Experizone: Integrating Situated Scientific Experimentation with Teaching of the Scientific Method

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ABSTRACT

Citizen Science projects ask their participants to contribute work to pre-defined topics, thereby typically rendering the participants as mere consumers of often narrowly defined tasks. In this work-in-progress paper, we present our work on an interactive experimentation platform that allows anybody – researchers as well as members of the crowd – to run experiments and test scientific hypotheses with a local crowd of volunteers. The platform also enforces a lightweight review process for teaching its users how to formulate valid scientific hypotheses and experimental designs.

CCS CONCEPTS

• **Information systems** → **Crowdsourcing**; • **Human-centered computing** → *Computer supported cooperative work*; *Collaborative and social computing systems and tools*; • **Applied computing** → **Collaborative learning**;

KEYWORDS
Citizen Science; Crowdsourcing; Human Subjects Research

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INTRODUCTION

Citizen Science [7] has enjoyed immense success, and Web platforms for Citizen Science are proliferating. From counting birds in eBird [21], identifing galaxies in Galaxy Zoo [11], folding protein structures in FoldIt [2] to mapping the brain by tracing neurons in EyeWire [22], users of Citizen Science platforms can engage with a wide range of research activities. The users of these platforms accumulate data, produce novel insights, foster a sense of community and learn in the process. For example, "green pea" galaxies were collaboratively identified and named by the contributors of Galaxy Zoo [1]. Citizen Science projects primarily engage the cognitive capabilities of humans or use citizens as sensors [5, 9]. Common to these projects is that they ask participants to contribute to a pre-defined piece of work, thereby casting the participants as consumers of often repetitive tasks.

The majority of Citizen Science projects can be thought to be contributory, allowing only for limited communication and interaction between researchers and citizen scientists [15]. Further, the tasks on these platforms are predominantly defined by and for the benefit of researchers. This is naturally not a problem in itself, as citizen science projects have clearly been successful in pushing the boundaries of science. Yet, we argue a similar model, employed locally in a situated fashion instead of online, may offer distinct benefits to audiences such as higher education students.

In this work-in-progress paper, we describe *Experizone*, a platform for guided experimentation with situated crowds in a higher education context. Experizone allows anybody to run experiments with a pool of situated volunteers who provide their own labour for the currently available set of tasks. The tasks, or hypotheses, are entered into the system following a scaffolded wizard-like process, and before a given hypothesis goes live, it goes through a lightweight peer review process by other registered experimenters and the administrators of the platform. Therefore, the platform also serves a pedagogical purpose of helping its users to learn how to formulate valid scientific hypotheses and how to design testable scientific experiments.

RELATED WORK

Despite the uncertainties and risks of involving the crowd in research [10], crowdsourcing has been explored as a tool for research. A number of online projects involve people in complex research, beyond mere contribution of data points, e.g. the Polymath [3] and Crowd Research [23] projects.

Earlier projects have focused on conducting experiments with the crowds. Reinecke's LabInTheWild [20] is an online experimentation platform that allows for running arbitrary experiments with uncompensated samples. The platform profits from the serendipitous availability of online surfers who like to engage in fun activities, simply to kill time. Similar motives for participation are evident in Virtual Citizen Science projects [19] and Games with a Purpose [24]. Experiments on this platform are, however, created by researchers, not by users.

GutInstinct [17] by Pandey et al. is a similar online experimentation platform in the context of research on the human gut microbiome. The platform enables anybody to enter hypotheses and run experiments with volunteers. The hypotheses are entered in a scaffolded way and are peer-reviewed by other users of the platform. Docent [18] is a system by the same authors that firmly incorporates pedagogical resources into the experimentation platform to educate participants. Both systems aim therefore to integrate Citizen Science with online learning.

Online Feedback Exchange systems [4] and *crowd-feedback systems* [13, 25] often ask the crowd to provide their feedback in scaffolded form. A scaffold is structuring the feedback in a way that even "novices" (i.e. users without domain expertise) can give useful feedback. It has been demonstrated that structure in the form of scaffolds and rubrics can improve the feedback from the non-expert crowd [8, 14, 16, 26].

Experizone publicly facilitates

(1) *Inquiry:* it allows anybody to ask scientific questions in form of testable hypotheses to be verified in experiments with the situated crowd,
(2) *Learning:* it teaches people to formulate scientific hypotheses,
(3) *Knowledge base:* it provides a pool of hypotheses and completed experiments for others to browse, analyse and learn from,
(4) *Running experiments:* it facilitates the execution of situated experiments drawing from a pool of volunteers, and
(5) *Self-improvement:* it feeds the new-found knowledge back to the volunteers and to the requester.

