces should function [15].

2.1 The project space

The project space interface is effectively the landing page of the MICS platform. It is where users can register to the platform and create a space for their project. To adhere to the heuristics mentioned earlier, a social media feel in terms of design has been taken, as this provides an intuitive user experience, especially when creating a personalised page. If people are visiting the platform for the first time or are not recognised, they are presented with a login dialogue, as can be seen in Figure 1. The login process includes social login, using existing information from the following social-networking services: Google, Facebook, Twitter, LinkedIn, and Github. By doing this, the MICS database does not need to collect password and username data that could potentially be identifiable and, therefore, represent a privacy risk. The platform only collects people's email, which is used to identify them when they return to the platform. People who do not want to use social accounts can create a traditional one with a username and password.

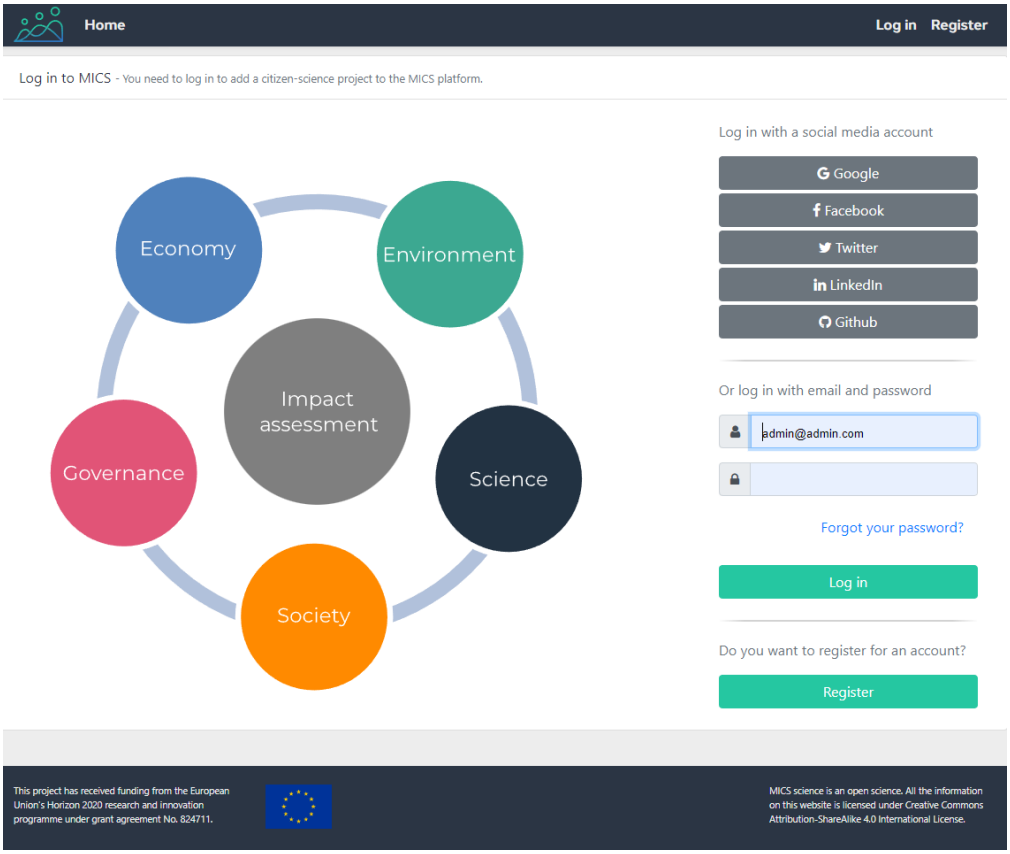

Figure 1: MICS platform register page

Once the user registers, they can create a page for their project. Here general project details can be added, such as its name, URL, location, logo and contact point. Figure 2 shows a project page for the "Planet Four: Craters" project.

