

BioSITE Summative Evaluation Report

Executive Summary

By Bernadette Chi, Ph.D. and Leah Reisman
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In the fall of 2011, The Research Group at the Lawrence Hall of Science at UC Berkeley was contracted by Children's Discovery Museum (CDM) in San Jose to conduct a summative evaluation study of BioSITE (Students Investigating Their Environment), a field-based environmental science education program. The Children's Discovery Museum has been operating the BioSITE program in its existing form for 20 years. Its flagship site is Pioneer High School (PHS) in San Jose Unified School District; this site is the focus of the BioSITE summative evaluation study. At PHS, BioSITE is offered as a field science elective course for tenth grade students that incorporates a mentorship component for fourth grade students from local elementary schools. This executive summary describes the design, methods, and findings for the summative evaluation study with recommendations and implications for BioSITE and CDM staff.

The summative evaluation study sought to answer the following questions:

1. In what ways, if any, does participating in BioSITE influence high school students' positive science identity, and their development of skills, knowledge, and tools to tackle the environmental challenges facing our world?

In particular, how does the program influence students' understanding of science and science thinking, their relationship to science, their connection to the environment, making a difference, and contributing to their community, their communication skills, their interest in science careers, and their understanding of the role and challenge of teaching?

2. In what ways, if any, does participation in the BioSITE program influence fourth grade teachers' instruction and their students' positive science identity?



The evaluation team used mixed-methods to address the study questions, including surveys of the high school BioSITE participants, BioSITE alumni, and fourth grade teachers, individual high school student interviews, journal responses from high school students, focus groups of fourth grade teachers, and observations of high school and fourth grade students to document potential program outcomes. Extensive data collection took place between September 2012 and February 2014.

Overall, the BioSITE program structure creates a potential pathway to provide students in fourth and tenth grade opportunities to deepen and/or expand their understanding of science and the environment in San Jose. At the high school level in particular, the program draws high school students to the program for different reasons, and also allows them to gain from the learning experiences in different ways. For example, as evidenced by the pre and post survey findings, the program attracts students already interested in science, but some students also reported being initially interested in BioSITE because of an interest in the environment or in teaching younger students.

Regardless of students' initial or primary interest in applying to participate in BioSITE, the program provided opportunities to reinforce an understanding of the nature of science that is active and participatory; that is focused on data collection, analysis, and communication of science; and that includes science content and skills not taught in typical science education classes but represent a more accurate understanding of the work of scientists. Fundamentally, BioSITE provides an important opportunity for students to continue on their pathway to become more scientifically literate citizens.



BioSITE provided *high school student participants* with important opportunities to deepen and enhance their engagement with science and science education. As a supplementary elective course, BioSITE served to move each student forward on his or her pathway toward becoming a scientifically literate citizen.

Especially pronounced were student outcomes related to personal development, communication of science, and students' connection to the environment, important components of students' development as citizens equipped to address the environmental issues facing our world.

I have become more confident in myself and more interested in learning. I have learned how to better ask questions and I also have more respect and appreciation for my teachers because I know what they go through.

- 2012-13 High School BioSITE Student

Personal development & communication:

In end-of-course journal prompt responses, 94% of BioSITE students mentioned a way in which they have developed personally as a result of the course. Additionally, 75% of interviewed BioSITE students mentioned a way in which BioSITE improved their communication skills.

Connection to the environment: Based on student journal responses, all BioSITE students entered the class interested in and concerned about the environment. BioSITE deepened, expanded, and empowered students' relationships with the environment—only 14% of BioSITE students reported that their relationship with the environment did NOT change as a result of the course. The program was especially influential in teaching students that they can make a difference in the environment, as 92% of interviewed students said that BioSITE taught them they can make a difference in the environment as individuals. In journal responses, 53% of BioSITE students overall reported that they learned how to make an impact on environment (as individuals) or about the human impact on the environment, and 44% reported a deeper understanding and awareness of the environment, or that they notice more in environment.

Learning about science in BioSITE has shown me how much more attention I need to spend on the environment. It has shown me how the environment is connected with every living thing. BioSITE has definitely made me more environmentally aware.

- 2012-13 High School BioSITE Student

I've always loved science but I think it's also encouraged me more. Just gave me a little extra push... I think I've become more of a scientific person.

- 2012-13 High School BioSITE Student

Relationship to and understanding of science. At the beginning of BioSITE, the majority of students had positive relationships to science, felt as though they were good at science and could do science thinking, and felt that science was important to them. Participating in BioSITE expanded and deepened high school students' already complex understanding of science. In addition to teaching students new science content, the course reinforced students' thinking about science, and also made some students' ideas more complex, connecting their ideas of science to their views of the environment and helping them to move away from "stereotypical" views of science. In journal entries, the percent of students who mentioned stereotypical ideas of science decreased from 55% of pre-course responses to 28% of post-course responses.

17% of high school BioSITE students also participated in BioSITE as a fourth grader, indicating BioSITE's potential to serve as a tangible pathway in students' engagement with science.

Three of these students were interviewed as part of the summative evaluation study. All reported positive experiences as fourth grade participants, and two claimed that their fourth grade experience motivated their interest in science.



The BioSITE class aligned with many of the elements PHS sophomores claimed made science class meaningful and engaging. Correspondingly, high school participants in BioSITE found the class to be meaningful and engaging.

BioSITE students reported in interviews that the course was better than other science classes because it was more hands-on and takes place outside, because course content was relevant to student lives and students applied concepts they learned, because the course provided students with opportunities to engage with the real process of science, and because the course facilitated social interaction.

