To Sign Up, or not to Sign Up? Maximizing Citizen Science Contribution Rates through Optional Registration.

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Caroline Jay[1], **Robert Dunne**[2], **David Gelsthorpe**[3], **Markel Vigo**[1]
[1]School of Computer Science, [2]Research IT, [3]Manchester Museum
University of Manchester
Manchester, UK
[caroline.jay, rob.dunne, david.gelsthorpe, markel.vigo]@manchester.ac.uk

ABSTRACT
Many citizen science projects ask people to create an account before they participate – some require it. What effect does the registration process have on the number and quality of contributions? We present a controlled study comparing the effects of mandatory registration with an interface that enables people to participate without registering, but allows them to sign up to 'claim' contributions. We demonstrate that removing the requirement to register increases the number of visitors to the site contributing to the project by 62%, without reducing data quality. We also discover that contribution rates are the same for people who choose to register, and those who remain anonymous, indicating that the interface should cater for differences in participant motivation. The study provides evidence that to maximize contribution rates, projects should offer the option to create an account, but the process should not be a barrier to immediate contribution, nor should it be required.

Author Keywords
Citizen Science; Gamification; Productivity; Crowdsourcing

ACM Classification Keywords
H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

INTRODUCTION
Citizen Science – the participation of 'lay' volunteers in scientific endeavour – is now an important means of collecting, curating and analysing data [31]. Notable successes in this domain include Foldit, a game to illuminate protein structure [4], and Galaxy Zoo [19], a web app for classifying galaxies.

Projects cover a wide range of topics and activities, and whilst some require interaction with the external environment [35, 5, 33, 18, 23], many are conducted entirely online, on platforms such as Zooniverse [29]. This brings huge opportunities – in many cases people need only an Internet connection and the motivation to participate. It also brings challenges: how can we ensure data quality, retain participants and maximize contributions in this domain?

In this note we examine the role of online registration in determining contribution patterns and participation rates in citizen science. Whilst many projects allow people to participate without signing up in advance, it is also common to encourage – or require – users to create an account. This has obvious advantages for the platform, as it makes it easier to keep out automated traffic, monitor contribution quality and prompt contributors to return to the project after a period of absence [20, 3, 28, 27, 9]. It is also beneficial for citizen scientists, who are able to keep track of their work, and obtain information about how their contributions are being used [20, 24, 25, 13]. Registration is also necessary for the functioning of certain 'gamified' UI components used in many citizen science projects, such as badges and leaderboards, which reward those who make significant contributions [2].

While gamification in citizen science has been demonstrated to be effective and motivating [1, 14, 8], concerns have also been raised that encouraging competitive behaviour may reduce altruism [7], and that game interfaces may have a negative effect on intrinsic motivation, and alienate traditional citizen science volunteers [10, 22, 34, 2, 21]. Competition is now an established part of citizen science, but it is only one aspect of the complex set of factors motivating participation, which include not only extrinsic, reward- or reputation-based factors, but also inherent interest in the task or subject matter, and the satisfaction of contributing to a collective goal [20].

Previous research has shown that increasing the 'work' done during registration for an online community decreases the number of people prepared to go through it [17, 6]. Here we examine the effects of making registration, and participation in the 'game' of contribution, completely optional. In a study conducted on a palaeontology-focused data cataloguing application, visitors are presented, at random, with a mandatory registration page that they must complete before entering the project, or allowed to contribute straight away, with the option of signing-up to 'claim' their contributions if they wish.

We hypothesize that removing the barrier of account creation will increase the number of people who make at least one contribution, but that to resolve cognitive dissonance [11] people

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who go to the trouble of signing up, either through necessity or choice, will make more contributions, on average, than those who do not. We discover that whilst people are, indeed, more likely to contribute when they do not have to register, registration status (whether someone has to sign up, chooses to sign up, or chooses not to sign up) does not appear to affect the number of contributions they make. We therefore propose a recommendation that, where possible, keeping registration optional may be a good way to increase the number of contributors, by removing a barrier to entry for those who are motivated by personal interest, but offering the possibility of recognition and competition for participants who are more extrinsically motivated.

