Science and Environment Council of Sarasota County

Final Report

LEMUR CONSERVATION FOUNDATION

Two-Year Science Curriculum Enhancement Pilot Project

Conducted in Collaboration with Sarasota County Schools

September 2008

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SCIENCE AND ENVIRONMENT COUNCIL
OF SARASOTA COUNTY

Table of Contents

I. Executive Summary

> *"I feel like a scientist!"*
> 9th grade Booker High School on-level science student
> participating in SEC's Science Curriculum Enhancement Pilot Project

In December 2005, representatives of the Science and Environment Council of Sarasota County met with Dr. Gary Norris, Superintendent, Sarasota County School Board; Lori White, Associate Superintendent; and Susan Puchalla, Science and Health Program Specialist, to explore ways to enhance science education in Sarasota County. Consensus was to create a pilot project that would leverage the combined resources of SEC members to make a difference for on-level science students. Individual SEC member organizations provide science education in their area of expertise to teachers and students. This project would focus on how SEC – as a collective – could augment science education, make science real, and inspire students to pursue careers in the sciences.

Working with School Board staff, SEC developed a two-year pilot project to localize the 9th grade textbook, *Glencoe Physical Science with Earth Science*, by:

- Showing students how abstract science concepts apply to their community, and
- Providing opportunities for students to interact with people who work in the sciences.

9th grade Booker High School was chosen for the pilot year because of an apparent flagging interest in science at this grade level. Booker High School's administration and science department welcomed the opportunity to participate and helped shape the project.

In pilot year one, the participating science class attended six field trips in six successive weeks. Additionally, six participating SEC member organizations sent a staff member involved in the field trip to provide instruction at Booker High School for a comparison class. The comparison class received a classroom lesson covering the same material as that presented on the field trip. The field trip and classroom lesson included information about careers in the sciences, and provided opportunities to interact with working scientists and science practitioners about their work.

In pilot year two, SEC expanded the project to additional 9th grade on-level science classes at Booker High School. Year two coincided with the introduction of Small Learning Communities (SLC). The pilot therefore expanded to integrate the science curriculum to other subject areas within one of the SLCs – SCREAM (Science, Construction, Research, Engineering, Architecture, and Math). Two teacher workshops helped teachers use the field trip and science instruction as a culminating activity for cross-disciplinary lessons.

Each class participated in three of six field trips and three classroom pre-visits. Classroom pre-visits provided orientation a few days in advance of each field trip. Information about careers in the sciences continued to be an integral part of the pilot. The field trips were scheduled throughout the school year to coincide more closely with the teacher's in-class lesson topics.

An outside evaluation firm provided an assessment of the impact of both pilot years on students, using a science attitude survey among other tools.[i] The evaluation for year one shows a positive affective impact toward science on students participating in six field trips over the course of six weeks. Students who attended the field trips demonstrated consistently better attitudes towards science than students in the comparison classes or control groups (which were taught by using traditional methods in teaching science). The results are reinforced by the pilot teacher's report that after the six field trips, the participating students saw her as a mentor, interacting with her and seeking advice and counsel much more than those students in her other classes. She was also convinced that the hands-on interaction students experienced during the field trips provided more stimulation than the class lab, even though the labs taught the same content.

Pilot year two involved more students, but each student attended only three field trips. The results of the science attitude survey for pilot year two on students participating in three field trips was not conclusive, however the evaluation firm found that student responses to questionnaires suggest a positive impact. The evaluation report concludes: "Overall, the responses demonstrate not only a greater understanding of scientific endeavors, but also an increased appreciation for the different types of activities in which scientists engage."[ii]

Overall, the evidence indicates field trips improve student attitudes and interest regarding science, and allows more student interaction with positive role models in the various scientific disciplines. It is apparent from these findings that multiple science-

related field trips further develop student engagement and help students develop connections from one trip to the next, as well as between the concepts they are studying in class and the real world. Six field trips closely spaced together had a clearer impact than three field trips spaced over the entire school year.

