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Research-in-Progress

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Abstract

How to enhance user performance becomes a key issue in citizen science research. Providing feedback is regarded as an effective design principle to promote user experience and performance in many contexts. Yet, there is a lack of study on how to design feedback to improve user experience and performance in citizen science projects. Based on feedback intervention theory and achievement goal theory, we propose a research model to depict the influence of feedback types (task, self-referential, social feedback) on user experiences (perceived enjoyment, perceived meaning, and self-expansion), which then impact participation performance. We also investigate whether a user's dispositional goal orientation (mastery or performance) moderates the effects of feedback types on user experiences. We will conduct an online experiment to validate our research model. The findings will provide the groundwork for guidelines and strategies to enhance use performance in citizen science projects.

Keywords: feedback, goal orientation, participation performance, citizen science

Introduction

Citizen science is a new paradigm based on the collaboration of the general public to gather public wisdom for research activities (Shirk et al. 2012). Online citizen science projects allow the collaboration of public to span the limitations of time and geography, providing new ways to solve scientific problems. Participants involve in scientific investigations, including collecting or analyzing data, solving scientific problems, and sharing computing resources (Raddick et al. 2009; Wiggins and Crowston 2011). One primary challenge encountered by scientists is that only a small group of the participants actively contribute in the project, and most participants contribute with little effort (Sauermann and Franzoni 2015), making it difficult to achieve the goal of supporting scientific research. Therefore, how to effectively design the project to enhance user participation performance has become a key issue to be solved.

Providing feedback is a design principle that leads to positive user experience and encourages ICT use (Zhang 2008). Prior study found that design feedback interventions can change individual behavior and enhancing citizen science contributions (Diner et al. 2017). For instance, in the eBird project, users receive feedback information of their contribution records, such as species observed and days of

checklist streak. The platform also shows the best photo and their creators' information. By informing the user of the completion of themselves and the project by feedback, the enthusiasm for participation can be stimulated and maintained. More importantly, the effects of feedback depend on how feedback is provided (Zhou 1998) and personal traits of the recipient (Wozniak 2012). Individual has their different dispositional goal-oriented (mastery oriented and performance oriented). Providing feedback will bring situational goals, whereas individuals with different dispositional goal-oriented individuals sometimes have different perceptions of situational goals (Yeo et al. 2008). It is still uncertain how the situational goals and dispositional goals work to influence user experience and participation. Therefore, this paper aims to investigate the following research questions: 1) how do feedback and goal orientations influence user experiences and their participation performance in citizen science projects? 2) Particularly, to what extent the effects of feedback differ when individuals have different dispositional goal orientations?

Research on feedback in citizen science is emerging, yet the effects of feedback on user performance still needs further investigation. According to the feedback intervention theory, feedback always affects individual performance through their intrinsic experience (Kluger and DeNisi 1996). Feedback can be designed in a way to match users' achievement needs to better promote user motivation (Pekrun et al. 2014; Steele-Johnson et al. 2010). Based on Elliot et al.'s (2011) conceptualization of three achievement goals, we developed three feedback types, task feedback (e.g., you have finished the task of high quality), self-referential feedback (e.g., you have done better than before), and social feedback (e.g., you have done better than others), and then investigated their influences to user experiences.

In information systems (IS) research, flow experience and aesthetic experience can lead to deep engagement and meaningful engagement which can improve participation performance (Suh et al. 2017). Perceived meaning and self-expansion are aesthetic experience which can lead to meaningful engagement, and perceived enjoyment is flow experience which can lead to deep engagement. Additionally, it is also valuable to examine to whether individuals' dispositional goal orientations would alter the effects of feedback on user experience and their subsequent participation performance. To sum up, drawing upon feedback intervention theory and achievement goal theory, we conduct a theoretically grounded investigation of how feedback types and user's dispositional goal orientation impact user experience and performance in citizen science projects.