Digitization of a museum fossil collection

Manchester Museum has a world class fossil collection comprising around 100,000 fossils. Half of these objects are not recorded in the museum's database and as such accessing, cataloguing, and generating knowledge from the collection is problematic and time consuming. Staff and volunteers are photographing the fossils with their corresponding labels as a stepping-stone to making the artefacts more widely available. To make these images accessible and useful to the public and scientists, they must first be catalogued in digital format.

To achieve a fully digitised record of the fossil collection, a web application was created to crowdsource the entry of fossil information from the photographs. Its goal was to engage citizen scientists interested in palaeontology, or otherwise keen to help with curation, in contributing to the scientific goals of the museum. The application was built using an agile participatory design process. It was constructed initially with feedback from curation staff at Manchester Museum to ensure it functioned correctly from a scientific and technical perspective, and then refined iteratively during a two-week *beta* testing period with a convenience sample of people who had not used the app before.

The application has two stages for serving images to users. Firstly it shows images in the image queue that have not yet been completed (see Figure 2). A contributor checks the information on the label, and then enters it into a form underneath the image. Secondly it shows images that have been completed and moved to the review queue. These images can be checked by other contributors, who can assess and edit the data (see Figure 1). This feature was put in to allow users to self-regulate the quality of the data supplied, ultimately resulting in fewer inaccuracies [12], and was used in addition to presenting images multiple times for cross-checking results [32].

Contributors received a point for each task completed (either submission or review), and a leaderboard displays the names of the 10 people with the highest number of points. An activity feed was added to give a sense of immediacy to the user experience, enabling the user to see that other users are currently completing tasks. Where contributors were registered, their name was displayed on the feed or leaderboard; if a contributor was not registered, 'Secret Scientist' was displayed instead.

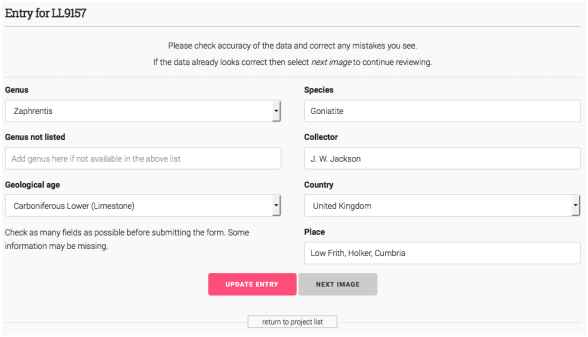

Figure 1. Data in a labelled item available for review.

Figure 2. A sample image.

STUDY

The study compares two landing pages: *Interface A* requires people to create an account or log in before they can see the rest of the app; *Interface B* takes people straight to the app, and allows them to interact with it and contribute straight away, with the option of signing up if they wish. Data was collected for the study for six weeks directly following the project launch, on August 12th 2015. The application was promoted via SciStarter[1], Manchester Museum's Twitter and Facebook accounts, the citizen science and palaeontology forums on Reddit, and internal mailing lists and email bulletins within the University of Manchester. We tested two core hypotheses:

H1: A participant is more likely to make at least one contribution, if he/she does not have to register.

H2: A participant with an account will make a greater number of contributions as he/she is able to get credit for them.

Method

We used A/B testing (split testing), and the pseudo-random number generator function built into PHP, to assign visitors at random to the following groups:

- **Group A**: directed to the registration/login pages to access the web application to complete or review image label data.[2]

[1] http://scistarter.com
[2] https://natureslibrary.co.uk

- **Group B**: directed straight to the web application to complete or review image label data.[3]

A further category, **Group C**, consists of those users initially allocated to Group B who decide to register. The time of the switch is logged in the database.

For each visitor, a unique ID was set as a tracking cookie, to allow us to monitor any participant who was not logged in (this applies to all participants in Group B, but also to members of Group A or C who were not logged in). This method has some limitations: if the same individual accessed the application through different browsers or computers this would result in different entries. On the other hand, it allows us to unequivocally identify individuals using several IP addresses (e.g., different Wi-Fi networks) or sharing IPs with other individuals (e.g., corporate IPs).

Additionally, controlling the traffic generated by robots — which can account for 40% of the traffic in some websites [16]— is a well-known challenge of A/B testing experiments [15]. These entries may introduce noise in the data, risking the reliability of the results. Therefore we followed a systematic approach to distinguish robots and humans:

1. Robots were removed by comparing their user agent string against the entries in a dictionary[4] which included common robot identifiers such as bot, proxy, spider, slurp, etc.