The Science Curriculum Enhancement Pilot is laying the groundwork for a long-term collaboration between SEC member organizations and Sarasota County Schools. It has the potential to enhance creative productivity in teachers working across the curriculum – specifically in using science to teach and enliven other subject areas – and to increase on-level student interest in science. This program advances Sarasota County School District's leadership in dynamic science education that prepares its students for an increasingly competitive world regarding science.

Background

> *"I am studying currents in school and I learned more on this trip."*
> Student answer on post-field trip questionnaire

A. A Challenge from Dr. Gary Norris: Enhance Science Education and Understanding of Careers in the Sciences

In December 2005, representatives of the Science and Environment Council met with Dr. Gary Norris to explore ways to enhance science education in Sarasota County. During the discussions, Lori White, Associate Superintendent, and Susan Puchalla, Science and Health Program Specialist, underscored the importance of providing students with real world science experiences that are integrated in the curriculum and that help students understand opportunities for science-related employment. Dr. Norris challenged SEC to develop a proposal for a pilot project meeting these two criteria.

A Task Force consisting of SEC members and Susan Puchalla presented Dr. Gary Norris with a two-year pilot project. Dr. Norris approved funding for both years. This report provides a summary of the project, outlining both achievements and challenges for the future.

B. Developing a Two-Year Pilot

The Task Force agreed on the over-arching goals of the Science Curriculum Enhancement Pilot Project:

To enhance science curriculum through community-based science education and inquiry-based activities. The project's aim is to make science "real" for students by:

- Showing students how abstract science concepts apply to their community, and
- Providing opportunities for students to interact with people who work in the sciences.

In addition, the Task Force identified guiding principles for the pilot. It should:

- Focus on on-level students rather than advanced specialized students
- Help "localize" the curriculum

- Help teachers place the science in the student's "backyards" and at SEC member organizations
- Focus on experiential learning
- Include research and testing, to demonstrate how and if the program makes a difference
- Start on a small scale, grow over time, and involve school board staff and financial resources to develop and sustain long-term

On-level 9th graders at Booker High School were chosen to pilot the project at the recommendation of Susan Puchalla. The focus of both pilot years one and two was to develop activities to localize the 9th grade textbook, *Glencoe Physical Science with Earth Science* and align with Sunshine State Science Standards. These activities present concepts explored in the textbook in a Sarasota County context. In-class instruction and field trips allowed students to experience science concepts learned in the classroom in their own community. Information about jobs in the sciences and skills needed to perform those jobs was included. Two criteria were used to select topics:

- Students must master the topic as part of the curriculum, and
- Topics are currently being investigated by SEC member organizations.

9th grade was chosen for the pilot years because of an apparent flagging interest in science at this grade level. Elementary and middle school science learning usually involves hands-on activities, field trips, and easily applied concepts. Beginning in 9th grade, more abstract concepts are typically taught. Outside-the-classroom learning and practical applications of concepts are rare. It is at this point that many on-level students (as opposed to honors or advanced science students) become disinterested in science.

C. Research on the Impacts of Field Trips on High School Students

Concern in the U.S. about generally poor student performance in science and a lack of interest in pursing careers in the science field has been growing. Curricula that do not include experiential learning and fails to make science relevant to the students' lives, as well as a negative perception of science, are often cited as possible reasons. Further research shows a decline in attitudes towards science beginning in the secondary grades.[iii]

As a result, it has become prudent for school districts to examine their science curriculum to look for ways to improve science attitudes as a means of improving science achievement. A recent study by Turpin & Cage[iv] demonstrated an activity-based

approach to science improves secondary students' achievement in science. While numerous high school science classes have a laboratory component, many educators agree that seeing science first-hand out in the "real world" raises the curriculum to a whole new level.

Over the past 30 years, a good deal of research has been conducted on the effect of field trips on students. Most of that research focuses on K-8. In general, the evidence indicates that field trips have a positive impact on students, in both cognitive as well as affective terms. Interestingly, Nazier[v] found that among science and engineering professors, a field trip was one of the top factors influencing their decision to make science their career.

