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Do Games Attract or Sustain Engagement in Citizen Science? A Study of Volunteer Motivations

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Abstract
Increasingly, games are being incorporated into online citizen science (CS) projects as a way of crowdsourcing data; yet the influence of gamification on volunteer motivations and engagement in CS projects is still unknown. In an interview study with 8 CS volunteers (4 from *Foldit*, 4 from *Eyewire*), we found that game elements and communication tools are not necessary for attracting new volunteers to a project; however they may help to sustain engagement over time, by allowing volunteers to participate in a range of social interactions and through enabling meaningful recognition of achievements.

Author Keywords
Citizen Science; Online Communities; Games; Gamification; Motivation; Engagement.

ACM Classification Keywords
H.5.3 Information interfaces and presentation (e.g., HCI): Group and organizational interfaces – collaborative computing, web-based interaction; K.8.0. General: Games.

Introduction

CS projects allow collaboration between scientists and volunteers in producing, analyzing and curating large quantities of scientific data. There are CS projects in many disciplines, including environmental studies [7], astronomy [5] and biochemistry [2]. Over the past decade, CS projects have started to utilize crowdsourcing via the internet. In the *Encyclopedia of Life* [7], volunteers submit and curate images of wildlife to a website. In *Stardust@home* [5], website users help classify existing images from NASA's Stardust spacecraft in the search for interstellar dust. Both these examples relate to *content curation communities*: "distributed communities of volunteers who work together to curate data from disparate resources into coherent, validated, and oftentimes freely-available repositories" [8; p. 1092].

Gamification and games with a purpose

In this paper we focus on online CS projects that involve game formats and elements. Gamification has been defined as "the use of game design elements in non-game contexts" [3; p. 9]. The approach is often used with the intention of enticing players and keeping them engaged. Similarly, the term "games with a purpose" (GWAP) [9] can be applied to projects such as *Foldit* and *Eyewire*.

Foldit (Figure 1) is an online puzzle game developed by researchers at the University of Washington, where players collaborate and compete in order to fold the structure of selected proteins using various tools provided within the game. Released in 2008, *Foldit* players have contributed to scientific problem solving through discovering new strategies and algorithms [2]. The game allows for group play and is supported by forum and chat tools. Leaderboards are used to rank players according to their scores.

Figure 1: Foldit homepage (http://fold.it/portal/)

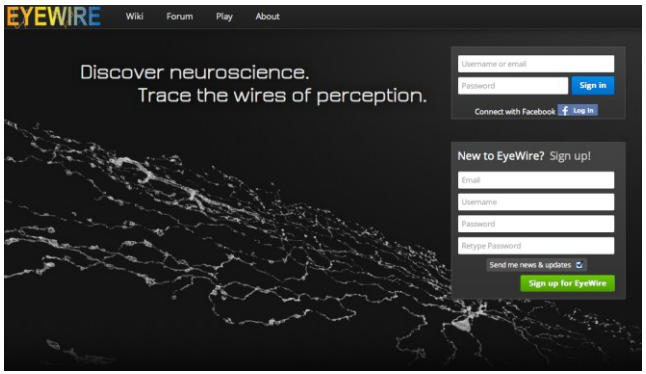

Figure 2: Eyewire homepage (https://eyewire.org/)

Eyewire (Figure 2) is a recently developed citizen science game from MIT and the Max Planck Institute for Medical Research. Launched in 2012, players aim to

map the connections between neurons in a slice of mouse retinal tissue by colouring in different sections of existing images. *Eyewire* is a single player game supported by forums. Leaderboards are also utilised.

Motivations and engagement

Currently it is unclear whether CS games such as *Foldit* and *Eyewire* encourage people to take part in a project, or help to sustain engagement, or both. Rotman and colleagues [7] suggest that games "may be used to attract people who are not initially interested in a less appealing topic (i.e., bacteria; worms) or engage them further in a topic of their liking." (p. 225). In contrast, Paharia [6] argues that "the entity being gamified needs to have some intrinsic value already".

