



Efficacy of STEM Education and Outreach Programs at Biosphere 2

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Summary

Biosphere 2 (B2), owned and operated by the University of Arizona, has two primary missions: earth systems research and education.

- ❖ Earth systems research: examining the effects of various agents, such as climate change and environmental changes brought by humans, affect the natural ecosystem.
- ❖ Education: Teaching the general public about B2's research findings and educating them on the impact these findings have on their community and/or the world.

Objective- This study comprises a program evaluation of the efficacy of Biosphere 2's education and outreach programs. The two related programs evaluated are the Summer Science Academy (SSA) programs for middle school and high school students and the Outreach Scholars (OS) program for college-level participants.



Photo of the Biosphere 2 campus at sunset.

Results

SUMMER SCIENCE ACADEMY

1.Question: How does Summer Science Academy influence students' attitude on being scientists?

- No effect on the middle school group's attitude on being scientists $t(20) 0.57, p = 0.576$
- No effect on the high school group's attitude on being scientists, $t(27) 0, p = 1.00$

2. Question: Are students able to better understand the scientific method process by the end of the program?

- No difference in the middle school students' initial ranking of the steps of the scientific method compared to their ranking at the end of the program $t(20) -1.41, p = 0.17$.
- No difference in the high school students' initial ranking of the steps of the scientific method compared to their ranking at the end of the program $t(27) -.69, p = .496$.

3. Question: Are students able to develop their presentation skills while at SSA?

- More middle school students rated feeling comfortable presenting in front of an audience by the end of the program, $t(19) 2.85, p < .01$.
- No change in the high school students rating on feeling comfortable presenting in front of an audience by the end of the program, $t(27) 0.49, p = 0.626$ (Figure 1)

OUTREACH SCHOLARS

1.Question: How does the experience of working with SSA students affect the level of confidence in the OS to communicate science and scientific terms efficiently to a younger audience?

- The experience with the first group of SSA students did not increase the level of confidence in the Outreach Scholars' ability to communicate science and scientific terms efficiently to a younger audience, $t(11) -0.61, p = 0.555$.
- Results for the high school group were omitted due to an error in the delivery of the question for this survey.

2. Question: How well do the OS perceive the training has prepared them to mentor SSA

- The training provided to the Outreach Scholars was effective in increasing the Outreach Scholars' perceived ability to mentor the summer science academy students, $t(12)=5.10, p<.001$. (Figure 2)

"I Feel Comfortable Presenting in Front of an Audience."

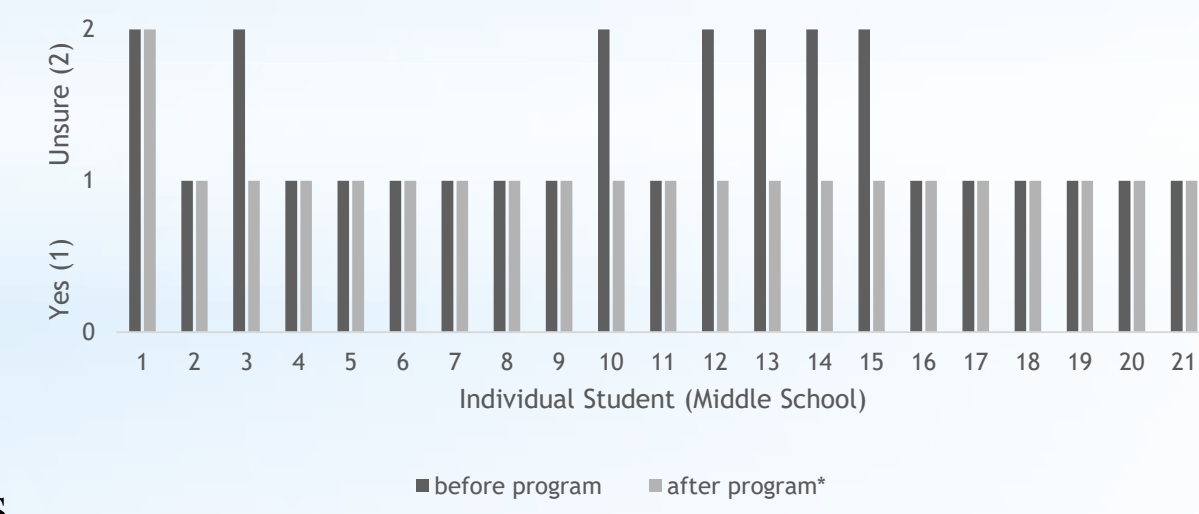


Fig. 1: Middle school students rated feeling comfortable presenting in front of an audience by the end of the program. *Question changed to open-ended format.

Ability to Mentor SSA Students



Fig. 2: Outreach Scholars' perceived ability to mentor SSA students after their training.

Although not a significant change, 29% of the middle school group ranked all steps correctly at the beginning of the program, compared to 41% at the end of the program. 28% of the high school group ranked all steps correctly at the beginning of the program, compared to 31% at the end of the program.

