The Impact of Task Workflow Design on VGI Citizen Science Platforms

James Sprinks*[1], Jeremy Morley†[1], Steven Bamford‡[2] and Robert Houghton§[3]

[1]Nottingham Geospatial Institute, University of Nottingham, UK
[2]School of Physics and Astronomy, University of Nottingham, UK
[3]Human Factors Research Group, University of Nottingham, UK

November 4, 2014

Summary

Citizen science platforms allow non-scientists to take part in scientific research across a range of disciplines, and often involve the collection of volunteered geographic information from remotely sensed imagery. What these systems ask of volunteers varies considerably in terms of task type, level of user judgement required and user freedom. This work studied the Zooniverse's Planet Four project and investigated the effect of task workflow design on user engagement and outputs. Results show participants found the more guided, less-autonomous interface more frustrating, while the less complex, repetitive interface resulted in greater data coverage.

KEYWORDS: Citizen Science, Volunteered Geographic Information, Planetary Science

1. Introduction

Citizen science, or "public participation in scientific research" (Hand, 2010), can be described as research conducted, in whole or in part, by amateur or nonprofessional participants often through crowd-sourcing techniques. It increasingly utilises virtual citizen science (VCS) platforms (Reed *et al*., 2012) that gather volunteered geographical information (VGI) from remotely sensed imagery, both of the Earth and other solar system bodies, through a website. As citizen science is a relatively new area of work, and while there has been research into human-computer interaction (HCI) design and functionality (Prestopnik & Crowston, 2012), there has been relatively little attention paid specifically to human factors issues regarding the collection of VGI. This comprises a significant research gap, given that the success of a citizen science venture is directly related to its ability to attract and retain users, both to gather the large amount of data required, and to ensure the utility of the data collected (Prather *et al.*, 2013). In this study we make a first step in considering how virtual citizen science systems can be better designed for the needs of the volunteer, exploring whether manipulating task flow would affect both the information collected, as well as the volunteers' experience of user the interface.

Some studies have considered motivation amongst citizen science volunteers (Raddick *et al*., 2010, Reed *et al*., 2013) but have not considered in any depth the form of work itself. This may be considered remiss as over thirty years of human factors research has identified a relationship between motivation, satisfaction and work design. Hackman & Oldham (1975) developed the "Job Diagnostic Survey" in order to better understand jobs and how they could be re-designed to improve motivation

* James.sprinks@nottingham.ac.uk
† Jeremy.morley@nottingham.ac.uk
‡ Steven.bamford@nottingham.ac.uk
§ Robert.houghton@nottingham.ac.uk

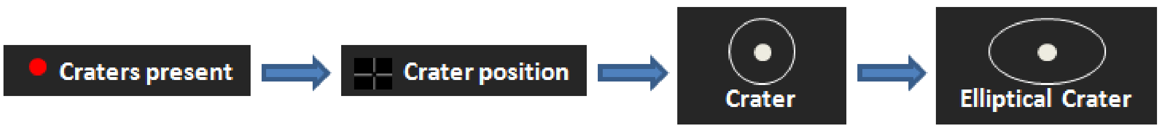
and productivity. Factors such as task variety, complexity and autonomy were identified as key to this process, all of which can be influenced in VCS design.

This paper describes the current active Zooniverse site Planet Four, a project that allows volunteers to mark the positions and directions of seasonal fans on the planetary surface, presenting the results of three different iterations of the site that differ in task workflow design, in terms of user experience/satisfaction and scientific output. Finally the impact of task workflow design on these results, and the implications for VCS platforms and other online mechanisms, are discussed.

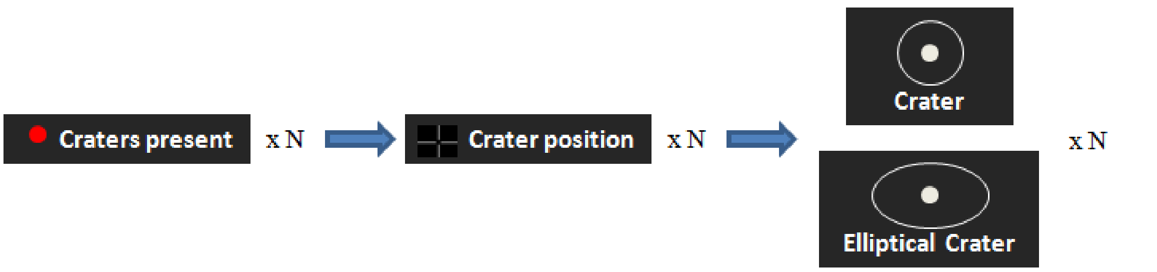
2. Methodology

In order to investigate the effect of task workflow design on user experience and VGI output, a new version of the Zooniverse's Planet Four project has been developed. The new site allows users to mark craters on images of the Martian surface. A lab study has been carried out to both consider task workflow factors and also act as a technical test, identifying any general functionality and usability issues before a public launch.

