Citizen Science as a Tool to Increase Students' Data Literacy and Self-Efficacy in the Online STEM classroom

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Curricular materials available at: https://classroom.zooniverse.org/#/

CITIZEN SCIENCE IN THE UNDERGRADUATE CLASSROOM

General education STEM courses for undergraduates are often non-science majors' **last formal exposure to science and scientific inquiry**. For this reason, it is critical that these courses engage students deeply using a variety of active learning strategies.

Citizen science projects give non-scientists an opportunity to participate in scientific research. This emphasis on active participation means that they are an excellent method with which to engage students in a classroom setting. The practical experience gained by participation is above and beyond what can be achieved in a traditional lecture, and **promotes student engagement and problem solving skills** (Coleman & Mitchell, 2014, Shah & Martinez, 2016, Vitone et al., 2016).

Online citizen science projects are particularly well suited to classroom use. They do not require external field trips, specialized equipment, or extensive training, and as such greatly reduce the costs associated with performing scientific research (Nov, Arazy, & Anderson, 2014).

Curated repositories of citizen science projects, such as **The Zooniverse**, make it easier than ever before for teachers to bring these research experiences into the classroom. With this work, we introduce a **novel approach to developing classroom curricula that incorporates participation in citizen science as a fundamental component**.

CURRICULAR MODEL

We created a 3-part curricular model with an emphasis on **data literacy** for the online, undergraduate STEM classroom:

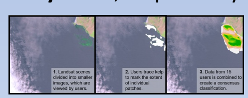
Part 1: Active learning activity that provides students with the opportunity to **develop representational competence** and essential background knowledge of the discipline (lecture-tutorial).

Part 2: A science investigation that empowers learners to explore real data from the forefront of active research in STEM, and allows them to **make contributions to the science communi**ty (citizen science).

Part 3: Data analysis activity that guides students to **engage in critical reasoning, while making evidence-based conclusions** in pursuit of answers to contemporary science questions.

HIGHLIGHTED PROJECTS

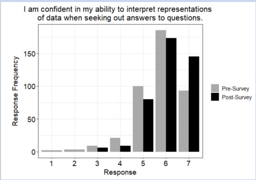
We utilized our curricular model to develop a curriculum based around 2 projects on the Zooniverse platform: **Planet Hunters and Floating Forests** to teach students about the **transit method for discovering exoplanets** (planets orbiting distant stars), and the **impacts of climate change on ocean ecosystems**, respectively.



RESULTS FROM NATIONAL STUDY

Our evaluation of the effectiveness of the curriculum focused on understanding **students' self-efficacy** as it related to their ability to **participate in the process of doing science** while using **data to inform scientific understanding**.

Fig 1: When asked about their ability to interpret data, students who utilized our curriculum trended more confidently after completion of the Planet Hunters or Floating Forests activities.



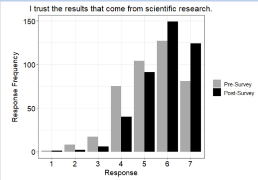
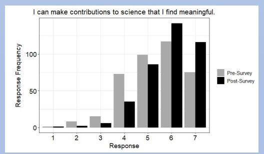


Fig 2: When given the opportunity to interpret unmanipulated datasets themselves, students who utilized our curriculum were more likely trust the results that come from scientific research.

Fig 3: When asked about their ability to make meaningful contributions to science, students who utilized our curriculum were more likely to strongly agree that they could participate in science, despite being overwhelmingly non-science majors.



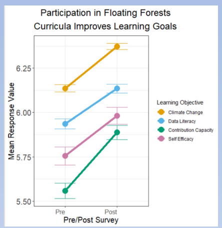


Fig 4: For the floating forests assessment in particular, we sorted our questions into 4 factors (climate change understanding, data literacy, ability to contribute to science, and general self-efficacy). We saw statistically significant improvements across all 4 factors after students completed the Floating Forests curriculum.

METHODS & PARTICIPANTS

We developed a **Likert-style survey** loosely inspired by Estrada-Hollenbeck et al., 2011 and Coburn, 2001. Each of these items were **rated on a scale of 1 (*strongly disagree)* to 7 (*strongly agree)*.** A majority of the questions were asked in a pre-post-test fashion, at the beginning of the semester (pre) and then again within a week after the curriculum was implemented in the classroom (post). Four items were only asked as part of the post-test, as they focused more specifically on students' perceptions of the activity's potential impacts.

We tested our Floating Forests and Planet Hunters curriculum with **N = 2,504 students** enrolled in introductory astronomy or geoscience courses at **12 institutions of higher education.** The pilot testing took place during the Fall 2020 and Spring 2021 semesters. As a result of the COVID-19 pandemic, **all pilot courses were taught online**.

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