Related Literature

Achievement Goal: Situational and Dispositional

Achievement goal theory holds that individuals have different goals when participating in an achievement behavior (Elliott and Dweck 1988). This different goal orientation shows a self-development belief that enables individuals to understand and participate with different attitudes and responses in a certain achievement situation. Ames (1992) focused on learning environments can be differentiated in terms of specific informational cues (e.g., social comparative vs. self-referenced feedback) and influence students' processing of information and cognitions about their performance. The initial achievement goal types are mastery goals, in which the purpose is to develop competence and task mastery, and performance goals, in which the purpose is to demonstrate competence. Based on the three competence evaluation criteria, Elliot et al. (2011) proposed that mastery goal focused on the attainment of task-based or self-based competence, the achievement goal can be further divided into: task, self and other goal. Task-based goals use the absolute demands of the task as the evaluative referent. Thus, competence is defined in terms of doing well or poorly relative to what the task itself requires. Self-based goals use one's own intrapersonal trajectory as the evaluative referent. The evaluation of the capability is relative to the past performance of the individual. Other-based goals use an interpersonal evaluative referent. Competence is defined in terms of doing well or poorly compare the ability of others (Elliot et al. 2011). The achievement goal affects the individual's cognition, emotion and behavior.

The conceptualization of orientation as either a trait-like predisposition or a task-specific orientation influenced by contextual factors(Hole and Crozier 2007). Achievement goal orientations represent the individual's ''orientation'' to the task or situation, their general focus or purpose for achievement, and

not just the specific target goal they have for the task. A dispositional goal orientation is one's belief about success or achievement in general rather than in a specific context (Giota 2007). Individuals can be either relatively mastery oriented or relatively performance oriented. Individuals participate in citizen science in order to achieve difference goals which include development of new skill, or deepen relationships with other people, performance better than others (Shirk et al. 2012). Individuals with mastery oriented are more likely to believe that success is mainly due to the effort they have made. Thus, when engaging in citizen science, they will be more proactive in completing tasks and learning from the community. While individuals with performance-oriented tend to believe that success is due to their ability to achieve high achievement, and the ability is inherently unchanged. They focus on getting a high status in the citizen science ranking and show better than others. Jagacinski et al (2001) suggest that there is an interaction between individual dispositional goal orientation and their context-inducing goals. Since the context of a citizen science task might raise goal-related issues that conflict with the individual's more typical orientation. It would be valuable to investigate the effects of interactions upon user experience which would affect their participation performance.

Feedback Design

Feedback can be viewed as control or information that satisfied psychological needs and intrinsic motivation in different ways (Bangert-Drowns et al. 1991; Kluger and DeNisi 1996). Kluger and DeNisi (1996) proposed that feedback is the information about the individual task operation or past behavior that can be consciously and purposefully provided by an external agent, in order to induce the internal motivation of the individual and thereby affect the individual's performance. Difference individuals have different perceptions of feedback interventions, induced distinctive intrinsic motivations, thus affecting the individual performance levels. Over the years, researchers have studied many types of feedback, different feedback types have different roles. Burgers et al. (2015) explored how the feedback valence (positive or negative) and feedback type (descriptive, comparative, evaluative) satisfy player's needs and the intention to play the game again. As learners' progress may be defined relative to an absolute, criterion-based goal or relative to the performance of others (social comparison), Kollöffel and de Jong (2016) study this two type of feedback (criteria feedback and social comparison feedback) how to impact students' scores and learning performance. In user-generated content (UGC) research, Huang et al (2018) investigated supply feedback aligns with user's social value orientation (SVO) including "cooperative", "individualist", and "competitive" on users' subsequent production of content.

The feedback information not only informs the user about their performance of the task, but also implies the gap between it and the target setting, the individual will adopt efforts to achieve goal. Feedback influences context-inducing achievement goals and achievement emotions (Pekrun et al. 2014; Steele-Johnson et al. 2010), which will then have an effect on performance. As we can see that in some citizen science projects, users can get information about the quantity and quality of completion. Some gamified citizen science projects informed users on their progress and current standing in the project. Providing feedback has been shown to improve performance by enhancing intrinsic feelings of accomplishment (Laut et al. 2017). However, we have yet unknown which type of feedback is most effective in stimulating user performance in citizen science. Therefore, we divided the feedback types consistent with achievement goal theory based on three competence evaluation criteria: task, self-referential and social feedback. Task feedback is providing information on how individual tasks are completed in terms of the comparison between individual completion and task requirements. Self-referential feedback is based on the change of individual internal self-ability as the evaluation criteria, and feedbacks the individual's current performance relative to past performance. Social feedback is giving the evaluation of individual doing task well or poorly compare with others completion. Individuals with relatively mastery oriented or relatively performance oriented will have vary perceptions of ability to high achievement.

