nQuire for the OpenScience Lab: Supporting communities of inquiry learning

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Abstract. We have developed a platform to support Citizen Inquiry activities, based on the nQuire Toolkit software which was originally designed to support inquiry-based learning activities for schools. Citizen Inquiry is an innovative way for learners to engage in practical scientific activities, in which they take the role of self-regulated scientists in informal learning contexts. The platform will be integrated with the OpenScience Laboratory and will allow individuals or groups to create inquiries that rely on virtual scientific instruments for collecting scientifically reliable data. A demonstration inquiry has been created using the Open University Virtual Microscope that enables learners to conduct investigations of lunar geology by studying rare and authentic samples of Moon rock collected during the Apollo programme. Inquiries created using such instruments are intended to arouse a sense of wonder in members of the public, attract learners to science, and build communities of users around non-professional yet authentic scientific activities. This demonstration will show the nQuire authoring tools and the prototype inquiry, focusing on the integration of the scientific tool and features that facilitate collaboration in citizen inquiries.

Keywords: Citizen inquiry, inquiry based learning, nQuire toolkit, OpenScience Laboratory, Geology of the Moon

1 Background (Pedagogy)

The goal of the TEL system presented in this demonstration is to support an innovative pedagogical approach to inquiry science learning: **citizen inquiry** [2]. Citizen inquiry refers to the design and enactment of scientific projects by non-professional scientists within a community of users. From a pedagogical point of view, citizen inquiry follows a similar approach as inquiry based learning [1]; however, citizen inquiry is driven by personal interest and is not related to a course curriculum.

At the same time, citizen inquiry integrates elements of open science [4] and citizen science [3]. Citizen inquiry shares with the latter the emphasis on involving members of the public who may have not received training as researchers.

However, citizen inquiry aims at developing their interest in science by making them responsible for the planning, management and realization of complete scientific projects.

Supporting citizen inquiry poses a number of interesting research challenges:

- **Challenge 1: Learners' motivation**. Citizen inquiry does not have the inherent motivation of inquiry based learning activities, nor that of citizen science projects. Our goal is to generate motivation through the creation of a user community that includes people interested in science with widely varying levels of expertise. Interaction with other users, the oportunity of helping or receiving help from experts, collaborative inquiries, and recognition within the citizein inquiry community are some of the features that are expected to motivate participants to join the community.
- **Challenge 2: Adopting a process of inquiry**. Supporting users through inquiry processes is a relevant problem of inquiry based learning. In citizen inquiry, in which the figure of a teacher or tutor is absent, the same issue may be problematic. This is related to one of the learning goals behind citizen inquiry: to facilitate learners acquire an understanding of scientific methodologies.
- **Challenge 3: Supporting scientifically relevant activities**. While our goal with respect to citizen inquiry is to facilitate learning, we are interested in enabling non-professionals to carry out scientifically relevant and accurate research. The objective is not necessarily to produce original researches, but to motivate participants.

These challenges have been tackled by the development of a TEL system. To demonstrate these features, a first prototype of a citizen inquiry has been created: the *Moon Rock Explorer*. It is an open, self-regulated investigation of lunar geology, designed for learners without large experience in Geology.

2 Background (Technology)

To support citizen inquiry activities, several extensions to the nQuire Toolkit have been made:

- **Integration of scientific instruments**. nQuire is currently being integrated with the OpenScience Laboratory (OSL). The OSL will provide access to virtual and remote scientific tools, such as virtual microscopes, Treezilla, the PIRATE remote telescope, and physics equipment to conduct experiments. These intruments allow the collection of valid scientific data, which can be used in the frame of scientific research. Additionally, all the instruments can be accessed using a web browser; some of them will be used exclusively in university modules, while others will be open to the general public. Application Programming Interfaces are being developed and tested to enable the creation of inquiries through the nQuire Toolkit that make use of these instruments to collect data. Figure 1 shows the Virtual Microscope

data collection interface within nQuire, which is used in the *Moon Rock Explorer* inquiry to investigate four samples of Moon rock collected by Apollo astronauts.

