1. Conference Strand: Community and Conservation Education

2. Title and Presenters

Increasing Enthusiasm and Knowledge in Freshwater Ecosystems

Dorothea K. Shuman, Ph.D.
Montreat College

3. Abstract

Recent science education reform proponents (Project 2061*)* explicitly put forward the ideas that increased knowledge and enthusiasm about science can be affected by field exercises. To address this need, the author developed and implemented a field-based environmental science program focused on freshwater ecosystems that engaged students in real-world science. The purpose of the project was threefold: 1) to improve students' competence in science, 2) to nurture students' enthusiasm for science and 3) to interest students in research or other science-related careers. Fifty-two, middle/upper school students from western NC participated in the 6-day, 5-night experience. The Student Science Enhancement Project Survey was used to assess progress toward the three goal statements.

This paper describes the program components and the impact of the program. The program began in the summer of 2005 funded with a Burroughs Wellcome Grant at Montreat College through the Center for Learning and Investigation in Mountain Backcounty Ecosystems (CLIMBE). The program focuses on water quality in and around the Mt. Mitchell watershed and provides important insight into successful environmental education programming. Scientific data collected by the students are used locally by federal and state agencies.

4. Paper

PROGRAM OVERVIEW

The Center for Learning and Investigation in Mountain Backcountry Ecosystems (CLIMBE) is an environmental training and research center for 8^{th} – 12^{th} grade students interested field and laboratory science. Students conduct valid research and implement widely recognized protocols, while living comfortably in the backcountry and hiking to data collection sites. The goals of the program include: 1) to improve students' competence in science, 2) to nurture students' enthusiasm for science and 3) to interest students in research or other science-related careers.

The mountainous, watershed ecosystems of Mt. Mitchell offer high-elevation environments in which scientific study is needed to understand the environmental factors threatening the air, water, and forests. The objective of the research is to assess the water quality along an elevation continuum within an entire watershed and to add to the baseline data for the southern Appalachians.

Students spend six days living in and learning about this unique ecosystem while they collect, analyze, interpret and report data. Almost 90% of the students' time is spent in remote backcountry ecosystems as they hike, camp, and cook their own food. Students collect data for each of the following environmental parameters: atmosphere, physical, chemical, macroinvertebrates, salamanders, soil, and vegetation. GPS technology is used to map the data collection sites for these parameters. In addition, students participate in lectures and environmental hands-on activities to formalize concepts.

Data are collected by students involves the use of current technology which meets standards established by the Unites States Environmental Protection Agency and the North Carolina Department of Environment and Natural Resources. The data collected by the students are available to local public and private organizations interested in the Mt. Mitchell ecosystem.

All data collection and analysis activities are inquiry-based and follow the North Carolina Standard Course of Study. Students use the scientific method during training in field collection and data analysis techniques by making qualitative and quantitative observations, synthesizing their findings and summarizing data to be presented to the public and scientific community.

STUDENT POPULATION

Students must apply to the program and usually come highly recommended from science teachers. The participating student population (N= 52) is described as follows:

- Gender: Female (51.9%) and male (48.1%).
- Race/Ethnicity: Western North Carolina (WNC) counties provided 52% of the students for 2007. The 2007 student demographic reflects the average number of white students (80%) and minority students (20%) that would be expected from this region.
- Grade Level: 8^{th} – 10^{th} graders represented 80.8% and11^{th} – 12^{th} graders 19.2%.

EVALUATION

Research is conducted on the impact of the program on students, as well as the ecosystemic factors. A variety of evaluation tools are used to analyze progress toward meeting the three science education goals of the project. The primary evaluation instrument is the Student Science Enhancement Project (SSEP) survey developed by The Evaluation Group (c/o Sally L. Bond 75 Eagle Point Road Pittsboro, NC 27312). Evaluation of each goal is addressed individually in the summary following.

Goal 1: Improving Students' Competence in Science

Two measures were used to address goal 1, a knowledge test and 4 statements from the SSEP survey. Both provided quantitative data. The knowledge test consisted of a pre-test (taken at least 1 week before the program) and a post-test (taken on last day of the program), which covered basic ecological principles, field science techniques, and watershed management principles.

