PR²EPS: Preparation, Recruitment, Retention and Excellence in the Physical Sciences, Including Engineering. A Report on the 2004, 2005 and 2006 Science Summer Camps

Nancy Bachman, Paul J. Bischoff, Hugh Gallagher, Sunil Labroo, John C. Schaumloffel

State University of New York College at Oneonta

Abstract

Now in its fourth year, PR²EPS is a National Science Foundation funded initiative designed to recruit high school students to attend college majoring in the physical sciences, including engineering and secondary science education, and to help ensure their retention within the program until graduation. A central feature of the recruitment effort is a free one-week residential summer engineering and science camp for high school students. This report describes the rationale for using a camp as a recruitment tool as well as the camp structure and engineering/science activities of the camp. The results of pre and post surveys (n = 135) designed to assess the campers' self-perceptions as scientists and assessments of the camp itself are provided, as well as attitudinal type survey data collected more than a year following the camp experience. Faculty similarly concerned with motivating high school students to major in the physical sciences or engineering should find the report useful.

Introduction

New geopolitical realities that restrict immigration, along with declining academic performance, justify the development of new strategies designed to encourage domestically-born American high school students to realize their abilities and pursue college degrees in engineering, physics and chemistry (NSF-STEP Program). For example, the 1995, 1999, and 2003 Trends in International Mathematics and Science Study (NCES, 2005), which compares the science achievement of high school students from approximately forty nations, shows that American student performance is stagnant and lags behind many other nations. Other studies (e.g., Moore, 2001) have also described a distressing decrease in both the quality and quantity of domestically trained science students in the U.S. As reported by Moore, the National Commission on Mathematics and Science Teaching for the 21st Century has pointed out that the mathematics and science preparation students in the U.S. are receiving is "unacceptable", and that U.S. children are not world class learners in these areas. The poor performance of science students is due at least in part, to a demonstrable lack of motivation to study science because of poor self-perceptions of their ability (Bauer, 2002; Cukrowska, et al, 1999; Howell, 1999; Shepardson & Pizzini, 1993). One thing is certain; the long-term security of any nation relies on the technological and scientific capacities of its youth. In this sense, it is imperative that strategies designed to motivate involvement in the sciences and then foster success need to be aggressively developed, and the results need to be reported to all stake holders in the education community.

The utilization of science camps to motivate students and show them that they have the ability to become physical scientists have been supported by the National Science Foundation (NSF, 1994), private funding agencies (Camille and Henry Dreyfus Foundation, 2002) and in the literature on chemistry education (Exstrom and Mosher, 2000), although relatively few camps appear to be engineering-focused. Some camps focus on chemistry or physics (U of Toledo, 2005; U of British Columbia, 2005) others bioinformatics (Gosser; Calhoun & Brennan, 2002) and others serve so support college science students as they advance from two-year to four-year institutions (Perkins, et al, 2002 and Wang, et al 2002). Internationally, we found one engineering camp operating in India (Murty, et al, 2004) designed to motivate students who have completed two years of college to pursue four year degrees in engineering, and another, funded in part by the National Science Foundation, operating in Korea (Sirica, 2002). The Korean camp is science and engineering focused, but is highly selective and enrolls few American high school students.

The State University of New York College at Oneonta (SUNY-Oneonta), like many other academic institutions in the U.S., has the infrastructure to graduate many more physical scientists than it currently does. A four-year college in the statewide SUNY system, SUNY-Oneonta offers degrees in chemistry, biochemistry, physics, astronomy and 3+2 cooperative engineering programs with partner institutions. SUNY Oneonta also offers degrees in all areas of secondary science education. In the spring and summer of 2003, a team of five cross-disciplinary faculty responded to a National Science Foundation request for proposals with a comprehensive strategy designed to recruit high school students into majoring in engineering or physical science programs and retain them though innovative programmatic changes. The funded project, PR²EPS: Preparation, Recruitment, Retention and Excellence in the Physical Sciences, has five major components. These include a free, weeklong summer science camp, a free walk-in chemistry and physics tutoring center, an equipment loan program for second-