EXPERIZONE

Experizone is a platform for scientific experimentation with a situated crowd. The platform serves five purposes (see sidebar). Its key distinction to most of the related work is that the platform allows not only researchers, but anybody to run scientific experiments. Further, Experizone exploits situated technology, namely tablet-sized public displays, to tap into people's free time, their cognitive surplus, for a worthy scientific cause while also teaching them about the scientific method.

Conducting an Experiment

We clarify the process of running an experiment with the Experizone platform from the perspective of a persona: *Anna*, a scientist interested in research on mobile devices. Suppose Anna wants to investigate the influence of cold weather on the use of mobile devices. Anna's intuition is that cold weather significantly reduces the task performance on smartphones. This exact experiment was conducted as a scientific study by researchers of the University of Oulu [12]. Anna posts a description of her experiment on the Experizone platform using Experizone's home page where she has registered as an experimenter already earlier. The online experiment submission wizard guides Anna through the multi-step process that helps Anna in describing her experiment. Essentially, the wizard informs Anna of what is a valid research question, what is a good hypothesis, and how to formulate the overall experiment and hypothesis so that it can most likely be tested by the local student population. The

experiment is then sent for a lightweight peer review to the other registered experimenters in the platform as well as the platform administrators. This review consists of a binary "valid/invalid" choice and a text fields for entering comments.

This review process is supported with rubrics that will help especially the other registered experimenters in peer-reviewing the new experiment and verifying that the experiment can be conducted in the first place, *i.e.*, that the hypotheses and research question are clear and testable. The peer review teaches the volunteers to review and give useful feedback. The results of the review are released by the platform administrators. If no fatal flaws are found, the experiment goes live automatically. If the experiment was found as misleading or poorly formed, Anna is emailed via the system to edit and resubmit the experiment.

After her experiment goes live, it can be seen on the public display's opening screen, where open tasks are depicted for volunteers to start working on. Initially, we only support tasks that can be answered *in-situ*, using the public display itself. Over time, the results are summarized and reported to Anna (in the form of a spreadsheet) and also published on the platform.

The platform will afford two modes of participation in experiments (see sidebar). Ultimately, our goal is to integrate Experizone into the array of services provided by the on-campus library that has already agreed to collaborate with us by promoting the deployment.

Modes of participation

- *Unsupervised experiments*: participants can partake in the experiment on their own time. In this case, the participants self-report on their results and these results are gathered and presented in the system.
- *Supervised experiments*: participants meet the scientist at a certain location and time. The experiment is conducted and managed *in-situ* by the scientist. In this case, results are collected by the scientist.

CONCLUSION AND RESEARCH DIRECTIONS

Experizone is essentially designed to engage higher education students in science and to teach them the basics of the scientific method in a fun way. Experizone motivates volunteers to contribute towards science in multiple ways: 1) by asking questions, 2) by peer reviewing experiments and hypotheses, 3) by participating in studies, and 4) by viewing results.

Our progress thus far is limited to several discussions about the details, feasibility and the concept itself with the library staff and getting permissions to be able to deploy Experizone on the campus as a (hopefully) permanent addition to the library's public services. We have purchased the necessary public displays – Android tablets and adequate enclosures and stands for them – and are working on the backend as well as front-end concepts during software and project -oriented courses, to co-create Experizone with its actual intended end users. We are reusing much of the backend logic from situated crowdsourcing deployments created earlier in our lab (namely [6]) and are confident we can perform the first longer field studies during late 2019.

Our first main research direction with Experizone is to investigate how will higher education students use the platform: What type of questions and hypotheses, if any, will they formulate? Another important area of research is how participation can be incentivised and how the value proposition of the pedagogical component of the platform can be made clear to prospective users.

The potential implications and benefits of our work for the CHI community are as follows. Experizone will be an innovative scientific experimentation platform available for running situated experiments to anyone in the world (via an API and online form). For example, one could run experiments with Finnish students and compare the results with Japanese students. Assisted and guided experimentation will help novices in formulating their hypotheses and running rigorous scientific experiments. The platform therefore has a strong pedagogical component. Lastly, the knowledge base of hypotheses, experiments and the record of their outcomes will be of value to the scientific community.

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