To date, there is little research on the impact of field trips on high school students. In light of this, the evaluation being conducted during this pilot phase adds to a lacking body of research. An independent consulting firm was hired to evaluate both pilot years one and two of the project. While the evaluation reports are not definitive, their cumulative analysis of evaluation materials does show a positive affective impact toward science on students. This despite the fact that evidence indicates that it is in 9th grade when students tend to loose interest in science.

D. SEC's Commitment to the Pilot Project and its Collaborative Approach

The SEC is a group of non-profit and government organizations that operate or support conservation and science-based facilities. SEC's mission is to promote and advocate science, conservation, and environmental issues in Sarasota County for maintaining and improving quality of life through education, public outreach, demonstration, information gathering and analysis, and special projects. By collaborating on projects, the SEC can offer services and provide educational materials that no one organization can do alone.

Each SEC member organization regularly works with Sarasota County teachers and students, providing resources and educational opportunities that over the years have been a tremendous asset to the School Board. The intention of this pilot project is to look at ways SEC member organizations can collectively enhance science education in ways no one organization can do alone.

Staff at many SEC member organizations was involved in the pilot. In particular:

- Crowley Museum and Nature Center: Bill Cowdright and Becky Karnas

- G.WIZ: Aleks Spalvins and Chris Puchalla
- Historic Spanish Point: Mike Sprout
- Lemur Conservation Foundation: Penelope Bodry-Sanders and Monica Hoffine
- Mote Marine Laboratory: David Niebuhr and Tim Oldread
- Marie Selby Botanical Gardens: Donna Krabill
- Sarasota County Division of Urban Forestry: Demetra McBride
- Science and Environment Council: Myriam Springuel and Rogene Patterson

III. Overview of Pilot Year One

> *I would be interested in pursuing a career as a scientific researcher "because it seems like an interesting career field."*
> Student answer on post-field trip questionnaire

A. Enhancing Classroom Instruction

Pilot year one participants included one class of 25 on-level 9th grade science students from Booker High School. Two 9th grade science teachers, one 10th grade science teacher, and Booker High's Vice Principal were involved in the project. The Principal and Assistant Principal at Booker High School enthusiastically welcomed the pilot project and helped shape the direction it took. Six SEC organizations participated in the project.

The participating science class attended six field trips in six successive weeks. Additionally, each participating SEC member organization sent a staff member involved in the field trip to provide instruction at Booker High School for a comparison class. For that class, they provided a classroom lesson covering the same material as that presented on the field trip.

B. Field Trip Lessons and Activities at SEC Sites

The field trips and classroom lessons included information about careers in the sciences, and provided opportunities to interact with working scientists and science practitioners

about their work. In addition, the field trips and lessons correlated to textbook concepts and Sunshine State Standards. The field trips included:

Lemur Conservation Foundation
Determining the Properties of Soil and Geophagy in Primates
Taking on the role of anthropology intern, students began an investigation into why lemurs consume soil (a behavior called geophagia and practiced by all primates, including humans). Soil samples were taken on-site and students, working in small groups, chemically tested the samples and drew conclusions. A visit to one of the lemur enclosures to study the primates first-hand concluded the field trip. A staff researcher was on-hand to answer questions.

Sarasota County Urban Forestry Program
Our Ecological Footprint
At the beginning of this field trip, students were asked the question, "What is your ecological footprint?" The group learned about the role of mangroves, estuaries, and trees in nature's balanced system, as they walked the grounds of Marie Selby Gardens. Thermometers in-hand, they were able to see how trees moderate ambient temperature. By the end of the tour, students not only knew the impacts humans have on the natural environment, but also ways they could reduce the size and impact of their footprint.

