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Gamers, citizen scientists, and data: Exploring participant contributions in two games with a purpose

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ABSTRACT

Two key problems for crowd-sourcing systems are motivating contributions from participants and ensuring the quality of these contributions. Games have been suggested as a motivational approach to encourage contribution, but attracting participation through game play rather than intrinsic interest raises concerns about the quality of the contributions provided. These concerns are particularly important in the context of citizen science projects, when the contributions are data to be used for scientific research.

To assess the validity of concerns about the effects of gaming on data quality, we compare the quality of data obtained from two citizen science games, one a "gamified" version of a species classification task and one a fantasy game that used the classification task only as a way to advance in the game play. Surprisingly, though we did observe cheating in the fantasy game, data quality (i.e., classification accuracy) from participants in the two games was not significantly different. As well, data from short-time contributors was also at a usable level of accuracy. Finally, learning did not seem to affect data quality in our context.

These findings suggest that various approaches to gamification can be useful for motivating contributions to citizen science projects.

1. Introduction

In this paper, we examine the interplay of motivation and quality of contribution in the context of crowd sourced systems. Crowd sourcing can be a powerful mechanism for rapidly generating high-quality outputs through distributing work across many different contributors. In this current research, we explore one specific form of crowd sourcing, citizen science.

In citizen science projects, members of the general public are recruited to contribute to scientific investigations. Citizen science initiatives have been undertaken to address a wide variety of goals, including educational outreach, community action, support for conservation or natural resource management, collecting data from the physical environment or analyzing data for research purposes. Many citizen science projects rely on computer systems through which participants undertake scientific data collection or analysis, making them examples of social computing (Cohn, 2008; Wiggins & Crowston, 2011).

Because many participants are not trained scientists and have limited scientific knowledge, a frequent concern about citizen science projects is the quality of the data participants generate (raw or analyzed) and the suitability of this data for the science goals of the project. For citizen science, "data quality" is a complex construct that encompasses validity, reliability, and ultimately, the usefulness of data (Orr, 1998; Pipino, Lee, & Wang, 2002; Prestopnik & Crowston, 2011; Wang & Strong, 1996).

Contrary to these concerns, previous studies have reported favorably on citizen science data quality. For example, Galloway, Tudor, and Vander Haegen (2006) compared novice field observations to expert observations, finding that observations between the two groups were comparable with only minor differences. Delaney, Sperling, Adams, and Leung (2008) checked data quality in a marine invasive species project, finding that participants were 95% accurate in their observations. However, their study did find that motivation had an impact on the final data set, with some

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participants failing to finish because of the tedious nature of the tasks.

This last finding is notable because citizen science projects often rely on the inherent appeal of the topic to attract and motivate participants. For example, "charismatic" sciences like bird watching, astronomy, and conservation all have enthusiastic communities of interest, and a number of successful citizen science projects have grown up around these topics. While the intrinsic motivation of science is undeniably powerful, citizen science projects that rely on this motivation to attract contributions face limits on their available pools of participants, namely those who share the particular scientific interest. Less charismatic topics of inquiry that lack a large natural base of users could therefore benefit from alternative mechanisms for motivating participants.

Purposeful games have the potential to become one such motivational mechanism. Games are recognized for their potential to motivate and engage participants in human computation tasks (e.g. Deterding, Dixon, Khaled, & Nacke, 2011; Law & von Ahn, 2009; McGonigal, 2007, 2011; von Ahn, 2006; von Ahn & Dabbish, 2008) and so seem to offer great potential for increasing the pool of contributors to citizen science projects and their motivation to contribute.

However, in citizen science projects that incorporate games, concerns about data quality are heightened. Designing gamified systems involves creative tradeoffs, where playful interactive elements compete for primacy against outcome objectives. Systems designed to maximize engagement and fun may do so at the cost of reduced data validity, reliability, and usefulness. Players who are engrossed in a game may find themselves concentrating only on the fun elements of a game, ignoring, neglecting, or even cheating on embedded science tasks. On the other hand, games that are designed to prevent such behaviors may improve data quality but impose difficult, boring, or even unpleasant constraints upon their users, making them less fun for players and leaving them unable to attract many participants.