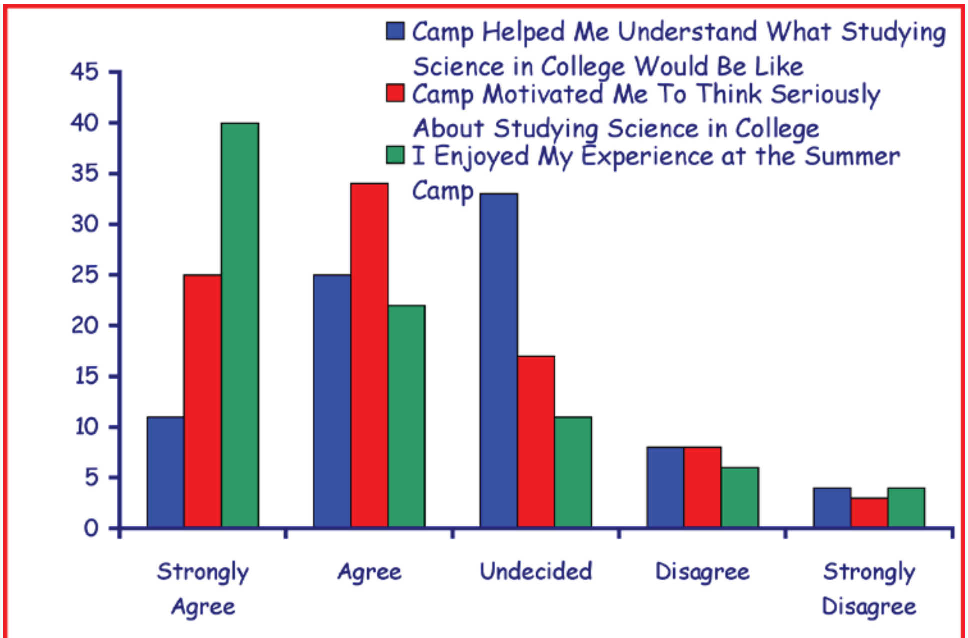

Figure 1: Results of alumni survey. The results are very promising in terms of the motivational effects the camp has on deciding to be science majors in college.

ary science teachers, scholarship opportunities for freshman engineering or physical science majors and opportunities for sophomore and junior level engineering or physical science majors to travel to scientific meetings. In this paper, we report on the processes of establishing the summer science camp, our experience with operating the camp and assess the progress made towards motivating high school students to enroll in college majoring in engineering or the physical sciences.

Rationale for Using a Summer Science Camp as a Recruitment Tool

Unlike some of the tedious aspects of practicing science itself, when high school students think of summer camp, their primary perception is one of recreation and social activities. It makes sense then, to take that perception of what a camp is and integrate scientific activities. This allows one to utilize students' preconceived notions to recruit them and retain their interest during the camp. Building on these associations, it is possible to create an exciting science atmosphere in a camp, especially one held on a college campus that is less restrictive than a high school environment. Participating students feel a sense of recognition and accomplishment because they are recommended by their high school teachers and then selected by the college science faculty. Once at camp, they are assigned to scientific teams where their ideas and contributions are absolutely essential to the progress of the team. They meet, work, socialize, enjoy recreational activities and interact with other science and engineering interested students, college faculty and college students majoring in engineering and the sciences. If done right, a summer science camp can be the single most academic and career influencing experience of their lives.

Summer Camp Recruiting

The recruitment objective was to competitively select 35-45 academically qualified, engineering or science oriented high school juniors and seniors to attend each years summer camp. Ideally, we wanted to recruit students who had not yet made up their minds to attend college as engineering or science majors. Our recruiting zone included the five counties surrounding SUNY-Oneonta, which are mainly rural farming communities with relatively low population densities. As an indication of the socio-economic status of the region, on average, 25% of the students in the region are eligible for free school lunch programs. From our past experience, some of the top engineering and physical science majors come from these areas, but the general perception of the faculty is that a greater number could be recruited. We developed a multifaceted recruitment plan, including personal contacts, and direct mailings to secondary school administrators and science teachers. As an indication of how challenging this outreach effort was, the response rate from educators to direct mailings was ~10%. Follow up phone calls were made in an effort to coordinate a time when one of the PR^{2}EPS team could come to the school and give a short informational presentation. The presentation emphasized that the purpose of the camp was to provide high school students with hands-on science experiences, resembling the nature of the scientific enterprise and ultimately, to act as a bridge experience between high school science and attending college as a physical science or engineering major. It also included a discussion of the relevant academic departments, facilities, and other aspects of the PR2EPS program. At the same time, postage paid reply cards were made available to students, as was the web URL for the program (www.oneonta.edu/academics/pr2eps). Recruiting efforts were enhanced by local media coverage and on-campus recruiting events. Co-PI Bischoff made primary contact with many secondary science teachers as he supervises student-teaching for secondary science education majors at SUNY Oneonta.