Marie Selby Botanical Gardens
Pick Your Poison (Poison Dart Frogs) and *Horticulture*
Booker students began their tour of Selby Gardens by learning about the life cycle of poison dart frogs while studying them in a replicated natural environment. Four groups of students each observed a frog's eating habits and recorded the number of fruit flies it consumed. The fruit flies used in the observation were grown by students a couple of weeks prior to the field trip. Students visited several greenhouses and research laboratories including behind the scenes visits to the herbarium and spirit collection to talk with botanists. Students identified plant species, studied details under a microscope, and learned to prune plants and how to properly mount dried plant specimens.

Crowley Museum and Nature Center

Scientific Fieldwork

The 190-acre wildlife sanctuary at Crowley provided the means for Booker students to investigate five different Florida habitats. Small groups performed scientific fieldwork using soil pH meters, light meters, and thermometers in several different habitats and recorded their findings on data sheets. Back at the Learning Center, they discussed their research and reported to the whole class. Several students commented this was the first time they had ever been "out in the wild."

Mote Marine Laboratory and Aquarium

Scientific Problem-Solving

Students were treated to a behind-the-scenes dolphin training session at the Goldstein Marine Mammal Center on the Mote campus. The Behavioral Husbandry and Rehabilitation Coordinator on staff explained the process and answered a myriad of questions. Using a real-life example of a problem facing Mote staff, students were asked to figure out how to get a stranded 220 pound dolphin onto a truck for transport to the rehabilitation center. Working in small groups, students applied and tested their knowledge of simple machines.

G.WIZ Hands-on Science Museum

Exploring Electricity

In this exploration of electricity, Booker students participated in demonstrations of current, static, and magnetism, then experimented with an electrical device to test their knowledge of basic principles. The remainder of the field trip was spent in the two large galleries of the museum, where students could interact with a host of exhibits to learn different scientific concepts.

IV. Overview of Pilot Year Two

> *I think this is something other people should learn "because it is fascinating."*
> Student answer on post-field trip questionnaire

A. Enhancing Classroom Instruction

The basic project structure used in pilot year one became the building blocks for the project in pilot year two. In planning for the second year, participating SEC organization educators took a close look at the project's strengths and weakness during year one. A debriefing session at the end of year one involved SEC participants, Booker High's vice-principal, three science teachers, the Science and Health Program Specialist, and an independent observer from the evaluation consulting firm. Their comments were instrumental in refining the project and moving it forward. The 2007 evaluation report was also carefully considered, in addition to student and teacher surveys.

While changes to the project were suggested, there were also several key components Booker High School faculty asked to keep:

- The priority of the program should remain providing students with an off-campus experience. Changing the environment enhances learning and provides opportunities simply not available in a classroom context.
- Each student should continue to learn in a small focused environment with the kind of individualized attention provided in the first year.

For the 2007-08 school year, SEC expanded the project to four classes of 9th grade on-level science students at Booker High School. 69 students total took part in the project. Each class participated in three of six field trips to Marie Selby Botanical Gardens, Lemur Conservation Foundation, Crowley Museum and Nature Center, Historic Spanish Point, G.WIZ, and Mote Marine Laboratory. Sarasota County Urban Forestry Program provided two in-class lessons. In response to teacher comments, classroom pre-visits were added to the project. The pre-visits took place several days prior to each

field trip and served as an orientation to the field trip site and introduction to the lesson.

A new goal during pilot year two was to integrate science learning into a Small Learning Community's curriculum across several disciplines so that the field trips could serve as a culminating activity for several classes. To help teachers in non-science disciplines, SEC invited teachers within the Small Learning Community SCREAM (Science, Construction, Research, Engineering, Architecture, and Math) to attend two workshops. Six teachers and councilors chose to participate in the workshops.

To effectively achieve the planning, scheduling, topic coordination, and curriculum integration, preparation work began in August 2007, working with teachers during their annual preparation days in August. Because of alternating A and B Day scheduling initiated at Booker in fall 2007, and the increased number of classes participating, time and date restrictions became more challenging and limiting. As a result, each class attended only three of six field trips.

The field trips were scheduled throughout the school year. This allowed extra time between field trips to add pre- and post-visit student activities. Field trip topics coincided more closely with the teacher's in-class lesson topics.