Feedback in Citizen science

Citizen science projects join the power of general public to conduct scientific research in a less expensive and more efficient way (Bonney et al. 2009). It has provided a platform for public training and learning, and also helped to solve problems in scientific research. The intrinsic motivation of public

are mostly meaningful, fun, personal interests, learning, and hope to contribute to society(Bowser et al. 2013). We need to provide design in the project to improve user experience which will encourage their performance.

Feedback provision can be used as a motivational tool to make volunteers feel valued and encourages them to continue participate. In Scheliga et al. (2018), most project initiators appreciate feedback mechanisms, but few projects seemed to have implemented feedback strategy. Providing feedback in the citizen science such as providing information about project progress, user's task progress and current status can let them feel interaction (Bharathi et al. 2016), which also enhances self-efficacy and perceived pleasure so that users would work harder. Feedback can enhance public performance and user motivation by enhancing the inner sense of accomplishment (Tinati et al. 2016). For example, in FoldIt, feedback is provided in a gamified manner. With scores and leaderboards, users know the number of tasks they finished and their rank in comparison with others. Participants tend to increase or decrease their contribution in response to the performance of their peers (Laut et al. 2017). Therefore, the participation performance in citizen science projects can be improved by adding feedback intervention.

Research Model and Hypotheses

We consider a citizen science feedback design where users receive information about their performance after completing tasks. The feedback types are task feedback (e.g., you have finished the task of high quality), self-referential feedback (e.g., you have done better than before), and social feedback (e.g., you have done better than others). We are interested in the effects of differing feedback types and user's dispositional goal orientation on the user experience, and thus influence their participation performance. Feedback intervention theory serves as an overarching framework to explain how feedback and personal traits may influence citizen science user experience and their performance. Achievement goal theory lends support to enrich the understanding of three feedback types and the influence of user's dispositional goal orientation on feedback types. Our research model as shown in Figure 1.
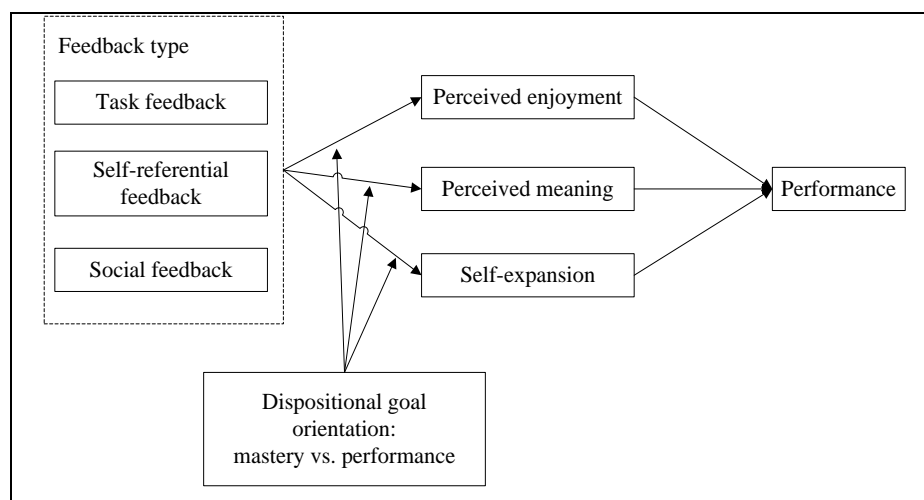

Figure 1. Research Model

User experience and participation performance

Perceived enjoyment refers to the degree of pleasure in interacting with the system. Users' hedonic experiences in citizen science will ensure continuance intention. When user perceived enjoyment, they will be induced to innovate and create solutions (Stock et al. 2014). In flow theory, immersion can produce higher enjoyment, which in turn leads to deeply engaged with task and more active participation (Suh et al. 2017). Accordingly, we hypothesis:

H1: Perceived enjoyment will positively influence participation performance.