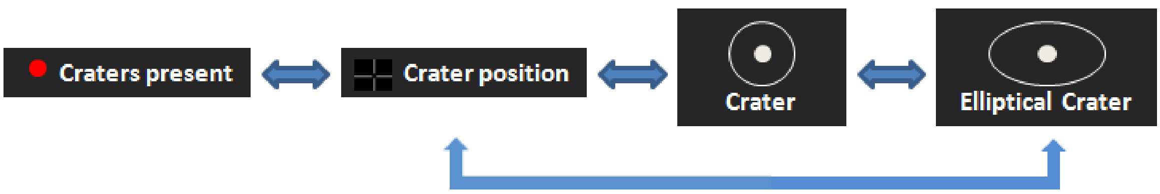
The platform has been developed to include three different interfaces for marking craters that vary in task type, number of tasks available to the user and user freedom. The crater-marking task has been split into four tools per crater: to indicate if any craters are present; to mark the crater centre; to draw a circle around the centre; and to adjust a second radius to make an ellipse. Figure 1 shows the tools available to each user and when for each interface, namely stepped, ramped and full:



STEPPED: All tasks completed in a predefined order (increasing in complexity) for each image, which cannot be diverged from



RAMPED: Users have access to one tool and complete one crater marking task for a set number of images, then use another tool and complete another task (increasing in complexity) for the next set of images etc.



FULL: Users have access to all the tools and can complete all crater marking tasks for each image in any chosen order

Figure 1 Flow Diagram of Tools Available to User for each Interface

Thirty participants took part in the lab study between January and March 2014. There were no specific prerequisites for participation. Each participant used each interface in a random order, and afterwards completed a questionnaire asking them to share their views across themes including *design & usability*, *tasks & tools* and *imagery*. At the end of each section, 'free text' boxes were available for participants to give additional comments and opinions.

3. Experimental Results

3.1. Participant Questionnaire Results

Table 1 shows a breakdown of the number of comments made by participants regarding each interface, sorted into four different topics. Usability comments were concerned with the general usability and mechanics of each interface; accuracy comments focussed on how accurately craters could be marked; tool issue comments were specifically about the tools provided to mark craters; and imagery comments discussed the remotely sensed imagery displayed.

Table 1 Numbers of Responses by Comment Topic and Interface

Topic	Full Interface	Stepped Interface	Ramped Interface
Usability	3	9	4
Accuracy	6	5	7
Tool Issues	7	6	6
Imagery	3	2	2

