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INVESTIGATING THE EFFICACY OF CITIZEN SCIENCE THROUGH A SEED COATING PROJECT

SUMMARY

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Investigating the efficacy of citizen science through a seed coating project

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Abstract

This case study explores the effectiveness of citizen science as a public engagement tool through a seed coating project. Conducted across seven events, including university open days and public science festivals, participants planted sunflower seeds and reported germination time and seedling height as a way to involve them in scientific research. Participants reported greater interest, confidence, and engagement with science, particularly in feeling that people like them could be scientists. These findings support the use of citizen science to enhance science capital in both prospective university applicants and the general public.

Keywords: Citizen science, public engagement, science capital, seed coating.

Background

Citizen science is a way of conducting scientific research that is carried out by members of the general public (Roche et al., 2020) and is considered a valuable tool in the field of science education through its ability not only to increase the scientific communities' data collecting capacity, but also to empower citizens into engaging with the scientific communities around them (Bonney et al., 2009; Winther, 2022). On a larger scale, citizen science projects have the potential to address complex and pressing societal challenges, from environmental conservation to public health (Ham & Kobori, 2022).

Intervention: Seed coating citizen science project

Plants need nutrients for healthy growth, with zinc being essential for key cellular functions (Fariduddin et al., 2021). 50% of farmland is zinc-deficient, lowering yields and quality. Conventional fertiliser use often leads to nutrient loss through run-off and leaching. Seed coating offers a targeted alternative and can improve handling, regulate

germination, and deliver micronutrients directly to seedlings. This sustainable technique enhances crop yields, seed viability, and input efficiency (Javed et al., 2022, Rocha et al., 2019).

Participants were provided with 3 treated seeds and 3 untreated seeds. They were then instructed to fill two 6.5cm plant pots with standard peat-free compost sourced from a DIY store. Labelled lollipop sticks identified the pots as “treated” and “untreated”, and the participants were instructed to plant the respective seeds in each. Participants were provided with a paper bag to transport their plant pots, which also included a participant information sheet, an instruction sheet for plant care and how to collect data, and a postcard to record results. After day 15, participants were directed to an online survey via QR code to input their results and answer questions regarding their experience.

Methods

Events

Participants were invited to be involved in the citizen science project at public engagement events and Sheffield Hallam University Open Days. The family-focused public engagement event was “Explore!”, which occurred on the 18th of March 2023. Adult-focused public engagements were “Live Late: Blue Science Sky to Sea” on the 16th of March 2023 and “Live Late: The Craft of Science” on the 14th of March 2024. Applicant events were Sheffield Hallam Open Days on the 25th of March 2023, 22nd of April 2023, 25th of February 2024 and the 23rd of March 2024.

Evidence collection

The seed coating citizen science project was undertaken at 7 events. A large family-focused public engagement event, two adult-focused public engagement events and 4 Biosciences and Chemistry Applicant Open Days. At these events, 236 citizen science seed packs were distributed, with 46 participants opting into the study and recording information about their seeds as well as the impact of the experiment (19% opt-in rate). Survey questions included details of seed germination and growth, as well as the impact on the participants’ view of science and themselves as citizen scientists.

Participants in the citizen science project were across a wide age range, with 10 participants under 16 years old, 3 participants aged 17-18, 16 participants aged 19-25, 8 participants aged 26-45, 6 participants aged 46-65 and 3 participants over 65 years old.

Data analysis

Questionnaire data was collected in a Google Form and transferred into Excel for analysis. Germination height at day 15 and germination as a function of time histograms were constructed in Python, data distributions were subject to Kolmogorov-Smirnov testing using the SciPy stats library. Likert plots were generated for the questionnaire responses using the Likert plot library, the potential differences between events were investigated using Kruskal-Wallis tests.

Ethics

Ethical oversight of the project was provided by Sheffield Hallam University (ER56235941).

Results

When participants submitted their data to the study, they were asked several questions on how the project had impacted them. The questions were on a Likert-type scale, with options of “strongly disagree”, “disagree”, “neutral”, “agree” and “strongly agree” available. To determine if the type of event participants attended altered the impact of the citizen science experiment, bivariate analysis was undertaken with the categories of public engagement: family-focused, public engagement: adult-focused and applicant open day (Figure 1).