Perceived meaning refers to the degree to which an individual understands the meaning of the project. When a participant perceives that a task is meaningful in a citizen science project, it creates a sense of

relatedness and is willing to devote more time and energy to accomplish the task (Aristeidou et al. 2017). Citizen science projects that have a significant impact on social life will motivate the individual to participate and contribute in the project. Meaning is an important motivation for users to participate in citizen science, and can lead to more effort (Tinati et al. 2016). Therefore, we hypothesize:

H2: Perceived meaning will positively influence participation performance.

Self-expansion refers to the extent to which an individual's sense of self has expanded by understanding scientific research or broadening his views, and is related to self-growth (Suh et al. 2017). According to the theory of aesthetic experience, when people enter the state, they will continue to participate in activities or objects, because they feel that they need self-progression or self-growth (Jennings 2000), so it will bring more positive performance. It is important to improve the ability during the completion of the task. When users in citizen science project feel self-efficacy, they are more willing to accomplish challenging task. Therefore, we hypothesize:

H3: Self-expansion will positively influence participation performance.

Feedback type and User experience

In task-feedback projects, users are provided information about the quantity and quality of scientific task completion. So that individuals focus on the completion of tasks and the improvement of research skills, they can produce enjoyment and positive emotions in achieving the task goal. But if they receive social feedback, they are designed to surpass others' ability, they have no positive effect on the fun (Brondino et al. 2014). As individuals pay attention to others performance, social feedback is easy to produce negative emotions such as anxiety. When someone get self-referential feedback information, they focus on the acquisition of individual abilities and self-development, emotions such as enjoyment and pride can be generated. Self-based standards require more cognitive ability than task-based criteria, and assess individual performance before and after. Concerns about self-expression may disrupt the process (Elliot et al. 2011). Therefore, task-based feedback can bring more fun to individuals than self-type feedback. Thus, we hypothesize:

H4a: Task feedback, compared to self-referential feedback and social feedback, will increase perceived enjoyment.

H4b: Self-referential feedback will increase perceived enjoyment over social feedback.

In task-feedback projects and self-referential feedback projects, individuals focus on the completion of tasks, the acquisition of research abilities and self-development. Therefore, users can sense the meaning of the task and more deeply understand the scientific research (Aristeidou et al. 2017). But self-based standards require more cognitive ability than task-based criteria, task feedback is more deeply aware of the meaning of tasks than self-based feedback. Social comparison feedback will make people ignore the meaning of the task process because the individual's attention shifts from task to comparison with other's performance. Therefore, we hypothesize:

H5a: Task feedback, compared to self-referential feedback and social feedback, will increase perceived meaning.

H5b: Self-referential feedback will increase perceived meaning over social feedback.

Elliot et al. (2011) proposed that task feedback can provide more direct ability evaluation and promote self-efficacy; there is a positive relationship between and self-efficacy, and self-evaluation is not related to self-efficacy. (Mascret et al. 2015) found that perceive self-expansion is positively related to tasks and social goals, but not to self-goals. Task feedback and social feedback have a positive effect on self-expansion. Self-feedback has no or weak positive influence, but task feedback is more obvious on improvement than social feedback. Therefore, we hypothesize:

H6a: Task feedback, compared to self-referential feedback and social feedback, will increase self-expansion.

H6b: Social feedback will increase self-expansion, compared to self-referential feedback.

Dispositional goal orientation interacts with feedback types

In citizen science, there may be different goal-oriented individuals involved in the achievement task. Individuals with mastery oriented are more likely to make their effort on tasks, focus on acquisition of knowledge and skills, and development of competence. While individuals with performance-oriented aim to demonstrate superior competence and to be recognized as a better performer than others in that virtual community. Individual dispositional goal fit with the environment goal can lead to better performance behavior (Jagacinski et al. 2001). In the face of task feedback and self-referential feedback, the content is about task completion, the acquisition of individual ability and the assessment of one's intrapersonal performance, so people who have a mastery orientation feel more comfortable. They are more responsive to task feedback or self-referential feedback projects. In contrast, people with performance orientation are more likely responsive to social feedback, they want to obtaining higher scores than others, and get recognition from others. Once the consistency between individual goal orientation and the environment feedback is achieved, individuals will bring a variety of positive psychological and behavioral outcomes, such as increased enjoyment, meaningful, and self-expansion. Thus, we hypothesize:

H7a: For users who are mastery orientation, the influence of task feedback and self-referential feedback on perceived enjoyment will be more positive.

