University Camp Increases Student Interest in Science

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NASA, the U.S. National Science Foundation (NSF), and many other funding agencies are trying to increase student interest in science, technology, engineering, and mathematics careers. While rare experimental efforts have shown that factors such as small class size [*Finn et al.*, 2001], community service [*Markus et al.*, 1993], and targeted training [*Zohar and Nemet*, 2002] may improve student performance, the outcome of many educational activities is unclear or anecdotal [*U.S. Department of Education*, 2007].

With support from the NASA New Investigator Program in Earth Science (NIP), we used a statistical assessment to determine that participation in a summer science camp at Utah State University (USU), consisting of an 8-week research experience, increased students' interest in science careers and fostered their intention to pursue activities likely to lead to a science career. Our results indicate that science-based opportunities for high school students have beneficial effects and that broader research on the topic may be justified. In conducting our assessment, we also learned some valuable lessons that although perhaps familiar to science education specialists, may be useful and novel for AGU members interested in similar research.

Recruiting High School Students

In the spring of 2005, we initiated a research agreement with Mountain Crest High School in Hyrum, Utah, prior to submitting a research proposal to NASA's NIP. Once funded, we visited science classes at Mountain Crest during the fall of 2005 and recruited junior- and senior-level students. We decided upon the following four project parameters: (1) Participation from about 40 students will be needed; (2) academic information will be gathered; (3) students will be in either a control group (unpaid, no jobs) or an impact group (paid, USU jobs); and (4) students will be assessed before and after the camp. This approach to assessment, called Before-After-Control-Impact (BACI), is a standard approach to identifying the effects of experimental manipulations.

For all students, we obtained academic records and information on previous science experiences. We also conducted precamp assessments of academic achievement and attitudes toward science (see Figure 1 and see Table S1 in the electronic supplement to this *Eos* issue (http://www.agu.org/eos_elec/)), and then randomly divided students into a 19-student control group and a 20-student impact group for assessment during the summer of 2006.

During the recruitment process and prior to the separation into control and impact groups, we explained the project parameters through in-person meetings, a project Web site, and informed consent documents. We especially emphasized the random assignment to control and impact groups and requested participation only from those students willing to accept a 50% chance of obtaining a paid position. An approach in which the control group students were unaware of the experimental group's employment would avoid a possible "sour grapes" effect, but such an approach would violate ethical guidelines and informed consent principles that require full disclosure of experimental procedures when working with human subjects. We used a range of assessment questions (see next section) to check for the sour grapes effect.

Summer Camp

While students in the control group spent their summer as they otherwise would have—typically a combination of other summer work experiences, family travel, or volunteer activities—the students in the impact group participated in a variety of summer research experiences with faculty in the College of Natural Resources and the College of Science, at USU.

To the furthest extent possible and to maximize student engagement in our study, we allowed students to select their job experiences. We held group meetings during the summer of 2006 to address potential problems and to maintain communication.

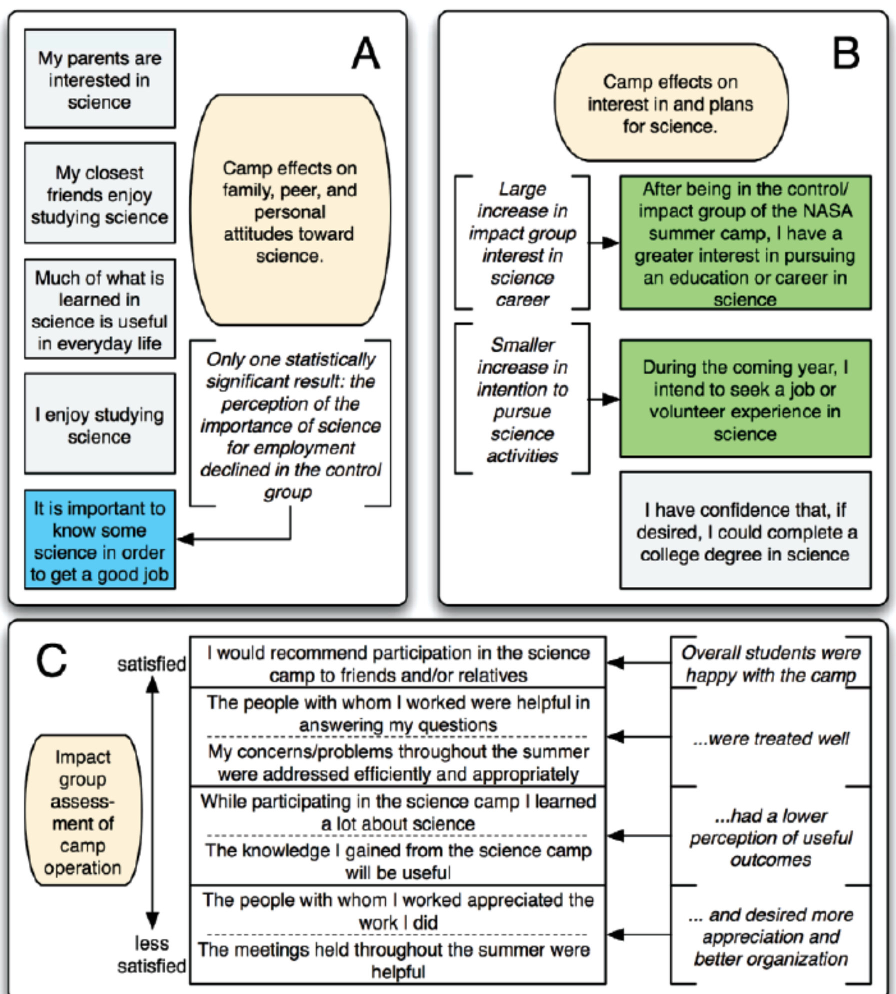

Fig. 1. Science camp results. Color shows statistical significance at the 5% level (t test with 95% confidence): gray, no difference; blue, decrease; green, increase. Beige boxes describe groups of statements assessed by students: (a) complete Before-After-Control-Impact analysis; (b) tests for the impact group after the camp versus the control group after the camp; and (c) quality of the camp assessed by the impact group. Text in square boxes shows the assessment statements; text in italic highlights important results.