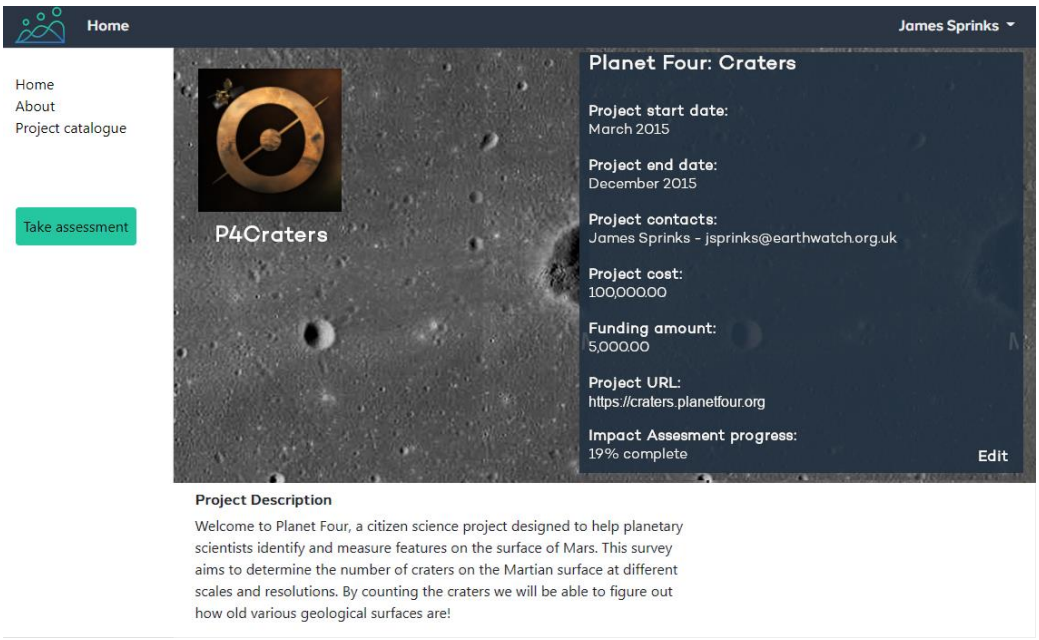

Figure 2: MICS platform example project page

In addition to the project details, the design also provides an access point to the second user interface of the MICS platform: the impact-assessment interface.

2.2 The impact assessment interface

The impact assessment interface of the MICS platform represents the most complex procedure of the user journey. Whilst the creation of user credentials and a personalised space is a widely known mechanism used on several platforms, the capture of impact and its assessment is much more unique. As such, it presented a design challenge for the MICS consortium, with few previous examples to influence the prototype approach. In order to fully assess the impact of a particular citizen-science project, a wide range of inputs needs to be collected, through many questions (into the hundreds) presented to the user. This will take time and commitment, and therefore the impact-assessment interface needs to be easy to use, engaging and informative – reassuring the user that the information they are supplying is of benefit to both the MICS platform and themselves (i.e., worth their time to complete). Figure 3 shows the design of the impact-assessment interface for the MICS platform, focussing on the environment domain.