Ultimately our recruitment efforts provided us with names and contact information from about 200 interested students each spring. Each student was mailed an application package approximately 90 days prior to the start of camp. Applications requested personal, health and safety information, high school courses and grade information, a short essay and a teacher's recommendation. Thirty five applicants were accepted to the 2004 camp, 44 to the 2005 and 55 students attended the 2006 camp. Slightly more than 50% of the campers have been female and attendees have represented more than 20 different school districts.

The Camp Staffing and Logistics

Five college faculty, two from physics, and one from each chemistry, biology and science education are the nucleus of the program. Additional, faculty specializing in astronomy, hydrology and music industry have also assisted in the summer camps by leading the campers through activities within their disciplines. Each spring 3-4 high school science teachers and eight science or secondary science education majors are hired to work the camp as team leaders. We work towards achieving a ratio of 3 campers to one adult-scientist thus providing an environment where the campers have ample opportunity to discuss their scientific goals with active scientists. All high school science teachers have been paid $1200 for the week and the college students are paid $600. For the high school teachers and secondary science education majors, the camp was also considered a professional development activity. The rationale was that participation in the summer camp would help them discover new teaching ideas for their classes, and generate positive professional relationships with the college faculty. The college students provided the campers with a realistic perspective of what majoring in college science is like. In addition, a registered nurse

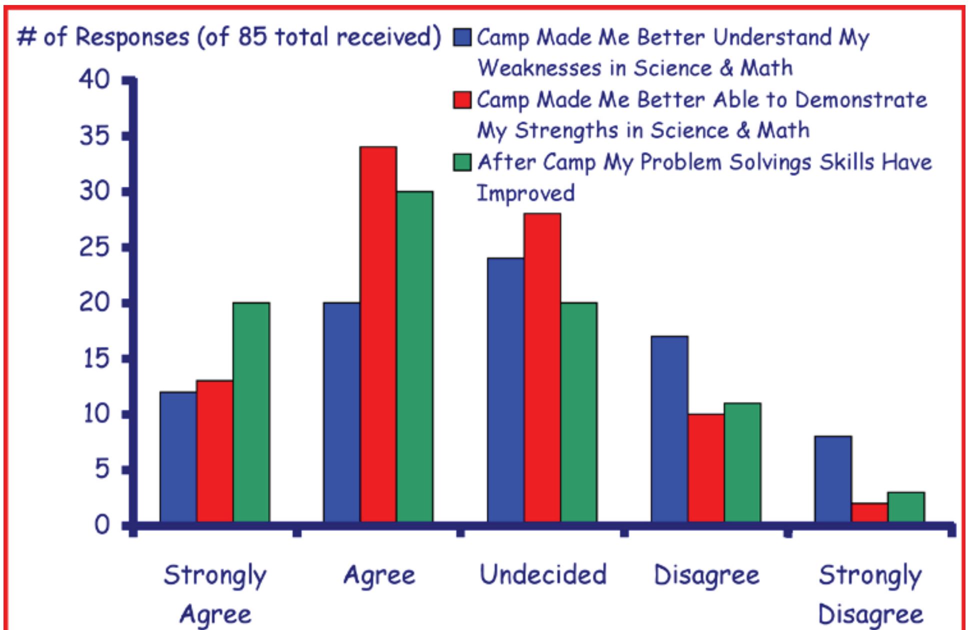

Figure 2: Results of alumni survey. Especially interesting is that the camp seems to help the students demonstrate their strengths in science and math.