B. Teacher Workshops

The addition of two teacher workshops encouraged SCREAM teachers to take an interdisciplinary approach by incorporating the field trip topics into their lesson plans. Teachers were given the opportunity to learn about each field trip topic and gather resource materials related to field trip sites and topics. Reading material, websites, classroom or homework activities, and research ideas were included in the resource materials provided by each participating SEC organization. A portion of the workshops was dedicated to brainstorming interdisciplinary approaches to teaching. SEC educators were available to teachers throughout the year to help incorporate classroom content and provide additional resources.

C. Classroom Pre-Visits

One observation from pilot year one was that it took precious time away from the field trips for the students to acclimate to the surroundings, listen to background information, and feel comfortable with the SEC educator. In response, classroom pre-visits were structured to serve as an orientation and to introduce the field trip topics.

Each included background/overview of the field trip site, related careers, an introduction to the topic, and hands-on activities. Whenever possible, they were scheduled during the same week as the field trip. 12 classroom pre-visits total were given (six SEC educators taught two classes each).

In addition, a classroom lesson and activity was presented to two classes by **Sarasota County Urban Forestry Program**. A brief description follows.

Survivor: Wasteland or Island
During this in-class lesson, students were divided into teams and "transported" to an urban wasteland. They live in an inefficient home with a treeless landscape, and have two dogs and two cars. Each team member was assigned a task or responsibility, then challenged to come up with ways to move their household from an urban wasteland to an urban island. Each presented their eco-upgrades/footprint downgrades, earning points accordingly. The team with the most points after two rounds was declared the winner. A discussion followed and take-home handouts were distributed.

D. Field Trip Lessons and Activities at SEC Sites

Information about careers in the sciences continued to be a focus of the pilot project. Students were informed of science-related careers and the training needed for those careers. Helping students understand how other disciplines inform science careers was included as well (for instance, the importance of English for writing science research reports, or of math for monitoring technical equipment and determining their reliability).

- Each topic was chosen from the students' textbook, *Physical Science with Earth Science.*
- Lessons align with Sunshine State Science Standards.
- Components include: introduction and/or discussion of science topic, on-site activity or lab, and interaction with science professionals.

Field trip topics were refined from pilot year one to year two based on comments, observations, and evaluation results. New topics are summarized below.

Marie Selby Botanical Gardens
Pick Your Poison (Poison Dart Frogs)* and *Horticulture

> *On the field trip I learned "what epiphytes are, how epiphytes help us in nature, and how some epiphytes catch their food."*
> Student answer on post-field trip questionnaire

Lemur Conservation Foundation
Determining the Properties of Soil and Geophagy in Primates

> *"I learned that the lemurs eat dirt to get minerals."*
> Student answer on post-field trip questionnaire

Crowley Museum and Nature Center
Understanding Your Watershed

A demonstration of how watersheds work introduced students to basic concepts, such as how land pollution affects water supply and quality. Groups of students walked through different habitats on Crowley's 190-acre site and collected water samples from the creek, swamp, and well. Each group tested water samples and recorded data. Findings were discussed and interpreted in regard to the local ecosystem. Crowley staff and a researcher with the Southwest Water Management District discussed their careers and answered questions.

> *The field trip was interesting "because you got to test the different waters."*
> Student answer on post-field trip questionnaire

Historic Spanish Point

Archimedes Principle

During the classroom pre-visits, students learned about the pioneer Webb family who lost substantial revenue from their cabbage crops because they did not own a boat capable of carrying the load to market. Students were instructed to use scientific research to design a model boat that can carry the most cabbage possible to market. For a homework assignment, material was provided to make three model boats to load test with pennies (cabbage). During the field trip to Historic Spanish Point, each team recreated their best-designed boat, based on their experiments. The team with a boat that carried the most cabbage without sinking, won.