Pre-test/Post-test.

The pre-test and post-test scores were analyzed quantitatively by averaging the scores. The average and range of scores were calculated, and a paired t-test comparison was implemented. The average pre-test score was 45% (+/- 2.22 SE) and the average post-test score was 75% (+/- 3.33 SE). The post-test scores were significantly higher than the pre-test scores based on a paired t-test comparison ($P <$

0.000). This is evidence of increased ability to correctly answer questions about environmental concepts. One hundred percent (100%) of students had an increase in their test score after the program. This is used as an indicator of improved competence in science.

SSEP Likert-type Scale Questions.

Four SSEP survey statements listed below were used as another measure of competence in science.

1. This program helped me understand science better,
2. Because of this program, I feel better about being able to learn science,
3. I learned things in this program that I can use in science class at school.
4. I think I am more aware of the importance of science in everyday living.

Students rated their agreement/ disagreement on a 5-point Likert-type scale for each statement. Results for each statement are presented.

Statement #1 summary: Ninety-eight percent of students responded either "Agree" or "Strongly Agree" to better understanding science and 2% responded "Uncertain". As a result of the program, students self-indicated that the program helped them understand science better.

Statement #2 summary: Ninety-six percent of students responded either "Agree" or "Strongly Agree" to feeling better about being able to learn science, and 4% responded "Uncertain". As a result of the program, most students self-indicated they felt that the program improved their confidence in science.

Statement #3 summary: One hundred percent of students responded either "Agree" or "Strongly Agree" to learning things that will be useful in science class. As a result of the program, students self-indicated that they felt that things learned in the field would be useful in science classes at school. This may reflect the students' feelings about the "real life" application of science.

Statement #4 summary: I think I am more aware of the importance of science in everyday living. One hundred percent of students responded either "Agree" or "Strongly Agree" to being aware of the importance of science in everyday life. As a result of the program, students self-indicated they felt that science seemed more important in everyday life.

Goal 2: Increasing Students' Enthusiasm for Science

More questions from the SSEP survey were used to understand if the program had any effect on increasing students' enthusiasm for science. Students responded on a 5-point Likert-type scale. Three measures were used as progress toward this goal and reported below.

1) SSEP survey question: Because of this program, I am more excited about science. Ninety-eight percent of students responded either "Agree" or "Strongly Agree" to being more excited about science, and 2% responded "Disagree". As a result of the program, students self-indicated that they were more excited about science.

2) SSEP survey questions: How would you describe your interest in science before this program? AND Has this program changed your feelings about learning science? The data were analyzed quantitatively by cross tabulating the students'

responses. The data is summarized in Table A. Ninety-four percent of students responded "More Interested" in learning science, 6% indicated "No Change", and NO students indicated "Less Interested" after the program. This is evidence of increased enthusiasm about learning science, even if the students were already interested in science prior to attending the program.

Table A. SSEP Survey Question 4 vs. 5 (cross-tabulated)
(n = 52 students)

4. How would you describe your interest in science ***before*** this program?
5. Has this program ***changed*** your feelings about learning science?

5. Future Interest →	Yes, I am more interested in learning science	No, my interest in learning science has not changed
4. Previous interest in science ↓	**Total = 94 %**	**Total = 6 %**
Not at all / Somewhat interested	5 %	0 %
Sort of interested	29 %	2 %
Interested / Very interested	60 %	4 %

3) SSEP survey questions: How would you describe your interest in science before this program? AND Do you think you will take more science in the future? The data were analyzed quantitatively by cross tabulating the students' responses. The data is summarized in Table B. Seventy-six percent of students responded "Yes, More" about taking science classes in the future, 24% responded "No Change", and NO student indicated "Less" interest in taking science classes after the program. This is evidence of increased enthusiasm in taking science classes, even if the students were already interested in science prior to attending the program.

Table B. SSEP Survey Question 4 vs. 6 (cross-tabulated)
(n = 52 students)

4. How would you describe your interest in science ***before*** this program?
6. Do you think you will take ***more*** science in the future?