As of yet, there is no research that specifically addresses motivation in relation to CS games. However, research has been conducted in relation to other types of CS projects. Nov et al. [5] found that the most salient motivational factors for taking part in *Stardust@home* were collective and intrinsic motives. Rotman et al. [7] found that volunteers participated in the *Encyclopedia of Life* because of an initial interest in the domain, previous engagement with science, having similar hobbies relating to CS, or a desire to gain career related experience. Regarding continued engagement, Rotman et al. suggest a number of factors: recognition, feedback, community involvement and advocacy. Volunteers particularly valued being *recognized* and appreciated for their contributions. The importance of *feedback* relates to informing volunteers about how overall contributions have led to project progress e.g. in the form of project updates. *Community involvement* was found to impact on a local level and also related to the forming of local and distant social ties. Similarly, volunteers discussed becoming *advocates* who wanted to influence environmental policy.

Exploratory Interviews

While there has been research examining the differences between initial motivations and reasons for sustained engagement, much of this has focused on *content curation communities*. The more recent emergence of *CS games* requires new considerations as we do not know why people participate in these communities and how motivation and engagement relate to the implementation of game mechanics. Furthermore, there is no research that explicitly examines the role of communication tools within this context. Therefore we conducted an exploratory interview study, to allow us to gain an initial understanding of factors affecting engagement and motivation to participate in different aspects of CS games.

Method

An opportunity sample of eight participants (F=4, M=4; Mean age: 47.5; SD=12.6) were recruited from *Foldit* and *Eyewire* project forums (4 from *Foldit,* 4 from *Eyewire*). Their experience ranged from a couple of months to several years.

Interviews were semi-structured. Participants were asked questions about why they took part in a project, what sustains their engagement and why they used tools such as forums. Iacovides et al. [4] have argued that when studying gaming motivation it is important to investigate both micro and macro-involvement so the interviews included a consideration of game-play and the activities that surround it.

Each interview lasted up to an hour, took place over Skype and was audio-recorded. At the end of the

interview, all participants were fully debriefed and received a £15 gift voucher for taking part.

Thematic Analysis

The resulting transcripts were coded using a qualitative methodology known as *Thematic Analysis* [1], where an iterative approach is adopted in order to develop themes that cut "across a data set... to find repeated patterns of meaning" (p. 86). We identified four main themes and several subthemes (reported in italics).

1. Initial motivations

Many participants had a *prior interest in science*, ranging from a casual curiosity to having obtained a doctorate. Initial participation was also motivated by being *pro-citizen science*, e.g. "My family's quite geeky, my mum had already installed one of the first collaborative sciences to compute proteins, so it's a long time that I've been aware of these things" (P2). The majority of participants reported finding out about the projects via avenues such as science related magazines, websites, TV shows and Twitter feeds. In fact, only 1 participant even mentioned playing other games (*Minesweeper*). Essentially, the participants in this study were not gamers, but people that had a keen interest in science.

2. Continued engagement

In terms of sustained engagement, the importance of *recognition* was emphasised. Participants wanted "to feel like we make a difference" (P4), e.g. being credited in publications such as *Nature* [2]. *Gaming elements* like points and leaderboards were viewed as features that extend a particular session, e.g. "the points don't motivate me but they do drive me further" (P4). Being provided with evidence of project *progress* was generally seen as encouraging involvement as the experience of making progress was rewarding: "If you feel like you've done something that they [scientists] couldn't possibly do because they don't have enough hours in the day, but you've done it, and you've helped, then you do really feel part of it. It's very rewarding" (P1).

Another reason for continued engagement related to *team-play*. *Foldit* allows for players to participate in teams. One participant described how "if there were no group I wouldn't be involved" (P7). Being part of a team appeared to spur *Foldit* players on to be more competitive and interact collaboratively with other players. *Eyewire* players also expressed a desire for team play, if implemented in a meaningful way: "it would depend on if the teams could have defined goals. I wouldn't be interested if it were just random neurons and points alone" (P4).