The interrelated issues of game-driven participant engagement and citizen science data quality are of interest to game designers, HCI researchers, and those involved with citizen science. It is important for these various constituencies to understand how citizen scientists produce data using games, how accurate that data can be, how different approaches to "gamification" can influence player motivation and data quality, and innate player attitudes and interests can mediate participation and data quality. In this paper, we address these questions.

2. Theory: gamification and games with a purpose

2.1. Gamification, diegesis, and rewards

The goal of most so-called "gamification" is to use certain enjoyable features of games to make non-game activities more fun than they would otherwise be (Deterding, Dixon, et al., 2011; Deterding, Sicart, Nacke, O'Hara, & Dixon, 2011). Often, the term gamification refers to the use of things like badges and points to place a "game layer" on top of real-world activities, especially in corporate, governmental, or educational settings. However, this usage is heavily contested by game designers and scholars, with some going so far as to criticize these approaches as "exploitationware" (Bogost, 2011). As Bogost (2011) and others have pointed out, points, badges, rewards, scores, and ranks do not really engage players, that is, they are not core game mechanics themselves. Rather, these are just metrics by which really meaningful interactions — the play experiences that truly compel and delight players — are measured and progress is recorded. To remove meaningful aspects of play and retain only these measurement devices is to produce something that is not really a game at all (Bogost, 2011; Deterding, Dixon, et al., 2011; Deterding, Sicart, et al., 2011; Salen & Zimmerman, 2004).

To conceptualize different rewards and different approaches to creating games, we distinguish two different kinds of rewards that a game might offer, drawing on the notion of diegesis, a term from the study of film that refers to the notion of the "story world" vs. the "real world" (De Freitas & Oliver, 2006; Galloway, 2006; Stam, Burgoyne, & Flitterman-Lewis, 1992).

Diegetic rewards in games are those that have meaning within the game but no value outside of it. For example, a diegetic game reward might be an upgraded weapon given to the player by a game character upon finishing a quest. The weapon has meaning in the game: it is more powerful and can be used to slay more dangerous enemies. This reward is strongly tied to the story and the game world and has no use outside of it. In-game money and items are simple examples, but more abstract rewards also qualify as diegetic, including the immersive exploration of a beautiful game world, the enjoyment of a rich game story, the joy of playing with fun game mechanics, or the player's dialogue with game characters or other human players. Malone (1980) has noted how many of these can be motivating in the context of gamified experiences, specifically educational games.

In contrast, non-diegetic rewards are those that have only limited connection to the game world, but sometimes (not always) have meaning in the real life of the person playing the game. For example, "achievements" (a kind of merit badge) are a common non-diegetic reward used in entertainment games. Players can collect achievements by performing certain actions within the game (e.g., "jump from a great height," or "collect 1 million coins"). However, these achievements do not affect subsequent game play. Non-diegetic rewards like badges, points and scores are frequently used in citizen science games to acknowledge player accuracy, time spent, effort, or milestone accomplishments.[1] However, because non-diegetic rewards are only weakly tied to the game world and do not impact the game experience, players are likely to value them only to the extent that they value the actual accomplishments for which they are awarded.

For "science enthusiast" players who truly engage with the scientific elements of citizen science games, non-diegetic rewards might have great significance. However, it is possible that such players do not really need a game to motivate their contributions in the first place. For "non-enthusiast" players, non-diegetic rewards likely have limited appeal. If the real-world science activity itself is not highly valued, non-diegetic rewards for working on it will also not be valued.

Rather than badges or points, non-enthusiast players are most likely to find value in a game that can turn "boring science" into "play." Diegetic rewards can be crafted to be engaging and meaningful even to non-enthusiasts who are not inherently motivated by the task or related non-diegetic rewards. Diegetic rewards focus player attention upon the game story, game world, and game play instead of the real-world task, and can thus become a powerful form of feedback to keep non-enthusiasts immersed in a game that occasionally asks them to undertake a science task. There is promise in this approach, especially the possibility of attracting and engaging large crowds of non-enthusiast participants.

We have described the mismatch between non-diegetic rewards and motivation in the context of citizen science, but suspect that it applies more broadly. Indeed, many scholars and designers have

[1] Examples include exergames like fold.it (http://fold.it), Phylo (http://phylo.cs.mcgill.ca), and Cropland Capture (http://www.geo-wiki.org/games/croplandcapture/), among others.