> *"The displacement of water" was one of the things we learned on the field trip that relates to what we are learning in school.*
> Student answer on post-field trip questionnaire

G.WIZ Hands-on Science Museum

Exploring Electricity

> *On this field trip, "I learned about static electricity, amps, and volts." In class "we are learning about positive and negative charges in electricity."*
> Student answer on post-field trip questionnaire

Mote Marine Laboratory and Aquarium

The Physical Parameters of Water and Its Inhabitants

On the shore of Sarasota Bay, students were introduced to the estuarine ecosystem and were given sampling equipment (nets, core samplers, sand sifters, and buckets). With samples in-hand, students discovered locally occurring marine species and shared their findings. Students also participated in a "convection in liquids" lab to learn about currents and observed a density demonstration. The field trip concluded with a visit to Mote's aquarium.

> *"I learned about convection currents." This is something other people should learn "because it's important to know things about where you live." To teach others about this, "I would conduct a field trip to the Florida Keys."*
> Student answer on post-field trip questionnaire

E. Sunshine State Standards

In addition to refining content for pre-visits and field trips, SEC educators considered time constraints and structured activities to fully engage small groups of students. All field trip lessons were aligned with the teacher's classroom lessons and incorporated State Science Standards.

> An observer/photographer at the Historic Spanish Point field trip made this comment:
> *"Because I was wandering amongst them taking the pictures, I was able to overhear their comments and asked some questions of my own. Several of the boys said they were getting more out of this experiment at the museum than they would have in the classroom. One of the girls told me she had researched freighter ships for tips on creating cargo space and capacity. She ended up being on the team that "won" the challenge. I believe their high sided boat held over 375 pennies."*

V. Evaluation

A. Evaluation: Pilot Year One

> *"In school we learned how to get the pH of water, and [then] we did it on the field trip."*
> Student answer on post-field trip questionnaire

Consensus among Booker High science teachers, the assistant principal, SEC educators, and the evaluation consulting firm, was that the first year of the pilot provided experiences that enhanced student interest in science and has the potential to interest students in science careers.

The evaluation utilized a science attitude survey, field notes, and post-trip surveys to assess the pilot's success in improving student attitudes toward science. Three groups of students were evaluated. To provide consistency across the groups, they all had the same teacher, Rosemary Schmidt. One 9th grade on-level integrated science class received instruction related to the curriculum via field trips to SEC sites. An honors science class received similar instruction presented by SEC staff, but in the classroom. One on-level class served as the control group and received traditional science instruction.

Science attitude was measured using a standard test – Science Attitude Inventory II (SAI II). Results of the SAI II showed that students who attended the field trips demonstrated consistently better attitudes toward science than students in the control (traditional instruction) or comparison (SEC in-class) conditions, although only the difference between the field trip and comparison groups was statistically significant. This finding was seen on the overall total scale of the SAI II, as well as the composite positive subscale and two individual subscales (5-A and 6-A):

- 5-A: Progress in science requires public support in this age of science; therefore, the public should be made aware of the nature of science and what it attempts to do. The public can understand science and it ultimately benefits from scientific work.
- 6-A: Being a scientist or working in a job requiring scientific knowledge and thinking would be a very interesting and rewarding life's work. I would like to do scientific work.

The statistical results are reinforced by the pilot teacher's report that by the end of the year, the students in the field trip group were utilizing her as a mentor and were more willing to interact with her and listen to her advice than students who were in her other classes. She felt that the students who had the experiences outside of the school environment got to know her better, and the shared experience of the field trips was a method of reaching a different level of interaction with her students. She was also convinced that the hands-on interaction students experienced during the field trips provided more stimulation than the class lab, even though the labs taught the same content.

Differences were also noted in the field trip students' responses over time on the SEC post-trip surveys. For example, students responded to the surveys given after the first field trip with short single word responses, while later survey responses were more elaborate and related to specific field trip experiences. Additionally, during the later field trips, students were overheard discussing earlier field trips.