3. Forum/chat motivations

Regarding communication tools not everyone reported using the online forums and chat options. For those that did use the forums, it was often a place where they could get *support,* e.g. "I'm constantly in the bugs thing, in that section in particular" (P1). These tools also enabled players to engage in wider forms of *social interaction*, unrelated to the project. This was reported more often in relation to *Foldit* where players described engaging in these types of conversations using group chat: "on the group chat we talk about whatever… pictures of kittens... families" (P8).

Similarly, another reason for engaging with communication tools related to developing a *sense of community*. For instance, with respect to the *Eyewire*

forum, "I went there and you can sense that there is a small community, but active" (P2), and regarding the chat feature on *Foldit*, "I see people coming and going from the chat all day long" (P7). There was a general consensus that forum and chat features enhanced the sense of community within the project, regardless of how often individuals posted, or if they were used specifically for project or social purposes.

4. Desired improvements

The importance of progress and recognition in the form of receiving evidence of helpful contribution was also apparent in participants' suggestions for improvements to the projects. Participants frequently expressed their desire for more information concerning:

(1) the *science* behind the project, "it doesn't actually explain each particular protein very well, you have to go off and research it yourself" (P5);
(2) *progress updates*, "I'd like a little more contact, perhaps like the 'weekly progress' gallery or similar" (P4);
(3) *personal contribution*s, "you could have a page where you see how you contribute to the overall structures of the neurons" (P2);
(4) the *developers/researchers*, "I'd like to learn more about who are the people behind the project" (P2); and
(5) being shown their *relative performance* in relation to others, "to see similarities and differences between the way I see a connectome [part of the detailed map of neurons and synapses within the nervous system of an organism] and the way someone else pictures the same one" (P4).

Discussion and Future Work

In this paper we have presented an initial study exploring volunteers' motivations in relation to CS games. Our findings suggest that gamifying CS projects may not be useful in attracting new volunteers to these projects. In line with previous research [5; 7], our thematic analysis revealed that an intrinsic interest in the project activity is a key initial motivation to join a project. Participants were not attracted to the CS projects because they were interested in games – they were attracted because they were interested in science.

Game mechanics do appear useful, however, in helping to sustain volunteer involvement. Our findings suggest that a sense of progression and team-play are factors that could help motivate volunteers to continue participating in the project – if implemented in a way that is perceived as meaningful to the project's goals. In addition, communication tools such as forums were seen to support a shared sense of community, contributing to further engagement.

Design implications

Based on our findings, we propose the following design considerations for sustaining involvement in CS games:

- *Use of teams.* Teams contribute to involvement by allowing for a greater range of interaction between participants e.g. collaboration and competition between players. Not all participants may want to engage in group play however so it is important to ensure there is also a single player mode. Foldit for instance, allows for both.
- *Meaningful game mechanics.* Team-play will encourage participation if participants view it as a meaningful activity in terms of contributing to the

project goals. Similarly, points and badges should be used as way to support primary motivators, e.g. as a method of recognising contributions and allowing players to establish their expertise.

- *Forums and chat facilities.* Forums and chat tools help to facilitate a sense of community and continued engagement by supporting further interactions between participants. In addition, scientists could use these tools as a way to sustain involvement by providing information about progress and recognizing contributions, e.g. through regular project updates. While chat tools provide immediate contact with other people logged in, forums are a good way of curating content/discussions.

Our results have important implications for CS designers, as they suggest that game elements and communication tools are not necessary for attracting new volunteers to a project. However they may help to sustain engagement over time, by allowing volunteers to participate in a range of social interactions and through recognizing their achievements as meaningful.

Though the findings are based on a small number of self-reports, they do suggest important avenues for further research. In future, we plan to build on this work by interviewing a larger number of CS volunteers. We will also collect objective data to allow us to corroborate volunteers' self-reports of engagement, e.g. user statistics such as date joined, date of last login, and number of posts.

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