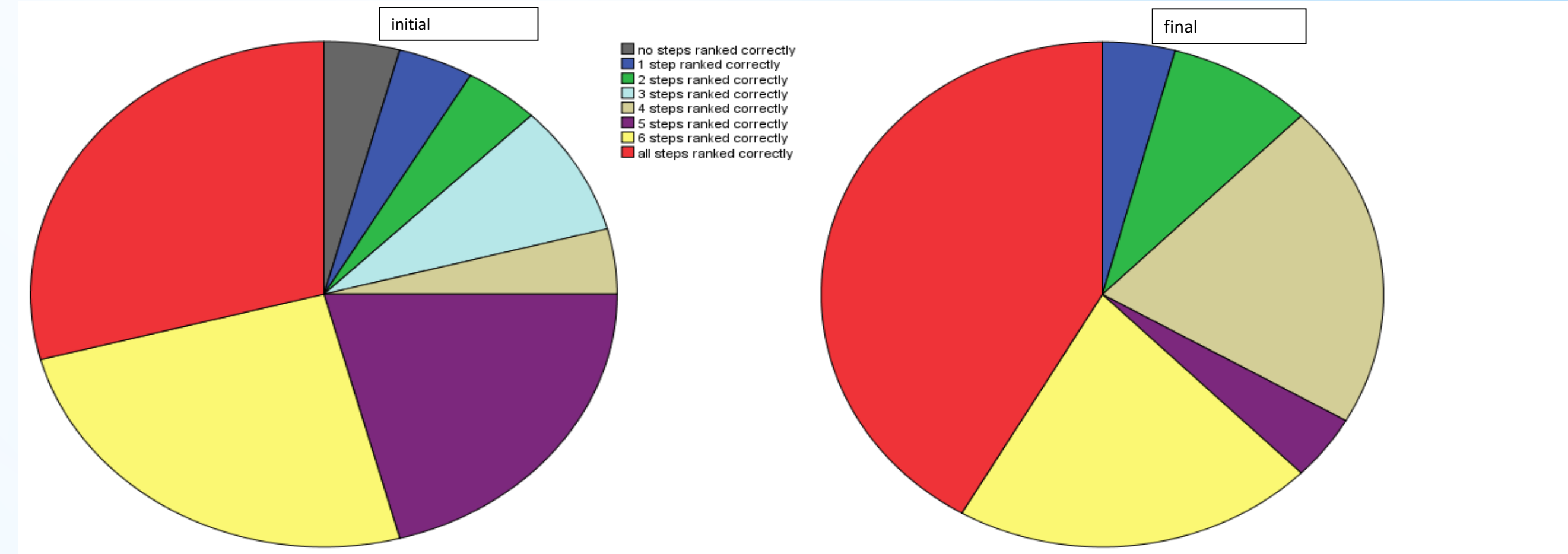


Fig.3: Number of steps ranked correctly by middle school students

Discussion

Through a survey evaluation and t-test analyses, Biosphere 2's Summer Science Academy program was found to be successful in increasing the number middle school students that felt comfortable presenting in front of an audience by the end of the week. Biosphere 2 was also successful in its Outreach Scholars training program by increasing the level of confidence in the scholars' ability to mentor the SSA students.

This study did not find any significant results in the students' attitude on being scientists or the students' increased understanding of the scientific method, possibly due to the small sample size or the way in which the questions were presented.

Applications

The purpose of Biosphere 2's education and outreach programs is to increase the general population's awareness and knowledge of earth systems research as well as to cultivate young minds into becoming the leaders of tomorrow. As outlined in the web article, *5 Ways Public Speaking Can Drastically Improve your Life* by Nathan Swan (2017), "[i]n public speaking, you learn to present yourself with strong body language, sincere tonality and engaging eye contact. This enriches your everyday interactions and results in higher quality business relationships, friendships and marriages." Biosphere 2's Summer Science Academy is able to fulfill its purpose by significantly increasing the participants' confidence in presenting in front of an audience.

Future Recommendations

It is recommended that for future research on Biosphere 2's Summer Science Academy and Outreach Scholars programs, the focus becomes on identifying and describing the aspects of the programs Biosphere 2 would like to focus on for assessment by "specifying the domain of the construct," as outlined in a presentation by Azra Dedic on Gilbert A. Churchill's (2017) framework for validating measures.

References

- Churchill, G. A. (2017, August 26). *A PARADIGM FOR DEVELOPING BETTER MEASURES OF MARKETING CONSTRUCTS*. Lecture.
- Swan, N. (2017, May 06). *5 Ways Public Speaking Can Drastically Improve your Life*. Retrieved August 2, 2017, from <https://magneticspeaking.com/5-ways-public-speaking-can-drastically-improve-your-life/>

Materials and Procedures:

- 1. SSA-** A survey was administered to each student as they arrived on B2 campus on their first day of SSA and was administered again in the morning of their last day of SSA before their final presentation. A paired-samples t-test was used to analyze the responses between each student's initial and final survey.
- 2. Outreach Scholars-** A survey was administered to each OS before and after their initial training, as well as after each week of SSA ended. A paired-samples t-test was used to analyze the responses between each Outreach Scholar's initial and final survey.

Outreach Scholars (left) and Summer Science Academy high school students (right) completing their surveys.



Summer Science Academy participants (left) in the Land Evolution Observatory (LEO) experiment group measure the changes in soil humidity affected by the terracotta olla balls placed inside the soil samples (right).



Summer Science Academy participants (left) present their research results to their families.



Outreach Scholars (left) and a Summer Science Academy participant (right) admire some of the inhabitants of the Biosphere 2 campus.

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