The evidence – both quantitative and qualitative – indicates that field trips increase students' attitude toward and possibly interest in science, and allows more student interaction with positive role models in the various scientific disciplines. It is apparent from these findings that multiple science-related field trips further develop student engagement and help students develop connections from one trip to the next, as well as between the concepts they are studying in class and the real world. The changes seen in the students who attended the field trips are not seen in either the control group (traditional instruction) or the comparison group (SEC in-class presentation). The results are even more compelling in that the comparison group (SEC in-class presentation) consisted of honors students who are traditionally viewed as excelling in science and presumably have a more positive attitude toward science.

B. Evaluation: Pilot Year Two

> *"We learned about three cultures that will help in World History class."*
> Student answer on post-field trip questionnaire

The same evaluation-consulting firm was again hired to conduct an evaluation of the project. Their assessment report for pilot year two was not conclusive about the affective impact toward science on students participating in the field trips, but found that their responses to questionnaires suggest a positive impact. Furthermore, questionnaires show the majority of participants in the teacher's workshops responded positively.

Evaluation consisted of student and teacher questionnaires, as well as a pre- and post-field trip attitude survey (SAI II). Science attitude data was collected from all students participating in the project. A class of 11 science students not participating in the project was used as the control group. There was no comparison group used in pilot year two.

The most valuable measure of student evaluation was in the form of questionnaires administered to students shortly after each field trip they attended. The majority of students responded in a positive manner to the field trips, indicating specific information they learned at each site, how it is relevant to what they are learning in class, and listing more specific, rather than general, science-related career titles. The evaluation report concluded, "Overall, the responses demonstrate not only a greater understanding of scientific endeavors, but also an increased appreciation for the different types of activities in which scientists engage."[vi]

The results of the SAI-II student survey did not show a significant change in attitudes toward science for students who attended the field trips nor the control group. However, the report points out that the control group was drastically smaller (11 students) than the field trip group (69 students), and therefore put limitations on statistical comparisons.

The SAI-II asked two questions that required written responses: What words come to mind when you think of a scientist? And: What areas of science do you like most? Students in the control group provided basically the same responses to both administrations of the survey (at the beginning of the school year and at the end). Students participating in field trips "…consistently provided responses that demonstrate a greater understanding of the applications of science to their own lives." Prior to field trips, their answers were broad and general. By the end of the field trip series, answers and terminology used were much more specific. The evaluation report concluded this change demonstrates that students were getting a better understanding of science applications, as well as the variety of careers and activities in the science field. In addition, students, who did not respond to the "area of interest" question at the first of the year, did respond on the second administration of the survey after the field trips were completed.

Teacher responses to questionnaires related to both the teacher workshops and the field trips were mostly positive. Of the teachers who responded to the workshop questionnaire, all felt the time was well-spent and afforded them the opportunity to share ideas. The teacher workshops were especially beneficial to the two science teachers whose classes participated in the field trips. The workshops allowed them a preview of planned activities at each field trip site and provided resource material for homework assignments and their own lesson plans. It also gave them the opportunity to ask questions and make requests/suggestions regarding topic focus or activities. One teacher commented, "I was particularly interested in the boat building activity even though my students will not participate in that field trip. I will also use some of the demos that Chris shared for his electricity unit at G.WIZ."

The interdisciplinary approach to the workshops was well-received by teachers and SEC educators. Science, math, and English teachers as well as councilors involved in SCREAM were invited to the workshops. The first semester workshop in October was well-attended and overall comments from teachers were positive. The second semester workshop in April was not as well-attended.

A sampling of comments from the teacher workshop questionnaire is cited below.

> Very well thought-out lesson plans were shared. I could tell that the various people had spent a lot of time thinking about and planning their activities.
>
> I would like to see the program expand to other teachers as well.

> I have already heard from some of my students about how much they are looking forward to these field trips.
>
> I just want to thank the whole SEC organization for devoting so much time to students. I hope you will continue to share your knowledge and experience with BHS students. I know sometimes it doesn't seem like they appreciate what you do, but I really think it has a positive impact on enough students that it is a tremendously worthwhile project.
>
> I think that well planned, relevant field trips help kids connect "classroom" learning to real world situations. If they can make a connection, they learn better.