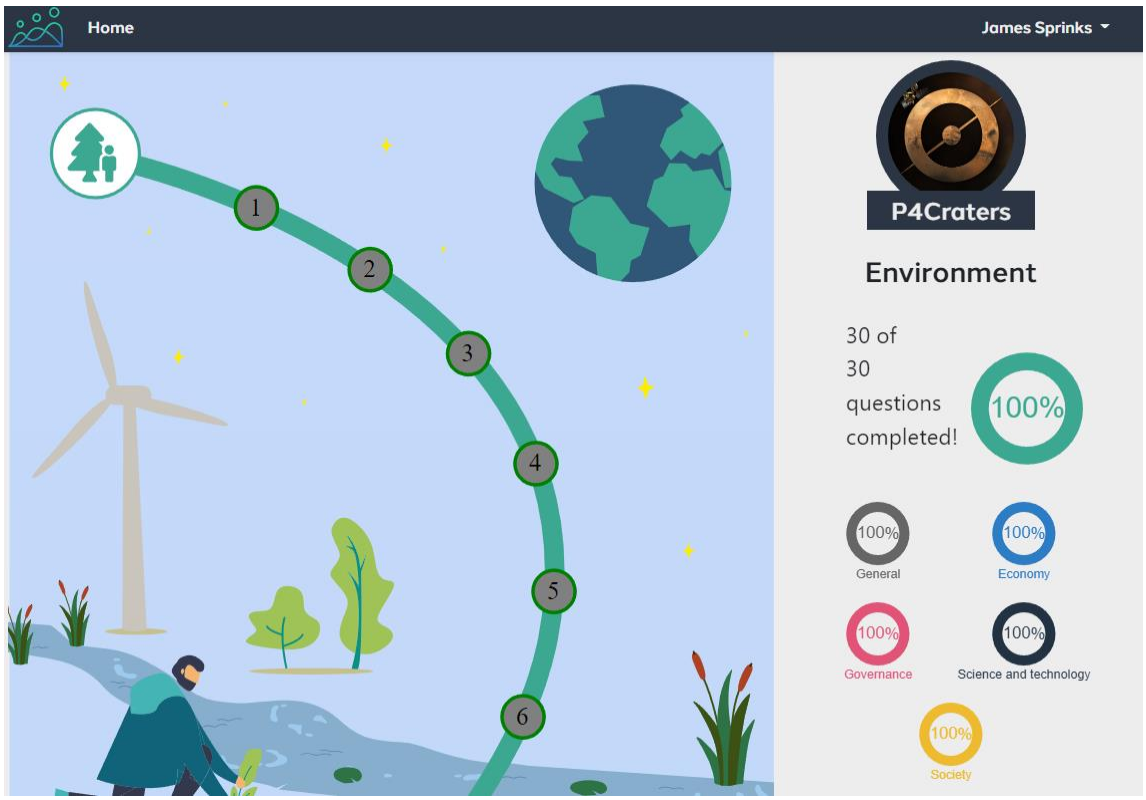

Figure 3: MICS platform impact assessment interface (environment domain)

The left of the interface comprises of the question interaction, with each of the circles representing a question to be completed, which will change colour to indicate that an answer has been supplied. The right of the interface shows the information screen. In addition to the general information regarding the project Planet Four: Craters (P4Craters), it contains dials displaying the users' progress through each domain. At any point that the impact assessment interface is in use,

the user can return to a navigation map, where other domains can be accessed. This allows for easy navigation, with people able to drop in and out of domains as they wish.

2.3 Impact assessment output

The final user interface of the platform is the assessment output. Again, this is a very important part, representing the reward to the user for all the contributions made during the assessment process. Figure 4 shows the design of the impact-assessment output for the MICS platform, for the "Planet Four: Craters" project.

Figure 4: MICS platform impact assessment output example (all scores are for display only)

The impact assessment output comprises of four sections: (i) **Project overiew**, displaying general project details to give context to the impact report; (ii) **Rule-based scores**, based on a set of rules that combine a specific set of impact metrics on the same indicator; (iii) **Recommendations**, guidance presented to the user on how to improve their impact; and (iv) **Machine-learning-based scores**, calculated using a statistically-driven approach that analyses the patterns in the data of all projects that have contributed. The output includes comparisons to overall average scores attained by other projects, and is intended to be an easy-to-absorb, shareable snapshot of a project's impact. Users will be able to download or print their impact report in pdf format enabling them to share the information with all relevant stakeholders. Through the process of turning the inputs collected from users into an assessment of impact, a range of data will be created regarding a projects' characterisation and activities, and its relationship with impactful outputs. This data will be used in the future to advise the discipline, with the aim of ensuring future citizen science initiatives maximise their potential.

3. Future development

This work describes the first release incarnation of the MICS platform, made available in Spring 2022. In order to ensure that the MICS platform and impact-assessment approach remain both sustainable and relevant long-term, they will be constantly and iteratively developed. This development will be two-pronged. Firstly, the platform, its impact indicators and questions presented to the user will be constantly reviewed and adapted based on both user feedback and the changing landscape of citizen-science and impact-assessment fields. Secondly, the platform is designed to allow users to constantly update their input, so they can monitor changes in their and other projects' impact over time. Future iterations of the platform will include visualisations to assist these temporal comparisons.

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