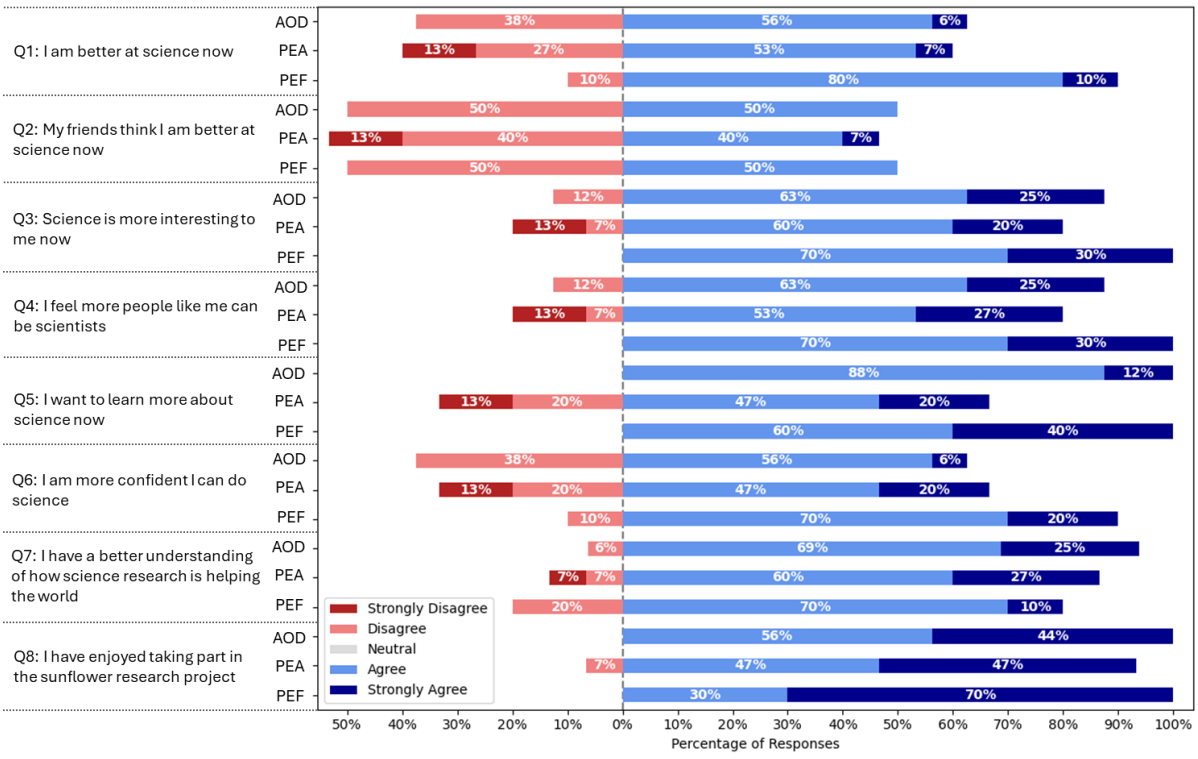

Figure 1: Impact of citizen science experiment on participants. Participants were asked, "Think about the seeds experiment… **Q1:** I am better at science now, **Q2:** My friends think I am better at science now, **Q3:** Science is more interesting to me now, **Q4:** I feel more people like me can be scientists, **Q5:** I want to learn more about science now, **Q6:** I am more confident I can do science, **Q7:** I have a better understanding of how science research is helping the world and **Q8:** I have enjoyed taking part in the sunflower research project. Applicant open day (AOD) n = 16, Public engagement family-focused (PEF) n = 10, Public engagement adult-focused (PEA) n = 15.

Over 95% of participants stated that they enjoyed taking part in the sunflower citizen science research project (100% applicant open day, 93% public engagement adult-focused and 100% public engagement family-focused participants respectively). The majority of participants stated a positive impact of their involvement in the project in terms of their confidence that they can do science, their interest in science and wanting to learn more about science, as well as feeling that people like them can undertake science. Finally, over 60% of participants reported that they felt better at science after taking part in the citizen science experiment (62% applicant open day, 60% public engagement adult-focused and 90% public engagement family-focused participants respectively), and approximately half of participants felt their friends thought they were better at science (50% applicant open day, 47% public engagement adult-focused and 50% public engagement family-focused participants respectively).

Applying a Kruskal-Wallis test to the questionnaire data suggests that there is no significant difference between the event types.

The results of the germination and growth of the seedlings are reported in Appendix 1.