- **Support for collaborative self-regulated inquiry**. The *Moon Rock Explorer* is an individual activity. Nevertheless, it includes support for interaction between users: they can share their investigations (including research questions, data, results, and conclusions) through automatically create forum topics. This feature is designed to facilitate the discussion of investigations, enabling experts to support participants, etc.
- **Support for self-management of inquiries**. The current version of nQuire allows any user registered in the system (not only teachers) to create their own inquiries, with any of the available scientific instruments. They can decide to share them with friends, or with anyone in the system. Each participant in an inquiry can be assigned to roles (e.g., *Project leader*, *Data collector*, etc.) to control the access to each inquiry activity. The authoring tool is designed to support the creation of inquiries with features of inquiry based learning activities, citizen science projects, and citizen inquiry.

The integration of nQuire with the OpenScience laboratory requires the definition of a series of Application Programming Interfaces (APIs) that enable communication between scientific instruments and nQuire. Currently, as shown in this demonstration, only the Open University Virtual Microscope has been linked to nQuire.

3 Results and outcomes achieved

The first prototype of the *Moon Rock Explorer* inquiry has been evaluated with PhD students in an informal learning context. The evaluation is described in [2]. The goals of the study were to assess the relevance of the challenges discussed in Section 1, and the technological support described in Section 2.

The evaluation showed that the nQuire Toolkit provides adequate support for citizen inquiry, even when the figure of the teacher is no present. Similarly, the results indicate that the integration of the Virtual Microscope, shown in Figure 1, was also successful. The feedback provided by the participants allowed us to improve the virtual microscope data collection interface, and points us to new features to support motivation and user interaction.

The evaluation has thus served to validate two parts of the system: inquiry process guidance, and access to the Virtual Microscope. Based on these results, we will proceed to integrate further scientific instruments. The evaluation has also provided insights as to the requirements to support community building around scientific inquiry, which are leading to further improvements of the system.

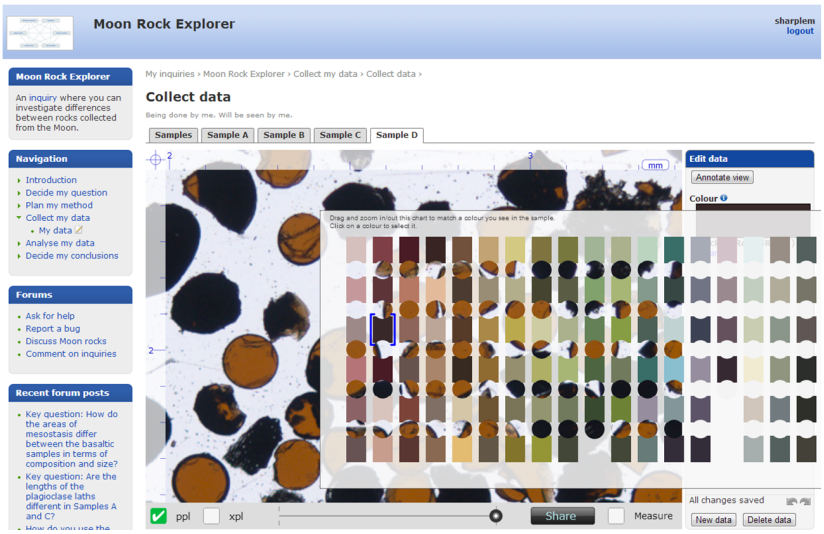

Fig. 1. Virtual Microscope data collection interface in nQuire

4 Demonstration outline

The demonstration shows the complete nQuire Toolkit system integrated with the OpenScience Laboratory. The first part of the demonstration will focus on the authoring tool, including: (1) Structuring citizen inquiry by creating phases and activities; (2) Creating data collection activities that integrate external scientific instruments; and (3) Specification of collaboration modes, including management of groups and participants roles within the inquiry.

The second part will deal with the runtime system. To illustrate it, the *Moon Rock Explorer* inquiry (see Section 3) will be presented. The demonstration will show briefly the whole process that the learners may go through, including the investigation of Moon rock samples using the Virtual Microscope.

The guests will be able to use the system, taking two different roles: inquiry designer, and inquiry participants.

References

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5 Specific Technology and Environment needed at conference

The demonstration will cover two complementary systems: an authoring tool, and the runtime system. It is posible to show both systems using one computer, or two computers. Therefore, there are two possible configurations to run the demonstration:

- Option 1: using two computers:
  - One laptop (provided by the presenter).
  - One large screen for the laptop.
  - A second computer, including keyboard, mouse and screen.
  - Internet access to enable the second computer connect to the laptop.
- Option 2: using a single computer:
  - One laptop (provided by the presenter).
  - One large screen for the laptop.

Under both options, the laptop will be provided by the presenter; we kindly request the rest of items.