2. People who accepted a cookie were classified as members of 'A' or 'B'.

3. People who did not accept the cookie were still allocated to a group on their first visit, and had a unique ID logged, which remained the same until they left the application. It is key to consider these individuals as the application allowed people to enter data without accepting the cookie. A caveat is that if the user did not accept a cookie and returned, he/she would be classified as a new user.

Results

383 individuals were allocated to Group A (registration was required), while 445 were free to enter data without registration (Group B). Thirty-two individuals (8.36%) who were allocated to Group A made at least one contribution, compared with 57 (13%) of those allocated to condition B – a 62% increase in contribution rate. A Mann-Whitney test indicates that there is an effect of having to register on likelihood of contributing $W = 3.8$, $p = 0.05$, which confirms *H1*.

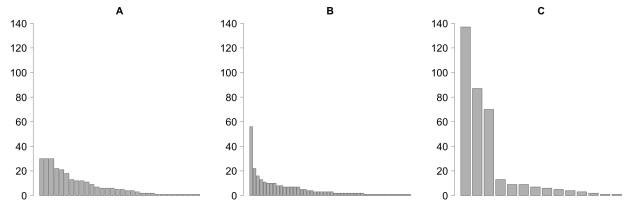

Figure 3. Number of contributions per individual in each group.

[3] https://natureslibrary.co.uk/share/index/0
[4] http://useragentstring.com

As shown in Figure 3 participation rates followed a typical pattern for a citizen science application. Most people tended to be 'dabblers', contributing in smaller numbers overall (see the mode in Table 1), with a small group of highly engaged participants who made large contributions [9].

A Kruskall-Wallis test suggests that, in terms of number of contributions per individual, there is no difference between the groups $\chi^2 = 4.77$, $p = 0.09$. In line with this, if we consider individuals from C as members of B, a Mann-Whitney test rejects group dissimilarity, $W = 972.5$, $p = 0.6$. Consequently *H2* is rejected, indicating that the fact of having registered does not have an effect on the number of contributions.

Group	N	% total	M	Mdn	Mo	Max
A (32/383)	269	30.22	8.41	5	1	30
B (57/445)	267	30	5.56	3	1	56
C	354	39.78	25.29	6.5	1	137
BC	621	69.78	10.89	3	1	137

Table 1. Descriptive statistics of contributions per group. Column 1 shows the group (n° contributing/n° allocated to group initially).

Analysis of Group C

Several individuals (N = 19) who fell in Group B registered despite the fact this was not mandatory for participation. Fourteen of them made at least one contribution. This accounts for 29% of participants in Group B who contributed at least once. Interestingly, 9 of them registered before making any contribution, whereas the remaining five made at least one —Figure 4 (left) shows the distribution of these individuals. Figure 4 (right) shows the number of contributions before and after registration per individual: on average, the number of contributions before registering accounts for 18% of total contributions in a broad range that expands from 1.4 to 44%.

It is worth mentioning that out of the 890 labelled pictures, 269 were submitted by individuals from Group A, 267 by Group B and 354 by Group C. Table 1 shows that the number of contributions of those who registered even if they did not have to clearly stands out as these 14 participants account for almost 40% of the contributions.

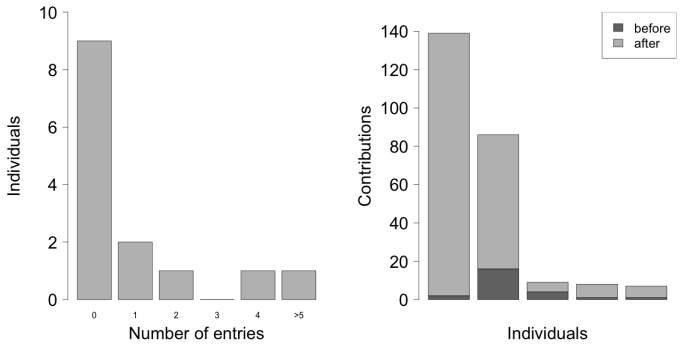

Figure 4. Group C behaviour: on the left, the distribution of individuals based on the number of contributions they made before they registered; on the right, the total number of contributions of those who contributed before and after they registered.