H7b: For users who are mastery orientation, the influence of task feedback and self-referential feedback on perceived meaning will be more positive.

H7c: For users who are performance orientation, the influence of social feedback on self-expansion will be more positive.

Research Method

Experimental design

We are developing a citizen science project which simulated the classification tasks of scenery photos in Zooniverse. We get pictures from Chinese Field Herbarium which contains more than nine million pictures of plant diversity. This simulated project aimed to help conservationists and researchers identify plants quickly.

We plan to conduct a 3(feedback type: task, self-referential, social feedback) by 2 (dispositional goal orientation: mastery and performance) online between-subject experiment. Participants will be recruited via university email invitation and crowdsourcing platforms. Task feedback is related to the task criteria, provided that if the user has achieved the task goal. Self-referential feedback provides whether the accuracy of user annotations increased. Social feedback provides whether or not the number of completions and the accuracy rate of user annotation exceed the average of the masses.

Experimental procedures

Subjects who accept the invitation go to the laboratory. After the welcome introduction, subjects first answer questions related to dispositional goal orientation and background survey. We classify subjects to dispositional mastery or dispositional performance based on their responses. Then, we will randomly assign these two types of subjects to one of the three feedback groups. In the main task, subjects are requested to annotate 20 photos, during the annotation, participants receive feedback information about their competence. They can withdraw from the task at any time during the study. Then, they will be directed to the questionnaire. Their objective behavior data such as the number of tags they annotated and the accuracy can be inquired from the database.

Measurements

The scales used to measure constructs are adapted from prior studies. Scales of three perceptual experiences are from Suh's work (Suh et al. 2017). Sample items of enjoyment include "I have fun interacting with the citizen science task" and "Participating in the citizen science task provides me with

a lot of enjoyment." Sample items of meaning include "I feel participating in citizen science task is very important to me." and "I feel that participating in citizen science task is personally meaningful." Sample items of self-expansion include "I feel that I have a larger perspective on citizen science task" and ")I feel that finished citizen science task result in learning new things". User's goal orientation scales are from Vandewalle and Cummings (1997). Sample items of mastery goal include "The opportunity to do challenging work is important to me" and "I prefer to work on tasks that force me to learn new things.". Sample items of performance goal include "The things I enjoy the most are the things I do the best." and "The opinions others have about how well I can do certain things are important to me". The participation performance is measured by subjective data and objective data, the objective data measures the number of participants completed and the accuracy, the subjective data measures the continuance participation intention. Sample items include "I would like to continue to use spare time to complete the task". We will also ask questions of perceived feedback type to do manipulation check.

Data Analysis

For the data analysis, we will use structural equation modeling (SEM) which was conducted using PLS-Graph 3.0. to explain the variance of users' participation performance with three experience variables (perceived enjoyment, perceived meaning, self-expansion). To compare the effects of feedback types and dispositional goal orientations, we plan to conduct two-way MANOVA with the three experience variables as dependent variables.

Expected contribution

This research will have both theoretical and practical implications. Theoretically, we integrate feedback intervention theory and the achievement goal theory to study how users' goal orientation interact with feedback types affect their experiences, which then influence participation performance. The feedback intervention theory facilitates the understanding of how feedback and individual trait may influence user experiences. The use of achievement goal theory suggests an enriched understanding of feedback types. Methodologically, we use experimental research to compare the effects of different feedback types and triangulate objective data with subjective measures to evaluate participation performance. Practically, a deepened understanding of the effect of feedback types provides effective guidance for interaction design in citizen science projects. Knowing how feedback works for individuals with different dispositional goal orientations suggests ways to better encourage and engagement citizen science participants.

Citizen science projects have the potential to bring great value to scientific research through the power and the wisdom of the public. This paper hopes to provide guidance for project feedback design through comparative study of feedback types. Findings of this research will help to promote active participation of the public and improve the quality of contribution contents.

Acknowledgments

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