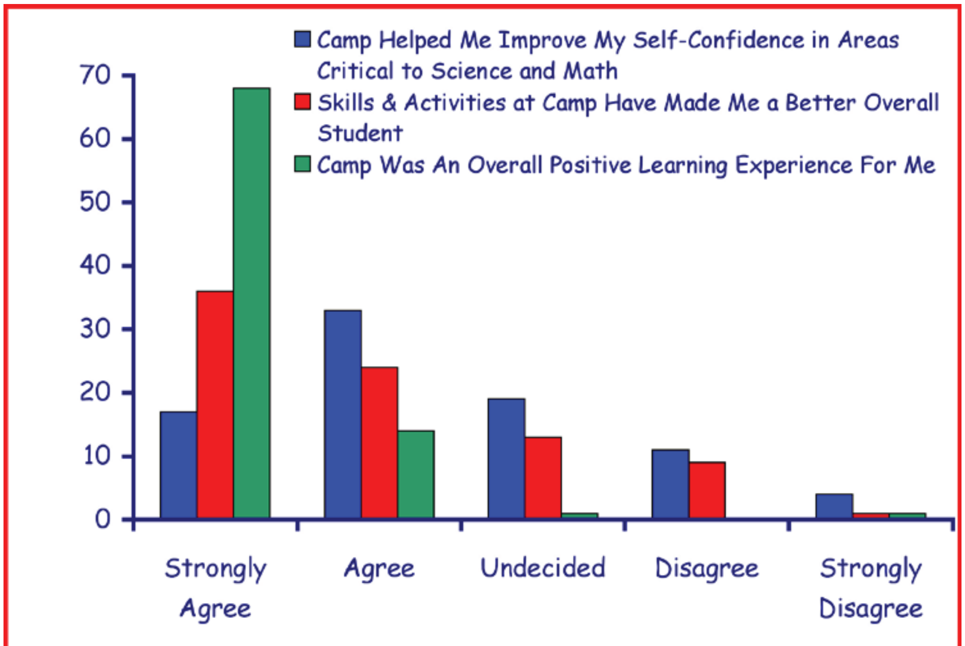

Figure 3: Again from the alumni survey, this data shows that the almost all campers believed the camp was a positive learning experience.

was hired from a local elementary school and served as the camp nurse, a New York State Department of Heath (NYSDOH) requirement.

A one-day training and orientation session is conducted a few days before the camps started. During these training sessions, the camp staff has the opportunity to explore the science activities and become familiar with the equipment, facilities and safety protocols. We also discuss the ultimate goals of the camp, which are to provide the high school students with a challenging, memorable and motivating experience where creativity, ingenuity and teamwork were the prized values.

During the camps, students and staff are housed in campus dormitories and meals are provided in campus dining halls. Students are paired in dormitory rooms with a student from another school district to the maximum extent possible. A ladies floor is established separate from the gentlemen's floors. Although male students were not allowed in female students' rooms, and visa-versa, this was largely the only housing restriction imposed on the students (other than the normal campus regulations prohibiting smoking, fireworks, alcohol, etc.). Students had available to them television, radios, and a video game system for "late-night" entertainment. Upon arrival at camp, the participants were checked in, their parents/guardians given camp contact information, they were assigned rooms and issued a camp manual (including laboratory activities) and an identification badge similar to those one receives at scientific meetings.

Investigative Teams

A major philosophical component of the camps has been an emphasis on teamwork, cooperation, and creative problem solving when faced with scientific or engineering challenges. That is, the major goal of the camps has been to enable the high school students to experience engineering and science like scientists do. To facilitate this atmosphere, we form the campers into scientific investigative teams prior to their arrival. The teams consist of four campers and one college student or adult (faculty, high-school teacher, etc.) counselor. Four of the principal investigators are not assigned to groups but 'float' around helping teams with their activities. The mixed gender teams, with students from different school districts, are created before camps started. The teams they work together for the entire week. The counselors have been instructed to assist the team as they worked to generate solutions to problems. They are told not to take charge or in effect, do the thinking or problem solving for the high school students.

Engineering and Science Activities

In keeping with the motivational goals of the camp, activities that necessitate problem solving, teamwork, and the application of engineer-

Table 1: Summary of Summer Science Camp Activities.