Data Quality

Data needed to be entered in up to seven fields of the form. A scoring system was developed to determine whether there was a difference between groups in terms of data quality: 0 = nothing/garbage; 1 = one field correct; 2 = two or more fields correct; 3 = completely correct. 5% of the total contributions for each group was retrieved at random from the database using an SQL query. The mean quality scores out of three were 2.87 for Group A and 2.71 for Group B (excluding Group C). On the whole the data entered for the image labels were high quality, with no garbage entries. A Mann-Whitney test indicates there was no significant difference between groups A and B when it came to data quality, $W = 543.5$, $p = 0.62$.

DISCUSSION

The results support *H1*: A participant is more likely to make at least one contribution if he/she does not have to register. In our study, 8% of people assigned to Group A made at least one contribution; for those assigned to Group B, this was 13%, equating to an additional 5% of site visitors participating – a 62% increase in the contribution rate.

A concern around trying to increase this potentially more casual participation is that it might result in lower quality data. Would participants take the task seriously if they are not accountable for their results? Previous work has linked online reputation to provision of higher quality data [30], but there is also concern that competition based on the number of contributions can lead to less care taken in entering data [10]. In this study we find that data quality is high, and does not vary as a function of registration status.

We do not have strong support for *H2*, as the difference in contribution rates between the groups is not statistically significant. The contribution rates show the long tail distribution typical of citizen science projects, and it is interesting to note that this is true of all groups, providing further evidence that this pattern of activity is typical in citizen science projects. It is, however, interesting to consider some of the descriptive data from the perspective of motivation and topic interest. Of the people who moved to Group C (optional registration), two-thirds did so before making any contributions, which potentially indicates that they wished to ensure they were able to get 'credit' before starting any work. It therefore appears important to cater to a group of people who may be keen to keep track of their contributions, or wish to publicly participate in the project via the leaderboard and feed.

Additionally, we see contributors in Group C making more than 70 submissions, and another high contributer (48 submissions) in Group B, whilst everyone in Group A made fewer than 40 submissions. It is difficult to draw any conclusions based on a small number of participants, but it is reasonable to assume that these four contributors were interested enough in the task to complete it in high volumes. The contributions of the 14 individuals from group C account for almost 40% of the 890 pictures that were labelled. If they had been allocated to Group A, where they would not have had a chance to even see the task before signing up, it is possible the project may have lost a lot of entries.

DESIGN RECOMMENDATIONS

The results point to two clear recommendations:

Allow people to start contributing as soon as possible. Visitors should be able to see the task, and contribute, before being required to register. We saw a 62% rise in the number of site visitors contributing when we removed the registration barrier, and allowed people to get straight to the task.

Allow people to register. There are many reasons that it is helpful to sign up to a project. Citizen scientists get to stay in touch with the project and become part of a community; platforms get to understand more about their contributors, and are better able to communicate with them [26]. There is also evidence that more extrinsically-motivated people may want to register, so they can get explicit credit for their contributions, and participate in game-aspects of an app [1]. It is possible this explains the behaviour of at least some of Group C, most of whom signed up before making any contribution.

Methodological Considerations

This study is relatively small in scale, although the number of participants is similar to other controlled studies in this area [21]. The long-tail distribution of contributions also matches that of other projects, indicating that the sample could be viewed as representative of 'typical' citizen science. The task was a relatively straightforward classification task, however, and it is therefore necessary to be cautious about applying the results to more complex or involved tasks.

The study was controlled and conducted in the wild, lending it both internal and external validity, but it was purely quantitative, and did not collect any data regarding participants' thoughts and motivations, so it is not possible to be certain why participants made particular decisions. It should also be noted that the results apply to purely online studies; where field work is involved, or there is some other reason that it is important to identify contributors, optional registration would not be recommended.

CONCLUSION

This work demonstrates that it is possible to increase contributions to online citizen science by more than 60%, by allowing people to participate in a project without obliging them to officially sign up. It also provides evidence that being able to record contributions, and potentially gain some form of recognition for them, is important for some people, and therefore registration should be offered. Many citizen science projects follow this model, but the way in which registration is handled by projects varies considerably, and has not previously been investigated systematically. We report an empirical study demonstrating that the way in which account creation is handled really does make a difference, and propose an evidence-based model for the registration process, that a new project can default to.

PROJECT DATA

We practise open science, and have made project code and data available at `https://github.com/refractiveco/natureslibrary` and `http://iam-data.cs.manchester.ac.uk/investigations/13`.

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