Conclusions

Here, we undertook a small-scale citizen science project over a range of public engagement events and university open days. Of the visitors to these events who engaged with growing sunflower seeds, 19% completed the questionnaire and reported their results.

The seed growing experiment described here is a simple way to engage university applicants and the public in a discussion about agriculture and sustainability, and the biology and chemistry of plant science. The activity proved a valuable opportunity for involving the public and young people in a hands-on scientific experiment.

The impact of being involved in the citizen science project on participants was developed using the science capital framework (Archer et al., 2015). Involvement was seen as an enjoyable experience, with a positive impact on participants in terms of their confidence and interest in science, as well as participants reporting they want to learn

more about science after the event. The citizen science project had a positive impact on increasing participants' feelings that people like them can undertake science. However, only a modest impact was seen in participants being better at science after the experience, either by themselves or their friends. This increase in science capital mirrors previous work, where participants at an adult-focused public engagement event increased science capital, specifically dimensions of science-related social capital and science-related cultural capital (Lacey et al., 2023).

Walker et al. (2021) review the impact on participants involved in citizen science and state, “Studies that investigated whether or not participants and communities actually benefitted from involvement, or experienced negative impacts, were uncommon”. Here, we have demonstrated the positive impact of a small-scale seed-based citizen science project on its participants, adding to the current literature.

Although the results reported showed no statistical difference between coated and uncoated seeds, many variables could affect the outcome of the experiment, including, not least, variations in the planting of the seeds at the events, and the conditions in which the seeds were grown by the participants at home, e.g. temperature, location and regularity of watering.

Limitations

This is a small-scale study with 46 participants. This limits the power of statistical analysis between different participant groups and the germination and growth of the seeds themselves.

Conflicts of interest

The authors have no conflicts of interest to report.

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Appendix 1: Seed coatings increase germination and seedling height

Citizen scientists were invited to plant uncoated and coated sunflower seeds and report the day when the seedling became visible (which we will use here as a proxy for germination) and the height of the seedling 15 days after planting (Figure 2).

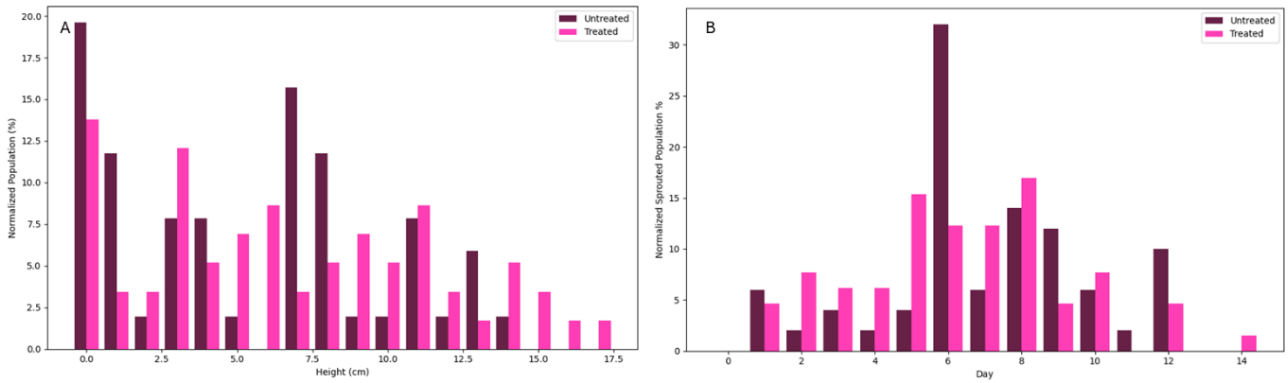

Figure 2: Germination and growth of uncoated and coated seedlings. A: Seedling growth after 15 days as reported by citizen scientists (uncoated n = 34, coated n = 46)**.** **B**: Day seedlings became visible after sowing (as a proxy for germination) as reported by citizen scientists (uncoated n = 60, coated n = 73).

A modest decrease in the time taken for coated seeds to germinate compared to uncoated seeds was seen. A small increase in the height of the coated seeds 15 days after planting, compared to uncoated seeds, was seen. Applying the Kolmogorov-Smirnov test and a t-test analysis to both the height of seedlings on day 15 and the germination rate, no statistically significant difference between the distributions was observed.

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Knowledge Applied