Activity	Science or Engineering Skills	Task Description
Computer Assembly	Interpreting schematic diagrams, assembly of complex machine, understanding structures and function of PC's including- system board, the CPU, Random Access Memory, interface cards and storage and memory and output.	Using schematics, campers assembled a functional computer out of parts and used the computer for the remainder of the week.
Rocketry	Computer modeling, testing effects of manipulated variables, data collection and analysis, modification of prototype based on data.	Using a software package, campers were able to modify major rocket components and obtain test-flights. They then used the data in construction of a 2-liter soda bottle-air powered rocket and compared the actual flight to the computer model.
Electronics	Interpreting electronic schematics, soldering, use of digital multimeters and solving circuitry problems	After a structure and function analyses of circuitry components, campers assembled functional devices from kits.
Forensic Investigation	Observing a crime scene, identifying biological and chemical evidence, executing appropriate forensic tests and protocols for manipulating DNA, running an electrophoresis gel, and interpreting DNA fingerprinting patterns	Campers analyze a crime scene, collect evidence and carry out traditional fingerprinting, a luminol test, polymerase chain reaction chemistry, and DNA fingerprinting. The test outcomes enable them to come to some resolution of the scenarios.
Video Analysis of Motion--Hugh	Students apply fundamental physical theories and graphical, quantitative and geometric analysis to understand the forces producing the objects motion.	Specialized software is applied to movies to track the position of objects as a function of time.
Astronomical Viewing	Guest lecture on astronomy, opportunity for students to interact one-on-one with the College Dean.	Celestial viewing with very high-quality optics, outdoor laboratory activity with nationally-renowned astronomy educator.
Remote Control Boat Construction	Engineering principles including application of electronics knowledge, buoyancy and displacement, propulsion, remote control assembly, building mechanical systems.	Using plexiglas and composite foam as main frame materials, campers assembled boats. The boats needed to be steered remotely, propelled by a motor, and in many cases, capable of disabling other class teams boats with a remotely operated weapon.
Hovercraft	Constructing a moving machine from parts. Modification of a complex machine (leaf-blower) for an alternative purpose.	Following standard procedures, teams construct hovercrafts and ride on them.
Detection of Cocaine on US Paper Currency	Analytical chemistry laboratory skills	Application and understanding of GC-MS (gas chromatograph-mass spectrometer.
Technology and Applications of Global Positioning Systems	Data collection and analysis, communication, problem solving, use and applications of current technologies.	Teams used the GPS to help them generate an inquiry oriented ecological science activity and ultimately collect data in response to a hypothesis. Most teams assessed some component of stream chemistry or stream physics and used the GPS as an aid in data collection.
Construction of Musical Instruments	Understanding of important concepts like "Resonance" and "Fourier Synthesis". Modification of prototype based on testing and evaluation.	To construct a percussion, string or wind instrument based on the understanding of "standing waves" and "harmonics". To test and fine tune this instrument with a sound spectrum analyzer.
Team Powerpoint Presentations	Public speaking, synthesis and evaluation of activities.	Teams are provided several hours to assemble a powerpoint presentation about the highlights of their camp experience. The preparation and presentation (made in front of parents) enables the camper to revisit favorite activities and synthesize the week's activities in a memorable way.

ing skills are selected and form the framework of the camp experience. Mostly, we look for activities that result in a 'finished product' that could be publicly demonstrated by campers to peer investigative teams. All activities are designed to last no more than a day, and generally no more than 4-5 hours. A few passive science activities such as a lecture on meteorology and an evening viewing stars from the campus telescopes are also included. These non-engineering activities appeal to some students, and are similar to what students will experience in college. Most importantly, they enable us to take advantage of some of the human and technological resources unique to our college campus. Detailed descriptions of every science activity are included in the camp manual which is provided to the campers upon arrival. The descriptions include information such as background information, helpful sketches and schematics, and learning goals.

The camp activities and general program of the camp day is adjusted each year depending on the feedback we receive from the campers on the post camp survey and our observations. For example, two activities from the inaugural 2004 camp were not included in future camps because the campers' responses on the surveys were not favorable. One activity involved determining the mass of water lost when popcorn pops and another involved assembling a functional computer out of parts. Both of these activities rely heavily on procedural knowledge and not engineering problem solving. They were not included in future camps. Most activities are not dropped completely from the program but are modified to include more technology, increased data collection and data analysis, and more opportunities for the campers to respond to preliminary data sets and improve the design and performance of the activity.

An outline of the science activities conducted at the 2004, 2005 and 2006 camps is shown in Table 1. To provide a greater sense of the nature of the camp activities a summary of selected activities is presented here.

