Citizen Science with *CosmoQuest*: Science and Strategies

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Abstract. *CosmoQuest* began as a citizen science portal for online users that would recreate virtually the kind of experience one might have at a research center. Through projects that map craters on the Moon and asteroid Vesta, citizen scientists have shown that accurate, authentic science research can be done through crowd-sourcing. We present comparisons of citizen-analyzed data to those analyzed by planetary scientists and show that there is a high degree of correlation in the results. These projects allow for new science to be done that otherwise could not have been achieved without the help of citizen scientists. These projects are also integrated within a larger virtual environment that provides educational content, media, and community interaction through blogs, forums, online classes, video seminars, teacher resources, and more.

1. Introduction

With the deluge of data coming in from various astronomical observatories, online citizen science is becoming a more valuable method of analyzing data in ways that include the public. Such projects provide an experience in helping astronomical research for anyone with a computer and an internet connection. These can also be used as important education and outreach tools.

*CosmoQuest* aims to be one such place where participants can both learn and do science. The ‘virtual research center’ provides a place to help with research, educational materials for participants to use in learning and teaching, and several methods of communication with the team and with each other.
2. Citizen Science Research

*CosmoQuest* currently has three active science projects, all taking data from NASA missions around the Solar System. Each one provides intuitive interfaces with which users can measure crater sizes and mark surface features to go into a database that is used by project scientists for analysis.

**Moon Mappers** is the longest running *CosmoQuest* project, featuring data from the Lunar Reconnaissance Orbiter (LRO). The main task is “Simply Craters,” a tool that asks users to identify craters and mark their position and size by means of drawing a circle around its rim. The interface and drawing tool is modeled after computer drawing tools that users are already likely to be familiar with. The interface also allows users to mark any unusual features, such as bright or dark albedo regions, boulders, and concentric craters. Moon Mappers reached one million crater marks within its first year of operation. First results show that the combined input of Moon Mappers users compares well with that of experts in the field using their own preferred method or the Moon Mappers interface.

**Asteroid Mappers: Vesta Edition** features images of asteroid 4 Vesta as taken by the Dawn spacecraft during its year-long visit, and uses the same crater marking tools as Moon Mappers and adds a separate “Mark Boulders” feature, since these are abundant on Vesta’s surface.

**Planet Mappers: Mercury Edition** is currently in beta-testing using images from the MESSENGER mission. This interface adds a linear features tool so that users can mark crater chains, scarps, and fissures that are common on the surface of Mercury.

All of these projects are building a database of surface features that will help team scientists understand the nature and history of these planetary bodies.

We find that many (32%) users try more than one project after joining *CosmoQuest*, likely aided by the similarity of the mapping tools from project to project. Almost 89% mark more than one image, and 29% come back for several days of mapping after their first day. We explore the motivations of a sample of these citizen scientists in Gugliucci et al. (2014, this volume).

3. Education

One of the main goals of *CosmoQuest* is to educate users about the science behind the images and citizen science tasks, and about the science of astronomy in general. We are particularly interested in how these tools can be used in classrooms along with supplementary educational materials. With the coming of the Next Generation Science Standards, citizen science can play a key role in introducing students to scientific data and practices.

The *CosmoQuest* Educators’ Zone contains news and resources for formal and informal educators. The first *CosmoQuest* unit, Terraluna, was completed in early 2013 and passed NASA’s Educational Product Review. This three-week unit is aimed at middle school teachers, aligning with the Next Generation Standards and Project 2061 benchmarks, comparing lunar and terrestrial geology.
The unit starts with simple visual comparisons of Earth and Moon surface features, and progresses through several engaging activities from NASA and other sources to explore the geologic complexity of Earth's satellite. Teachers and students working with this unit use the Moon Mappers tools to contribute to the science about which they are learning, and a new mapping activity was created to show how counting craters can be used for relative dating of surfaces. We have presented the material in this unit at several conferences, and in June 2013 ran a five-day teacher professional development workshop where middle and high school teachers in southern Illinois were immersed in the material. The second *CosmoQuest* unit, “In-VESTA-Gate,” will explore asteroid, comets, and meteorites, and is currently in production.

*CosmoQuest* is engaged in outreach efforts through Science on the Halfsphere, a project with the Ward Beecher Planetarium to produce full-dome planetarium shows featuring the unique science being done by the project’s collaborators. All of the products of Science on the Halfsphere are being made available for free under Creative Commons licenses. The first full-length production, *Cosmic Castaways*, explores the galactic collisions that can scatter stars into intergalactic space, and is available for full-dome planetaria and as a flat-screen movie.

Online learning is becoming popular among free-choice learners, and *CosmoAcademy* is catering to that crowd as well. In contrast to large MOOCs (Massively Open Online Courses), *Cosmoquest* runs small, private classes using Google Hangouts. The technology allows for 10 participants, so the class section size is capped at eight to allow for an instructor and possible guest instructor in all classes. These small, intimate learning settings allow for people to learn about basic astronomy or niche topics, such as image processing and black hole physics.

### 4. Social Media and Community

Part of being at a research facility includes attending talks and discussions about new work in the field. *CosmoQuest* fills this virtually with the use of Google Hangouts on Air, a freely available video platform that allows a group of up to 10 participants to broadcast to an unlimited number of viewers while simultaneously recording the event for later viewing. It is, in fact, fortuitous that Google Plus began to roll out this technology while *CosmoQuest* was just starting, as the Hangouts have shaped and guided our outreach efforts considerably.

The weekly schedule of *CosmoQuest*-affiliated programming includes *Astronomy Cast*, a long-running podcast about every topic in the Universe; *Learning Space*, a weekly discussion of science education and outreach topics with special guests; the *Weekly Space Hangout*, a round up of the week’s news in astronomy and space with several scientists and science journalists; and the *Virtual Star Party*, where amateur astronomers share their telescope views with a live audience. Special events with astronomers and other scientists bring content directly to viewers, while hosts help to guide and interpret discussions for the lay audience. In fact, the Dawn Mission Hangout series is one of the most popular, after special events such as the Venus transit and annular solar eclipse of 2012. Audience participation and questions are encouraged for all Hangouts on Air through comment threads. By becoming part of a thriving science communication community on Google+, *CosmoQuest* has gained wider exposure through this platform. Asynchronous communication with fans, friends, and followers also takes place through the *CosmoQuest* blog, Twitter, and Facebook. In 2012,
the *CosmoQuest* forums merged with the Bad Astronomy and Universe Today forums, becoming the most visited astronomy forum on the web.

5. Conclusion

*CosmoQuest* uses a many-pronged approach to reach an audience and create a community of people bent on learning, doing, and teaching science. Particular focus on educational resources, and weekly, virtual seminars are being used to attract teachers to using citizen science in the classroom and building a dedicated group of users who go beyond consuming media to actually participating in the process of scientific research. Plans for the future include expanding on *CosmoQuest’s* citizen science projects to include ground-based telescope observations of astrophysical phenomena beyond the solar system, and expansion of our teacher development efforts with new lesson plans and workshop opportunities.

References