In August 2006 we held an informal research symposium for students to present their summer projects. In October 2006 we designed and distributed a survey to assess the impact of participating or not participating in the summer camp.

Using statistical hypothesis tests (*t* tests) and the "1 = strongly disagree to 5 = strongly agree" scale, we investigated differences in responses to the assessment statements. Figure 1 shows conceptual results; numerical results are shown in Tables S1, S3, and S4. Ratings for statements relating to the enjoyment of science, the perceived utility of science, parental interest in science, and peer enjoyment of science showed no statistically significant differences for any of the four possible BACI comparisons (Figure 1), strongly suggesting that the camp did not change peer or family attitudes toward science.

Uniquely, in response to "It is important to know some science in order to get a good job," the control group experienced a decline from 4.7 (before) to 4.0 (after) while the impact group experienced no statistically significant change. In isolation from other assessments, the finding of decreased perceptions of science's usefulness may appear to provide evidence of a sour grapes effect; that is, lack of summer employment created a sense of bitterness in the control group. However, if this were the case, similar reductions for the statements "Much of what is learned in science is useful in everyday life" and "I enjoy studying science" would be expected. No such findings emerged, suggesting a more likely interpretation that the nonscience work experiences in the control group made the students aware of a broad range of career opportunities outside of science, and that the perception of science's usefulness thus declined.

Compared with the control group, the impact group was significantly more interested in a career in science after the summer of 2006 (*t* test with 95% confidence; see Figure 1 and Table S3). The average increase of 1.4 per student was the largest difference for any comparison in the study. In particular, we would like to highlight that students working as a small group with Anne Anderson, a microbial ecologist, found a short-term and hypothesis-driven project to test for the presence of polycyclic aromatic hydrocarbon-degrading bacteria in fire pit soil samples [*Moon et al.*, 2006] to be especially supportive, enjoyable, and fulfilling.

To a lesser extent, the camp also appeared to increase student intentions to take steps to realize a career in science (see Figure 1 and Table S3). However, students' perceptions of their ability in science were not affected.

The increase in interest and intent, although based only on our small study, may provide a quantitative and experimental basis for additional, long-term research on the outcomes from similar activities—perhaps to specifically target students without an initial interest in science (see Table S1).

The impact group evaluated the overall value, logistics, and personnel of the science camp (see Figure 1 and Tables S4–S6). Responses indicated that while participants were satisfied with the camp (scores 4.5 and higher), project meetings, with a score of 3.6 (slightly above "neutral"), could be improved. Students in the impact group were generally in the "agree" range when assessing whether the knowledge gained from the camp was useful and whether their coworkers in the university community appreciated their work.

Given a list of motivating factors, students in the impact group picked the top three reasons for choosing to participate in the study. These were (1) money; (2) the summer camp was better than alternative jobs; and (3) the desire to learn about research. Consistent with our other results (Figure 1), students in the impact group seemed more likely to have an inclination toward a science major for college; when presented with a list of potential college science majors, students in the impact group selected an average of 1.8 science majors while the control group picked only 1.1 on average.

Lessons Learned

As is the case for many research scientists, the principle investigator for this work was untrained in education, educational research, and sociological assessment protocols. As the NASA NIP and some NSF programs mandate an educational component in proposals they approve, our experiences here may be of some use.

First, while experimental educational research sounded simple during proposal writing, the implementation was wildly time consuming. A full-time graduate student managed day-to-day camp operation, and the principle investigator and postdoctoral associate both dramatically overspent their allotted time. Second, investing in collaboration with an expert in the design and execution of educational surveys was invaluable. Finally, we were unaware of the need to obtain approval from the Institutional Review Board (IRB), which reviews all experimental research with human subjects. Because IRB review and approval were required—which we learned from our educational assessment collaborator—we encountered a multiweek delay during the spring of 2006. Another IRB requirement for our study involved obtaining a mandatory informed consent document for all participants, which for minors had to be signed by their parents.

For AGU members interested in pursuing similar research, we offer the following five specific recommendations listed in approximate chronological order: (1) Obtain institutional (i.e., primary or secondary school) partners and agreements prior to proposal submission; (2) obtain institutional IRB approval for the planned research prior to proposal submission—this step in particular will provide evidence to reviewers and program managers of appropriate planning; (3) allocate funds to pay students in the impact group because relying on unpaid participation will remove a large potential demographic; (4) develop specific strategies for building student group identity; and (5) work with educational research professionals to develop appropriate student assessments before and after the research.

Supplemental Tables S1–S6 can be found in the electronic supplement to this *Eos* issue (http://www.agu.org/eos_elec/).

Acknowledgments

We gratefully acknowledge the support of the NASA New Investigator Program and the participation of the students and teachers of Mountain Crest High School. Two anonymous reviewers, Ramakrishna Nemani, Christos Michalopoulos, and Chris Donovan provided helpful comments.

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