Rocketry is a very popular activity. Investigative teams build high-pressure, 2-liter soda bottle rockets using the Rockets-Away software program and curriculum (Ohio State University Extension, Columbus, OH, U.S.A., http://www.ag.ohio-state.edu/~rockets/). Although originally designed for middle-school students, the curriculum is also well tuned towards high school students who have the motor skills and design ability to more effectively create and alter rocket nose cone shapes, masses, mass distributions, air/water ratios, etc. With 2-liter bottles for the bodies and polycarbonate plastic for fins, our campers used expanding urethane foam and various weights to customize their rockets, often modeling them after a design optimized using the software program. Additionally, our students used a compressor to charge their rockets, up to 100 psi. Thus, altitudes and down-range distances greater than 100 meters were achieved. Blasting off the rockets was the end of the rocketry program for the first year. However, we realized that we were losing an opportunity to encourage data collection, analysis and a refinement of the rocket to more closely approximate the computer generated model so years 2 and 3 campers were provided opportunity to refine the rocket prototype in an effort to gain enhanced performance.

An activity that has gained increased popularity due to our experience in helping student avoid structural pitfalls is the engineering of remote control boats for use in our college pond. The goal is to engineer small boats that can be first remotely guided through an obstacle course, and then win a naval battle with the use of a remotely operated weapon useful in disabling classmates' boats. Boats were generally constructed with a hull or pontoons made of expanding polyurethane foam poured into cardboard molds (cooking spray was used as a release agent), with polycarbonate plastic decks. Propulsion was provided using a 6-volt, DC electric motor and the groups' choice of paddle wheel or propeller propulsion. A two-channel, AM-band, remote control system with two servos was used. The first servo was intended to control steering, while the second was used for a weapon to attempt to disable other boats. Paddle wheel boats were clearly superior, and the most popular weapons were either an "axe" intended to cut or disable the wiring on another boat or a "flipper" intended to flip the other boat over. A successfully engineered boat requires the team to tackle problems of electronics, steerage, propulsion, and buoyancy and balance among others.

Construction and riding on hovercrafts is also a popular activity. Hovercrafts were constructed from directions commonly found in physics classroom laboratory demonstrations, using a plywood base and plastic sheeting for the skirt. Our students started from scratch, using square plywood bases cut into octagonal shapes. This was simpler than cutting circles, particularly with handsaws. Most students used a foam "bumper" around the perimeter of the hovercraft, which seemed to help avoid tearing

Table 2: Pre and post summer camp survey data (n = 136). Data for summer 2004, 2005 and 2006 are combined. The mean is followed by the standard deviation in parentheses. Only small changes are shown in most categories. This is most likely due to high levels of self confidence prior to attending camp.

Categories from Pre and Post Camp Survey.	Pre Camp data	Post Camp data
Interest in Science. 1. I am very interested in studying a physical science in college.	4.0 (.89)	3.8 (.98)
2. I am very interested in attending SUNY-Oneonta to earn a college degree in the physical sciences (chemistry, physics).	2.9 (.95)	2.8 (1.0)
3. I am very interested in attending college so I can become a high school physics or chemistry teacher.	2.3 (.97)	2.2 (.97)
4. I am very interested in attending SUNY-Oneonta and earning a degree so I can teach high school physics or chemistry.	2.1 (.85)	2.1 (.90)
5. I enjoyed math courses.	3.8 (1.0)	3.7 (1.0)
6. I enjoyed computer courses	4.0 (.87)	3.9 (.90)
Attitudes towards science 1. I enjoy reading school science books.	2.9 (1.0)	2.9 (1.1)
2. I enjoy being a part of scientific discussions.	3.8 (.86)	3.9 (.82)
3. I enjoy listening to scientific lectures.	3.3 (.94)	3.3 (1.0)
4. I enjoy hands-on science laboratory activities.	4.5 (.54)	4.5 (.63)
5. I can make useful contributions to science activities when working in a group with other students.	4.2 (.60)	4.3 (.58)
6. I have confidence in my abilities to solve scientific problems involving mathematics.	4.0 (.78)	4.2 (.62)
7. I have confidence in my abilities to learn how to use science equipment.	4.2 (.63)	4.3 (.53)
Self-perception of science skills 1. I am good at understanding scientific problems and thinking of ways to solve the problems.	4.3 (4.5)	4.2 (.57)
2. I am good at collecting and recording scientific data.	4.0 (.61)	4.1 (.71)
3. I am good at analyzing scientific data.	4.0 (.59)	3.9 (.69)
4. I am skilled at building things such as models, machines, etc.	3.7 (98)	3.9 (.94)
5. I am good at engineering tasks where I have to collect information on a project and come up with ways to modify or change the project so it works better.	3.7 (.80)	3.9 (.82)

(or even simple abrasion) of the skirt. A 2-stroke leaf-blower motor, on which the throttle could be locked, was used to power the hovercraft. All riders wore both hearing and eye protection. In general, groups completed their hovercraft in about 2-3 hours, and then all teams rode on them on either a sloped sidewalk or gymnasium floor.