3.2. Crater Marking Results

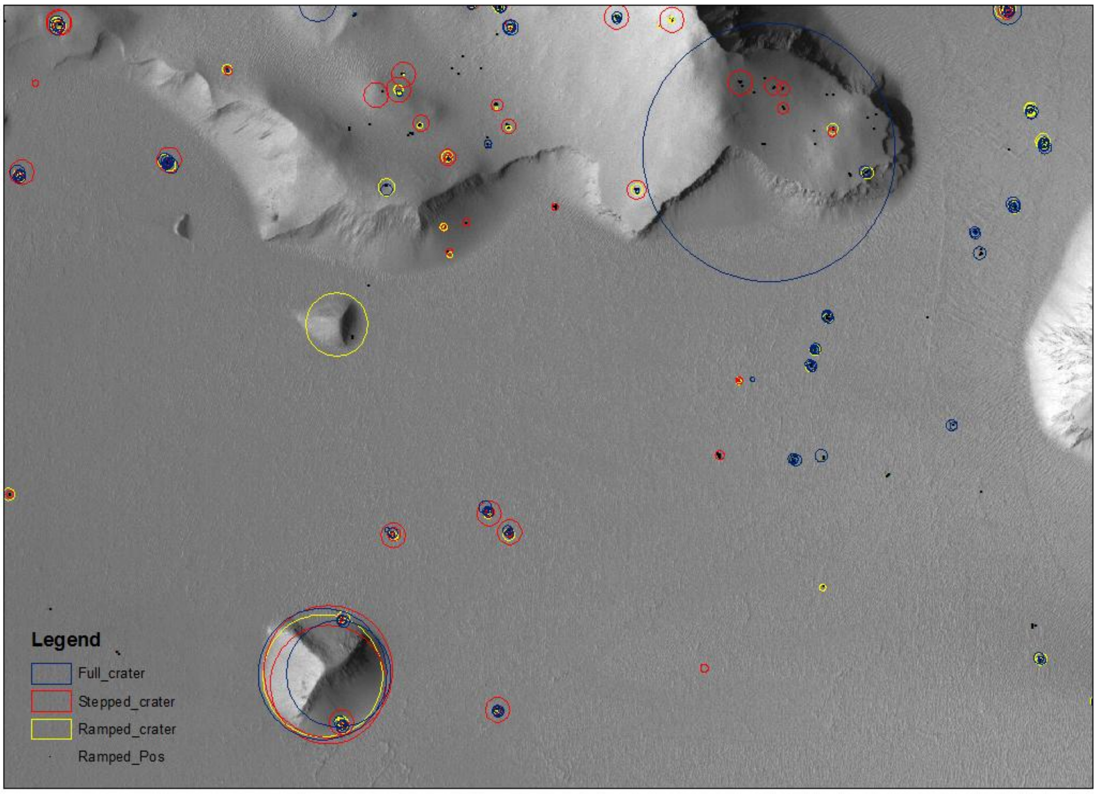


Figure 2 Participant Markings using each Interface, Full (blue), Stepped (red) & Ramped (yellow)

Table 2 shows the crater marking results for each interface, in terms of the number of crater clusters identified (craters marked by more than one participant), the average standard deviation of the cluster centre position and the average standard deviation of the cluster crater diameter in terms of screen pixels (i.e. the level of agreement between participants).

Table 2 Crater Marking Results for each Interface

	Full Interface	Stepped Interface	Ramped Interface
No. of Crater Clusters	182	185	298
Stand. Dev. of Position	2.64 ± 0.35	2.41 ± 0.46	6.28 ± 2.69
Stand. Dev. of Diameter	6.52 ± 0.57	7.70 ± 0.57	5.10 ± 0.44

While participants using the full and stepped interface have identified similar numbers of craters (182 and 185 respectively), it is clear that the ramped interface has resulted in more craters being marked (298, ~61% greater). Similarly, the standard deviation of the central positions is comparable between the full and stepped interface (2.64 ± 0.35 and 2.41 ± 0.46 pixels respectively), whilst the ramped interface has an average standard deviation of 6.28 ± 2.69 pixels. Regarding the standard deviation of crater diameter, the stepped interface is highest at 7.70 ± 0.57 pixels, followed by the full at 6.52 ± 0.57 and ramped at 5.10 ± 0.44.

4. Discussion and Conclusions

This study found that altering the task workflow design of the interface can have an effect both on the user experience and on the resulting VGI data. Regarding the topics of accuracy, tools and imagery, participant comments are comparable in number and predominantly concern the difficulty of marking small craters across each interface. This is perhaps as expected as this issue is more related to the imagery displayed (which is constant in this study) rather than the interface used. However when considering usability, participant comments were much greater in number for the stepped interface and predominantly negative regarding the restriction of choice, as explained by participant S19:

> *"I don't like to be forced to use a certain task order, and I couldn't go back or switch tools…"*

This is in agreement with Hackman & Oldham's findings which suggest that both variety and autonomy are important in ensuring greater job satisfaction.

When considering VGI output, again task workflow design had an effect. The ramped interface resulted in a much higher number of crater clusters being identified, but less agreement in their central position. This is an important result, as reducing the number of null returns (images with no markings) would in turn reduce the time spent on data reduction by the science team, however the greater range of marked position would require extra consideration.

When considering task workflow design, future citizen science platforms involving VGI and remotely sensed imagery will need to perform a balancing act, weighing up the importance of user satisfaction, the data needs of the science case and the resources that can be committed both in terms of time and data reduction, more than likely on a case-by-case basis.

5. Acknowledgements

The first author is supported by the Horizon Centre for Doctoral Training at the University of Nottingham (RCUK Grant No. EP/G037574/1) and by the RCUK's Horizon Digital Economy Research Institute (RCUK Grant No. EP/G065802/1).

6. Biography

James Sprinks is a PhD candidate at the University of Nottingham's Horizon Doctoral Training Centre. He is researching how citizen science platforms, and the 'user' tasks associated with them, can be designed to ensure that the data generated is scientifically robust, while maintaining a user experience that builds the community.

Jeremy Morley is the Geospatial Science theme leader at the Nottingham Geospatial Institute at the University of Nottingham. His research has included the quality of VGI data; presentation of GIS data online; and planetary mapping, particularly of Mars.

Dr Robert Houghton is a Horizon Transitional Fellow and a member of the Human Factors Research Group at the University of Nottingham. He is interested in exploring ways in which Crowdsourcing and Human Computation can be optimised to improve the quality and utility of contributions made by citizen science.

Dr Steven Bamford is a STFC Advanced Fellow and a member of the Centre for Astronomy and Particle Theory at the University of Nottingham. His research focuses on galaxy morphology, structure and environment. He is involved several collaborative projects that involve the coordination and utilisation of Citizen Science.

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