6. Future Interest →	Yes, thinking about taking more science classes	"No Change" in thoughts about taking more science classes
4. Previous interest in science ↓	**Total = 77 %**	**Total = 23 %**
Not at all / Somewhat interested	4 %	2 %
Sort of interested	23 %	8 %
Interested / Very interested	50 %	13 %

Goal 3: Interesting Students in Science-related Careers

Quantitative data were collected to determine the fulfillment of Goal 3. Three measures were used as progress toward this goal and reported below. Data were collected after the program.

1) SSEP Survey Question: Has this program encouraged you to think more about a science-related career – 73% of students responded "Yes, Thinking More" about a science-related career, 2 % responded "No", and 25% responded "No Change" or did

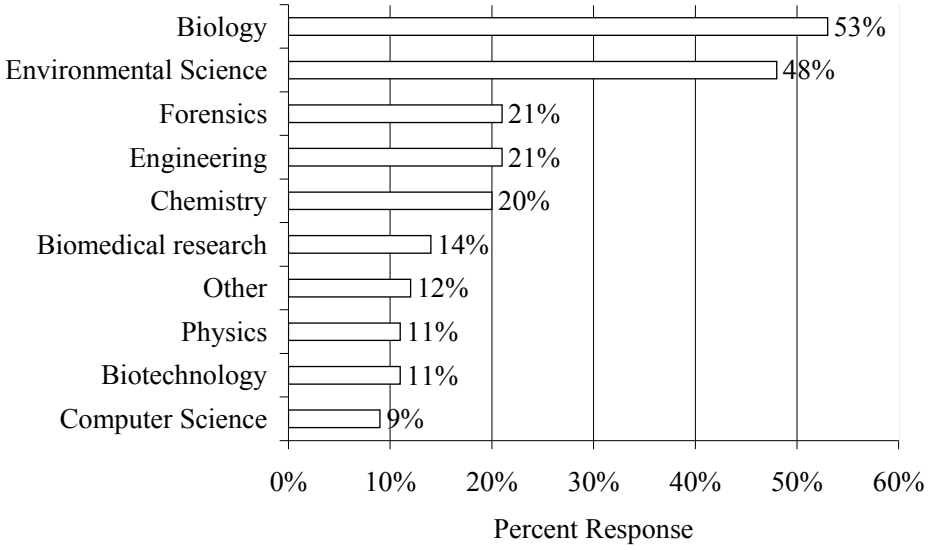
not respond. These data indicate that interest in a science career has increased after the program.

2) SSEP Survey Question: What job areas are you most interested in? Sixty-eight percent of the students responded "Science". Other areas of interest included health care/medicine, arts and entertainment, sports and technology and computers.

3) SSEP survey question: Which of the following areas of science are you most interested in? Of the 68% of students who responded "Science", 53% responded that "Biology" was an area of interest and 48% responded "Environmental Science". Biology and Environmental Science were the most commonly listed as areas of interest. The data is summarized in Table C.

Table C. SSEP Survey Question
(n = 52 students, based on 68% who responded science)

Which of the following areas of science are you interested in?



Note: Percentages add to more than 100% since most students gave more than one answer

LIMITATIONS ANDCONCLUSION

It should be noted that there are inherent limitations in the data that were collected. The overall student population (N = 52) may be too small to confirm the statistical significance of the results presented, although data collected over three years will be summarized and published at a later time. Much of the data is self-reported by the students directly after the program, and long-term success has not been investigated by means of student follow-up. However the data, collected on participants, show some strong indicators of the impact of hands-on science programming and field exercises on students' knowledge, enthusiasm and interest in science careers. CLIMBE will continue to serve students in Western North Carolina with a focus on

water quality and now, with additional funding from Burroughs Wellcome Fund is now adding new programs with a focus on climate.

5. Reference List

American Association for the Advancement of Science, *Project 2061, Science for All Americans.*, Washington, D.C, 1989.

North Carolina Standard Course of Study, Public Schools of North Carolina, State Board of Education, Department of Public Instruction. http://www.dpi.state.nc.us/curriculum/