The two science teachers who participated in the project had the following comments at the end of pilot year two:

> Several students said that they learned more going on field trips than they learned sitting in class.
>
> Students' attitude and behavior were much better in and outside of class.
>
> The environment is different and that helps with a different way of interaction.
>
> I think that there were a few students that were already interested in science and the field trips helped them make a stronger commitment to pursuing that as their career choice.
>
> I thought it was a terrific program this year. It seemed much more organized than last year and it benefited the students because what we did on the field trips correlated with our curriculum and acted to reinforce some of the things we did in class. I would like to see more diversity in the activities for the students (Lemur and Crowley were too much alike).
>
> I think the program is wonderful and I hope we are able to continue and expand. If I seem a little uncertain of the results, it's not because of the program: it's because of the students. This group of students was just not as appreciative as the group I look last year and they were really a tough bunch of kids. But I feel the field trips did help achieve a little progress with them which otherwise wouldn't have happened.
>
> One thing I did notice was that they approached me more often on the field trip than what they do in class. In class they act like they could care less what I have to say, but on the field trips, they seemed to value my opinion more.

Negative remarks from both teachers and students, for the most part, centered on transportation problems, cold weather at one of the outdoor sites, and time restraints.

Teachers attending the fall workshop agreed that the interdisciplinary approach to teaching would have a positive impact on both student learning and student attitudes. However, those teachers but did not respond to the follow-up survey.

C. Evaluation: Comparisons Between Year One and Year Two

In comparing evaluations of pilot years one and two, there appears to be several contributing factors that changed the field trip experience for students. Participating students in year one scored higher on the SAI II attitude survey at the end of the school year. One possible conclusion is that attending six field trips within a two month time span has a deeper impact than attending three field trips over the course of the school year.

Expanding the project to four classes in year two added logistical challenges, especially when scheduling field trips. The introduction of A Day and B Day student groups at Booker in 2007/2008 put time constraints on scheduling that were much more inflexible than in year one. This, along with busing problems on three occasions, resulted in less time at each site in year two, thereby lowering the quality of the experience.

Integrating science into a Small Learning Community in year two also presented logistical challenges that need to be addressed in the future. While teacher workshops were well received, improving workshop attendance will be a goal.

VI. Looking Forward

> *"I want to be a Marine Biologist as one of my career choices."*
> Student answer on post-field trip questionnaire

The Science Curriculum Enhancement Pilot is laying the groundwork for a long-term collaboration between SEC member organizations and Sarasota County Schools. It has the potential to enhance creative productivity in teachers working across the curriculum – specifically in using science to teach and enliven other subject areas – and to increase on-level student interest in science. This program advances Sarasota County School District's leadership in dynamic science education that prepares its students for an increasingly competitive world regarding science.

[i] Report submitted to SEC by Consult Jem: *The Effects of Field Trips on Attitudes toward Science; Science Curriculum Enhancement Project, Year One (2007)* and *The Effects of Field Trips on Attitudes toward Science; Science Curriculum Enhancement Project, Year Two (2008).*

[ii] Report submitted to SEC by Consult Jem: *The Effects of Field Trips on Attitudes toward Science: Science Curriculum Enhancement Project Year Two (2008).*

[iii] *Osborne, J., "Attitudes Toward Science: A Review of the Literature and Its Implications," International Journal of Science Education 25, no. 9 (2003): 1049–1079.*

[iv] *Turpin, T. & Cage, B., "The Effects of an Integrated, Activity-Based Science Curriculum on Student Achievement, Science Process Skills, and Science Attitudes" Electronic Journal of Literacy through Science 3 (2004): 1–17.*

[v] *Nazier, G. L., "Science and Engineering Professors: Why Did They Choose Science as a Career?" School, Science and Mathematics 93, no.6 (1993): 321–324.*

[vi] Report submitted to SEC by Consult Jem: *The Effects of Field Trips on Attitudes toward Science: Science Curriculum Enhancement Project Year Two (2008).*