Technology and Work Practices in Citizen Science

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ABSTRACT
Citizen science is a form of research collaboration that actively involves the public in scientific research to address real-world problems. Research designed specifically for public participation is a form of information work for which the design of tasks and supporting technologies for volunteers is critically important to the scientific outcomes. This study examines the relationship between information and communication technologies (ICTs) and work practices, with the goal of generating insights to inform the design and management of cyberinfrastructure for citizen science. Comparing three projects with similar volunteer participation activities but varied organizational structures highlighted the importance of project goals and resources in the adoption of technologies, and strategies for using ICT to support ongoing participation and quality assurance.

Keywords
Citizen science, cyberinfrastructure, context, sociotechnical systems, design, participation

INTRODUCTION

This study examines the role of technology in citizen science projects, a form of research involving the public as active collaborators in scientific research. Citizen science is related to long-standing programs employing volunteer monitoring for natural resource management (Firehock & West, 1995), such as the Audubon Christmas Bird Count, which started in 1900. Participation in citizen science usually involves contributing data according to an established protocol, or completing structured recognition and problem-solving tasks that depend on human competencies because automatically generated data are as yet inadequate (Silvertown, 2009). The modern form of citizen science places more emphasis on scientifically sound practices and measurable goals for public education than similar historical efforts (Bonney et al., 2009), as well as the increased access for, and subsequent scale of, public participation via ICT. eBird is a good example of the economies of scale that can be achieved, reporting over 10 million observations collected in 2008 at a cost per observation of approximately three cents, a price that continues to drop as the number of contributors increases (Sullivan et al., 2009). The falling cost and rising availability of Internet access is partially responsible for the recent growth of such large-scale projects.

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Research designed specifically for public participation is a form of information work for which the design of tasks and supporting technologies to support public contributions is critically important to the scientific outcomes. The goal of this study is examining the relationship between ICT and work practices in order to inform design and management of cyberinfrastructure for citizen science.

RELATED WORK

Researchers have long recognized the importance of context in work design, and in turn, the importance of the task to performance (Ilgen & Hollenbeck, 1991). Designing and implementing technologies to support cooperative work requires understanding the setting and the nature of the task (Bannon & Schmidt, 1989). Numerous prior studies of computerization of work have observed social consequences of the introduction of technology into the workplace, and vice versa, the influences of social actors and practices on technologies (e.g., Barley, 1986; Star & Ruhleder, 1994; Suchman, 1987). There are parallel settings to these studies in citizen science, where many long-term projects are transitioning to online formats and most new projects are eliminating local coordination in favor of online coordination and decentralized project management.

METHODS

Three citizen science projects were selected for comparison. Each involves independent volunteers who monitor plant species in natural environments with data reported via online forms. These cases were chosen for similarity in research focus and variation across project goals and organizational characteristics. Inductive qualitative analysis methods were applied to data collected from 18 interviews with project leaders and staff, participant observation in project planning meetings and 6 days on site at two locations, and over 120 documents such as maps, brochures, monitoring protocols, and data sheets.

PROJECTS

The first project ("Parks") was an inter-organizational partnership developing a long-term regional plant and animal monitoring program in the Northeast region. Project goals focus primarily on conservation and natural resource management. Participants monitor the life cycles of plants and animals at locations in several U.S. National Parks.

The second project ("Mountains") was a well-established plant monitoring project for Northeastern mountain ranges, managed by a nonprofit membership organization and collecting contributions from partner clubs. The main purpose of this long-term project is education and outreach. Participants report the reproductive stages of targeted plant species throughout Northeastern alpine and forest areas.

The third project ("Gardens") was established by a single academic researcher to monitor plant-pollinator relationships. Despite a meager budget, it acquired 77,000 registrants in just over a year from launch. This project was a multiyear effort focused on formal scientific knowledge production. Participants report the times that bees visit garden flowers during 15-minute observation periods.

DISCUSSION

This work-in-progress analysis focuses on the different ways that technologies have been adopted and used in organizing these projects, discussing the integration of online data reporting in each project, and additional project functions supported by ICT.

All three projects support task-related participation with online data entry, but only the Gardens project started out that way. The others transitioned to online data entry after the monitoring protocols were fully established. The Parks project spent a full field season testing the monitoring protocol before adding online data reporting during the second year, when the number of participating parks expanded from three to seven. For the Mountains project, however, the conversion from paper to electronic data forms took several years. The reasons for these different approaches were largely contextual, as the available resources and organizational goals played a significant role in these decisions. In addition, both the Mountains and Parks projects are explicitly long-term programs, while the Gardens project's lifespan had not been predetermined.

In addition to marketing and online data entry, each project made additional uses of ICT. The Gardens project is currently alone in providing tools for community interaction through social technologies. Accordingly, the uses of ICT for organizing the Gardens project included substantially more communication tasks for participant support, relationship management, and decision support. The Mountains project prioritized outreach and member development, so identity management was another function they addressed through technology. Operating as a virtual organization, the Parks project already needed to provide access to numerous distributed partners, and went a step further to provide public access to the shared data. Finally, all of the projects recently started testing methods to use images for verification. The Gardens project collects photos shared in a Flickr photo group, while both the Parks and Mountain projects are testing automatic digital field cameras as a form of volunteer data validation.

CONCLUSION

Comparing the adoption and use of ICT in three different citizen science projects highlighted the importance of project goals and resources on the implementation of online data reporting. The current uses of ICT show a dominant interest in expanding and supporting ongoing participation, while also exploring ways to leverage ICT for research quality assurance.

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