We also plan activities with learning objectives in chemistry and biochemistry. These activities extend the scope and learning opportunities beyond engineering and physical sciences and capture the interests of more students. Additionally, activities in chemistry and biochemistry allow us to engage the campers in the use of some sophisticated technologies which serves to teach them about the technologies as well as generating increased motivation to study science in college. For example, campers conduct a laboratory activity where dollar bills are examined for cocaine residue using a mass spectrometer, and we teach the students about DNA and gel electrophoresis within the structure of a crime scene investigation activity.

The final group activity for camps has been the development of a short PowerPoint presentation. At the closing ceremonies, where certificates of camp completion were handed out, each group gave a presentation to all the campers, staff, faculty and their parents. Presentations usually include the highlights of each activity and what they learned and most included reference to one or more exciting or memorable social experiences that were positive outgrowths of the camp experience.

Camp Assessment

Three measures have been used to assess the motivational effects of the camp on high school students. These are pre and post camp surveys; a summer camp follow up alumni survey; and during the 2005 and 2006 summer camp, an independent evaluator was hired to attend and assess how the camp was meeting its goal of motivating high school students to consider attending college as science majors.

The data from the pre and post summer camp surveys are shown in Table 1. The data for 2004, 2005 and 2006 are combined. Science interests, attitudes and self-perceptions of skills were evaluated. The pre and post survey data are remarkably similar. There is no evidence that the camp is dramatically affecting the motivational disposition of the campers. We first saw this result in the 2004 data. Although we were pleased to see the relatively high scores on the surveys, we were discouraged to identify virtually no real motivational differences in the campers. The pre-camp survey data was so high, that there was no room for expansion. We hypothesized that maybe the campers were coming to the camp with artificially inflated self-perceptions of their science skills. After all, the camp survey was completed the first morning of the camp and the campers were excited about the week ahead. To assess the hypothesis that their self-reported measures were inflated we conducted semi-structured interviews with seven randomly chosen campers during the 2005 camp. To do this, we separately interviewed the seven campers and asked them to explain why they rated themselves as 'strongly agree' on many of the survey items. Listening to the campers explain the reasoning for their selections convinced us that the self-report measures were very accurate. The campers described how they do science activities at home for fun, love to solve problems with math, and are among the top scorers in their high school classes. The surveys appeared to very accurately reflect the academic strengths of the groups pre-inclination towards science. This observation that the camp is attracting the pre-inclined was also noted in the report of the independent evaluator.

During the fall of 2006 an alumni survey was sent to all of the 2004, 2005 and 2006 campers to see if students' perceptions of the camp and its effectiveness were changing with time. Thus far, eighty five campers have responded to the alumni survey. Results of the alumni survey are shown in Figures 1-3. There is strong and consistent evidence in the alumni survey data that the camp was a high enjoyable experience and that the camp experience motivated them to think seriously about studying science in college.

Discussion

Based on our observations of the campers, discussions with camp staff and analysis of the survey data, the camp appears to be meeting its fundamental objectives of providing high school students with a motivational and rewarding engineering and science experience. Clearly, students accurately perceive that the camp is a rewarding 5-day experience that is not designed to instantly make them ready for college.

We would be hard pressed to state with confidence that the camp is motivating the unmotivated. All our survey data, observations of the campers on site, the observations of the independent reviewer, and interviews indicate that the campers are a highly motivated before they arrive.

There is evidence in the retrospective alumni surveys that the camp may be strong at retaining students pre-inclined towards the sciences to remain on that career path. The fact that almost all of the eighty five respondents to the alumni survey state that camp motivated them to consider science in college is very encouraging.

Future high school recruitment visits will continue to stress the idea that the camp is for average students who really don't know what they want to study in college. It is our hope that many students in that category will participate this year and that they will return for their senior year in high school motivated to do well and focused on the future.

Acknowledgements

The PR^{2}EPS program is funded by the National Science Foundation via awards DUE-0336580 and DUE-0441107.

