Evaluating the High School Lunar Research Projects Program

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The Center for Lunar Science and Exploration (CLSE), a collaboration between the Lunar and Planetary Institute and NASA's Johnson Space Center, is one of seven member teams of the NASA Lunar Science Institute (NLSI). In support of NASA's and NLSI's objective to train the next generation of scientists, CLSE's High School Lunar Research Projects program is a conduit through which high school students can actively participate in lunar science and learn about pathways into scientific careers. The High School Lunar Research Project engages teams of high school students in an academic year-long, authentic lunar research experience that envelopes them in the process of science. Teams of students from across the country conduct lunar research under the guidance of a lunar scientist mentor. This mentorship takes place remotely which enables teams who are geographically distant from lunar scientists to participate. Over the first three years of the program, 152 students from 21 schools from rural, urban, and suburban communities, including underserved/underrepresented communities, have participated in the program .

Evaluation Instruments

Does this research experience increase students' knowledge of lunar science? Does this research experience make a positive impact on students' attitudes toward science? Does this research experience change students' views on the nature of science? We developed or modified three instruments to evaluate the extent to which the High School Lunar Research Projects answers these questions. The nature of science instrument (Fig. 1) is a modified version of the Views of Nature of Science Questionnaire developed by Lederman et al. (2002). The science attitudes Likert-scale instrument (Fig.2) is a modified version of the Attitudes Toward Science Inventory developed by Gogolin and Swartz (1992). The lunar science content instrument (Fig. 3) was developed by CLSE education staff. All three instruments are administered to students before and after their research experience online via Survey Monkey®. The program was piloted during the first year and focus was placed on developing the program's content. Evaluation instruments were developed and/or modified during Year 2. Pre and post data from the instruments were to be used to determine the efficacy of the instruments in evaluating changes in student knowledge of lunar science, attitudes toward science, and views of the nature of science. Unfortunately, very few students completed the post surveys making it impossible to assess the instruments, or completely evaluate the program. Sufficient evaluation data collected during Year 3 allowed for a complete evaluation of the efficacy of the evaluation instruments and the impact of the program on participants.

What is the Impact?

Lunar Science Content Survey

This survey evaluates changes in student knowledge of the Moon's formation, lunar geology, the lunar cataclysm, relative dating of surface features, and differences between high-resolution versus low-resolution spacecraft imagery. Student responses to the items on this survey were scored with a rubric developed by CLSE staff. The two graphs here compare pre and post data for two questions that appear on the survey. At the beginning of the program, most students could describe the Giant Impact Hypothesis as the leading explanation for the Moon's formation (Fig. 4). The percentage of students describing the GIH in the post survey increased by about 21%. Very few students, however, could identify or describe evidence supporting the GIH. Students' ability to identify the three main types of feature seen on the Moon by the naked-eye increased from pre to post (Fig. 5).

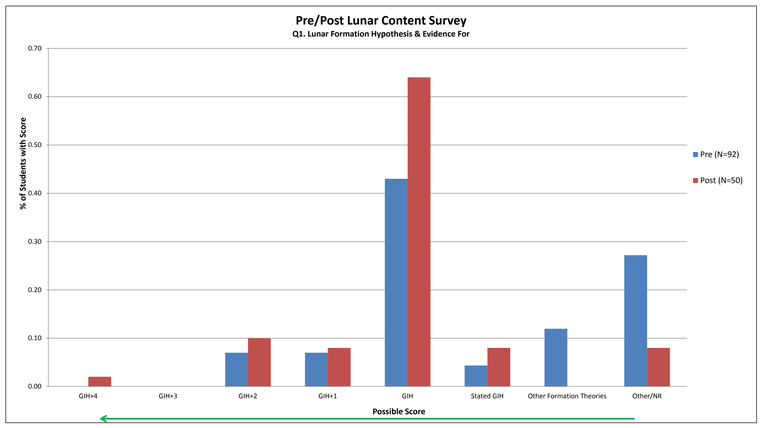

Fig. 4. Pre/post data on student responses to lunar formation and evidence for. The green line indicates the direction of increasing complexity in responses.

