Gamifying Citizen Science: Lessons and Future Directions

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Abstract
Gamification is a promising mechanism to motivate the contributors to citizen science projects. This paper describes our experience designing Biotracker, a gamified citizen science data collection platform. We also present important challenges facing future designers of gamified citizen science apps.

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Gamification; Citizen Science; Floracaching

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K8.0. Personal computing: General games

Introduction
Gamification is the use of elements of game design in non-game contexts [5]. Empirical research demonstrates that Gamification can encourage some people to use an application more often [14] and to derive greater enjoyment from their use of an application [6, 7]. Gamification is already being utilized in domains that collect user-generated content such as mobile social reporting and citizen sensing [4]. Citizen science provides another opportunity for gamification; in fact, a recent position paper on the future of citizen science identified "motivations driven by interest in technology and rewards, such as online gaming badges

and competitions" as a potential future direction benefitting volunteer motivation and retention [10].

Citizen science is a collaborative process where volunteers work with professional scientists to study real world problems [3]. Different types of citizen science projects include action projects, where citizens intervene in community concerns, conservation projects that support natural resources management, investigation projects where data is collected to advance scientific goals, technology-mediated virtual projects, projects that support educational outreach [15], and biodiversity curation projects [13]. The motivations of citizen science volunteers are complex—researchers recently identified 12 types of motivations for a single project, noting that the majority of participants had multiple motivations—and those motivations evolve over time [12, 13].

The success of Foldit (http://fold.it/portal/) and Phylo (http://phylo.cs.mcgill.ca/) has proved that serious games can inspire citizen science volunteers. Gamified platforms are being built using the same motivational elements at a lower cost of time and effort. Tiger nation combines computer vision with elements of gamification to identify and track wild tigers [9]. Happy Moths uses badges, leaderboards, and occasionally a narrative to inspire users who perform classification tasks [11]. Another platform, Biotracker, is described below.

Building a gamified citizen science app

Biotracker is a gamified citizen science data collection platform. The Biotracker app, a major component of the platform, has the ability to track location data, create user profiles, allow users to upload multimedia, and incorporate game-like elements such as badges and a leaderboard. As such, the app is a collection of technologies that can be molded to fit the needs of a specific project.

Biotracker was inspired in part by Floracaching, a serious geocaching game for citizen science that encourages players to gather plant phenology data. Two prototypes of Floracaching were recently evaluated at 2 Universities with 58 participants, as detailed elsewhere [2]. Floracaching users were both plant experts (n= 22) and technology enthusiasts (n= 36). Players shared their motivations for using Floracaching, the activities they enjoyed, and suggestions for improving the app through surveys, focus groups, and behavioral trace data. A screen shot of the Floracaching prototype is presented in Figure 1.

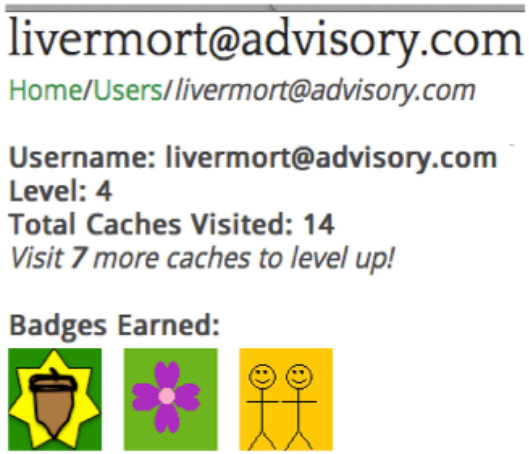

Figure 1. A Floracacher's user profile. This user earned badges for visiting 5 oak trees, finding a plant on a conservation list, and for using the app with other people.

Our work designing and evaluating Floracaching allowed us to study firsthand the motivational effects of game elements in citizen science and infer design implications for the gamified Biotracker app.

Research questions and design challenges

Designing to support both experts and casual gamers
One noted challenge in citizen science projects is gathering and retaining enough participants to make a project's goals worthwhile [11]. A gamified app might encourage a gamer audience to contribute to a project that they might otherwise ignore. Consistent with [12], we learned that some of our gamers did enjoy Floracaching precisely because it was a game-like application that contributed to citizen science. As one explains, "With Geocaching it's cool, and it's fun, but it's like 'what's the point' whereas for this, you're contributing to science while you're doing it." Other participants said it would be motivating to use the app "if it were more like a game with badges, achievements, etc." or "if there was a way to 'win'".

While gamification is designed to increase motivation, hardcore citizen scientists may eschew game-like aspects in favor of a more serious interface. For example, one plant enthusiast who tested Floracaching considered the game-like elements "distracting;" another advocated for more tools designed for plant experts such as a taxonomic key. As such, part of the design challenge for Biotracker is to make the app appeal to both citizen scientists and casual gamers.

Designers of the Citizen Sort classification portal appeal to their dual audience by offering a classification suite including Hunt and Gather, a true tool without motivational elements, Happy Moths, a game-like tool, and Forgotten Island, a game world that supports classification activities [11]. Additionally, the designers of Happy Moths evaluated both a bright, game-like interface and a lower key "natural" interface, learning that gamers preferred the game-like interface while natures preferred the more "natural" look. This suggests that designers could potentially use different skins to appeal to different user groups. Unfortunately this approach requires considerable cost and effort. Finding ways to have a single interaction experience that appeals to both groups thus is a worthwhile goal.

Ensuring that gamification does not have an adverse effect on data quality
As citizen science relies upon the efforts of volunteers who receive minimal training, scientists emphasize the importance of a rigorous process that produces high quality scientific data [3]. As users of gamified applications may attempt to "game the system," for example by gaining points for sub-par contributions, the use of gamification in citizen science may exacerbate scientist's concerns about data quality [9]. A few solutions have been proposed. Repetition can be built into a game so that an answer or piece of data is not accepted until submitted or verified by multiple players [1]. Gamified activities or even complete games can also be built to ensure data quality; for example, Odd Leaf Out is a sorting game that combines human efforts with a computer vision algorithm to identify mislabeled images of leaves [8].

Conclusion and Workshop Goals

While many serious games exist to support citizen science activities, designing gamified citizen science applications is an emerging challenge. We have

identified the following challenges to gamifying citizen science, which we believe also effect those working in different domains:

- How can gamified apps be built to appeal to an audience that enjoys game-like interfaces, and an audience that may find them distracting?
- How can gamification enhance the experience of an audience that already displays powerful intrinsic motivations?
- How should gamified apps be modified when supporting data quality is a crucial task?

It is our hope that a discussion of these and similar questions will help us design a better app.

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