References

1. National Science Foundation. Science Talent Expansion Program. National Science Foundation, Washington, DC. (2003).

2. National Center for Educational Statistics. Trends in international mathematics and science study (TIMSS). Available online at [www.nces.org] (2005)

3. J. W. Moore. Before it's too late. J Chem Ed. 77, 1535-1536 (2001)

4. C. F. Bauer, What students think: college students describe their high school chemistry class. The Science Teacher. 69, 52-55 (2002).

5. E. Cukrowska, M. G. Staskun and H. S. Schoeman. Attitudes towards chemistry and their relationship to student achievement in introductory chemistry courses. S-African. Tydskr Chem. 52(1), 8-14 (1999).

6. J. E. Howell, A year to make a difference. J. Chem Ed. 76(1) 7 (1999).

7. D. P. Shepardson and E. L. Pizzini, A comparison of student perceptions of science activities with three instructional methods. School Science and Mathematics. 93(3), 127-131 (1993).

8. National Science Foundation. Summer Science Camps Program. National Science Foundation, Washington, DC. (1994).

9. The Camille and Henry Dreyfus Foundation, Inc. Funding information available online at [http://www.dreyfus.org/] (2005)

10. C. L. Exstrom and M. D. Mosher, A novel high school chemistry camp as an outreach model for regional colleges and universities. J. Chem Ed. 77(10), 1295-1297 (2000).

11. The University of Toledo Perstorp Chemistry Summer Camp. Available online at [www.chemstockroom.utoledo.edu/new_page_2.htm] (2005)

12. The University of British Columbia Phenomenal Physics Summer Camp. Available online at [www.physics.ubc.ca/outreach/camps/2005/index.htm] (2005)

13. D.K. Gosser, D.H. Calhoun, T. Brennan. NSF Award Abstract #0230670: Pathways to interdisciplinary science, engineering and mathematics. National Science Foundation, Washington, DC. (2002)

14. S. F. Perkins, A.K. Agrawal. C. Gopalan, D. Friedman, L. Dunbar. National Science Foundation Award Abstract #0230131: Pathways to success in science, technology, engineering and mathematics. National Science Foundation. Washington, DC (2002).

15. T. Wang, G. Liu, J. Kotowski. National Science Foundation Award Abstract #0230682: Partnerships to increase science, technology, engineering and mathematics enrollment and student success. National Science Foundation. Washington, DC. (2002).

16. C.V.R. Murty; O. Dikshit; R. Tandon; M. C. Tandon; S. K. Jain. Recreating romance of civil engineering: 2001 summer camp at Indian Institute of Technology Kanpur, India. J Prof Issues Engineering Ed Practice.130 (9)182-189 (2004).

17. C. Sirica. Camp in South Korea for U.S. high schoolers. Science, 296(5577), 2415. (2002).

Nancy J. Bachman is Associate Professor of Biology at SUNY-Oneonta. In 2002, she was a recipient of the SUNY Chancellor's Award for Research in Science, Engineering and Medicine. Her research interests include eukaryotic gene expression, genomics and proteomics, and biocomputing.

Paul J. Bischoff is Associate Professor of Science Education at SUNY-Oneonta. He earned his doctorate in science education from Columbia University. His research interests are in applications of neurocognitive science to science learning and microbial ecology.

Hugh Gallagher received his B.A. in Physics from Holy Cross College in 1986 and taught high school physics and algebra at The Canterbury School before moving on to graduated school. In 1996, he received his Ph.D. in Physics from Boston College specializing in remote sensing observations of electrodynamic processes in near earth space plasmas. He continued this work as a post-doc at Johns Hopkins Applied Physics Laboratory where he used data from the SuperDARN Radar Network and NASA's Polar Satellite to measure electric currents in the ionosphere and magnetosphere. Since 2000 he has been an assistant professor of physics at SUNY Oneonta, where he teaches a wide variety of Physics and Engineering courses and is Assistant Director of the Science Discovery Center (a 3000 square foot hands on physical science museum).

Sunil Labroo is Associate Professor of Physics at SUNY-Oneonta. He has recently served as the faculty advisor to students in the 3+2 Cooperative Engineering programs and has research interests in the magnetic and other properties of solid phase materials.

John C. Schaumloffel is Assistant Professor of Chemistry at SUNY-Oneonta. His scientific expertise lies in the areas of environmental and analytical chemistry, particularly oriented towards the bioaccumulation and cycling of trace elements. He has a strong interest in chemistry education, including the incorporation of advanced instrumentation in lower-middle level college curricula.