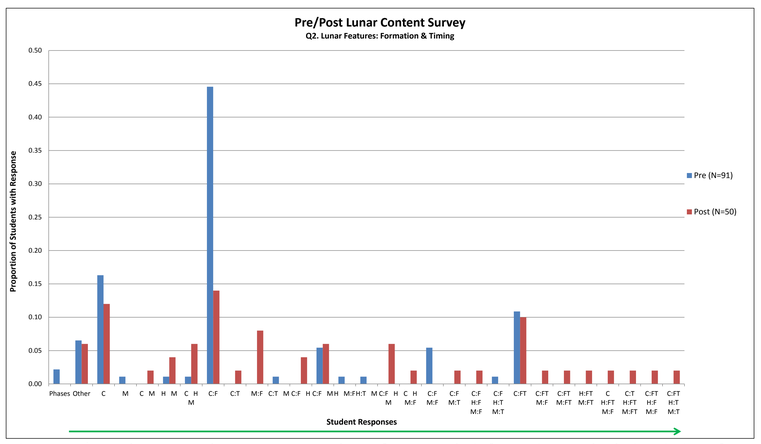

Fig. 5. Pre/post data on student responses to lunar features, their formation, and relative timing of formation. The green line indicates the direction of increasing complexity in responses.

Most students could identify craters *AND* describe how they form, as well as their relative timing of formation on the pre survey, but very few identified mare or highlands. On the post survey, students were not only able to identify craters, mare, and/or highlands, they were also able to describe their formation, and their relative timing of formation.

These two data sets are representative of students' changes in lunar science knowledge: small gains can be seen in student understanding of the various topics included in the survey. This may be a reflection of the instrument itself or a reflection of the program's ability to broadly increase students' knowledge of lunar science.

Attitudes Toward Science

Data from the pre and post attitude survey suggest that the research program does little to alter students' attitudes toward science. A strong majority of students enter the program with very positive attitudes toward science; they are comfortable talking about science, science does not make them nervous, they believe science is useful for solving everyday problems, they enjoy doing science, and they have a desire to learn science. Post survey responses show that these attitudes remain the same following the program. This is not surprising; most students participating in this type of program do so because they already have a strong interest in science.

Student Reflections on the Research Experience

"It gave me a lot of experience and helped me decide that this is a career I feel I could be successful in."

"This taught me what it's like to be a scientist, and it doesn't really seem completely unattainable and alien anymore."

Views of Nature of Science

We use a modified version of the Views of Nature of Science Questionnaire to look for changes in students' views of science. Use of the instrument is complicated with the absence of a standardized rubric to assess student responses. To evaluate changes in student views of the nature of science, student responses were coded, or grouped into similar themes that arose from individual responses. Coding was done by two individuals and results were compared. To look for changes, themes coded in the pre survey were then compared to themes that arose from the post survey responses. It is difficult to conclude from the pre/post results if students' participation in the research program had an affect on their views of science. It was not practical to conduct follow-up interviews with students to verify that our interpretations of their words were accurate.

Discussion

Lunar Science Content Survey Using the 2011-2012 program data, items in the Lunar Science Content survey were modified for the 2012-2013 program. Questions were re-written to focus on the important concept(s) intended to be assessed by each question. This instrument will be validated by conducting interviews with both students, and teachers, regarding their interpretations of the questions and how the questions can be further modified to be more easily understood. There is some difficulty with the rubrics created to score the students' responses. Overall, the two graders agreed on scores, though there were two items with variability between the two graders. The graders discussed each disputed response and came to an agreement on a score for each one. The rubric will be modified by both reviewers for future use so that misinterpretation is kept to a minimum.

Attitudes Toward Science Inventory Many if not most students participate because they have a high interest and/or proficiency in science. Pre and post data from the attitude inventory confirm this. Despite seeing a ceiling effect in the attitudes data, we know from conversations with students and teachers that the experience changes the way students view science.

Views of Nature of Science Questionnaire We chose this instrument because we believe this program can enhance student views on nature of science. Some questions were modified to align with the lunar science context of the program. However, a key activity not done by the program is conducting follow-up interviews with students to discuss their responses on the instrument. According to Lederman et al. (2002), interviews are key to meaningful assessment of student responses. Unfortunately, follow-up interviews with every participant is impractical, if not impossible.

We plan to further modify these instruments, and the program, going forward to better assess the impact on students and to create a more impactful program. Specifically, further modification to the nature of science instrument will take place to focus on particular aspects of science the program can best address.

A Teacher's Reflection on their Students' Research Experience

"The only reason that any of these students were not pursuing science degrees is because they did not have the confidence in themselves to believe that they could actually achieve it. Because of this program, they have found that confidence and are reassessing their degree options as they prepare for college."

References

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