Data from *BioSITE alumni* provided evidence to suggest that the BioSITE course's impacts on high school students related to their communication skills, relationship to science and the environment, and understanding of science persist after they finish the course, and to suggest that BioSITE may have influenced some students' choices of college majors and careers. BioSITE alumni who responded to a voluntary survey reported very positive reflections on the BioSITE program both in terms of their experience in the program and its effect on them.

Alumni reported that the course had particularly strong influence on their development of leadership and communication skills, their ability to work in teams, and their presentation skills. Alumni also reported strong influence on their belief that they can make a positive difference in the environment, their interest in the environment, and their motivation to make their community a better place.

Additionally, 30% of the total number of alumni survey respondents indicated that BioSITE influenced their career goals.

The program definitely made me realize my impact on our environment and how educating our community can increase others' understandings as well. It definitely gave me new insight on the environment.

- BioSITE Alumnus

It made me interested in the environment. It partly influenced my decision to take AP Environmental Science. I ended up majoring in environmental economics and policy in college.

- BioSITE Alumnus

Evaluation findings suggest that BioSITE positively influenced *fourth grade students'* connection to the environment, perception that science is “cool,” and comfort in some foundational science skills. Fourth grade BioSITE participants are just beginning on their pathway toward becoming equipped to tackle the environmental issues facing our world, and the BioSITE program has the potential for additional impact in this area.

Hands on activities [are] also, I believe, very valuable—being out there, even using those goggles for the first time, any equipment they work with that they have not seen before or don't know the purpose of, was very valuable.

- Fourth Grade Teacher

Having that interaction [with the high school leaders] and giving [the fourth grade students] that opportunity for someone else to work with them, to give that positive feedback and positive reinforcement was very good for my students.

- Fourth Grade Teacher

84% of the fourth grade teachers who participated in the BioSITE online survey (21 of 25 survey respondents) reported that the BioSITE experience was valuable or very valuable for their students. They cited the hands-on science opportunities provided to students in an outdoor setting and the existence of the high school student leaders as role models as the most valuable program elements.

Teachers suggested ways in which the program could improve to further improve the program's influence on fourth grade students. The main program component cited as least useful was that journals were used inconsistently by high school students—improvements regarding the use of journals has potential to deepen BioSITE's influence on fourth grade students' science identity.

River site visits, hands-on activities, and access to BioSITE staff as science content helped to bolster *fourth grade teachers'* confidence in teaching science. Revisions to the program have the potential to increase equitable access to BioSITE opportunities and to better support teachers' integration of BioSITE in their classrooms and their science instruction in general, in light of the recent Common Core Standards implementation.



In summary, the BioSITE program creates a pathway to provide students in fourth and tenth grade opportunities to deepen their understanding of science and the environment.

At the high school level, by supporting students on their individual learning paths BioSITE facilitated students to progress along their learning trajectories in individualized ways. Through participating in BioSITE, students became more global citizens with stronger connections to their environment and who felt confident and empowered about themselves as learners, leaders, and contributors. Findings suggest that students may maintain these gains after they finish the course.

Findings suggest that BioSITE is a valuable experience for fourth grade students that has the potential to support them in developing a positive science identity at the beginning of their science learning pathway.

BioSITE was also shown to support fourth grade teachers in teaching science. Revisions to the program have potential to deepen and expand BioSITE's impact in this area.



Recommendations for CDM staff regarding the BioSITE program focus on four topics: (1) Strengthening the pathway for science; (2) Revisions to program design; (3) Increasing support for teachers; and (4) Opportunities for further research.

Recommendations regarding *strengthening the pathway for science* include deepening the program's focus on fourth grade students, considering a middle school BioSITE component to "complete" the pathway, sharpening program messaging around science careers, and considering ways to systematically engage BioSITE alumni.

Recommendations regarding *revisions to the program design* include potentially restructuring course recruitment processes to yield students who are not already interested in science, and prioritizing and communicating key BioSITE outcomes to clarify expectations for staff and participants.

Recommendations regarding *increased support for teachers* include enhancing teachers' role in BioSITE, improving consistency in journal use in the program, expanding access to BioSITE at elementary school sites such that all students at a particular school get the same opportunities to participate, and leveraging BioSITE as an opportunity to support teachers in implementing the Common Core Standards.

Opportunities for further research include the potential for a retrospective study with BioSITE alumni, systematic research regarding program impact on fourth grade students, and research regarding the efficacy of different iterations of the BioSITE program.

**BioSITE
Summative Evaluation Report**

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Submitted to

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Introduction

In the fall of 2011, The Research Group¹ at the Lawrence Hall of Science at UC Berkeley was contracted by Children's Discovery Museum (CDM) in San Jose to conduct a summative evaluation study of BioSITE (Students Investigating Their Environment), a field-based environmental science education program. This report describes the design, methods, and findings for the summative evaluation study with recommendations and implications for BioSITE and CDM staff.

BioSITE (Students Investigating Their Environment) is a field-based environmental science education program developed and implemented by Children's Discovery Museum in partnership with the San Jose Unified School District. Started in 1993 in two schools, BioSITE supports students' study of the Guadalupe River watershed and now serves nearly 1000 children and youth annually in a total of 22 schools. Initially focused on serving fourth grade students, it has expanded to include programming components for high school students as well as periodically serving students in grades three through six from schools countywide. Today, BioSITE students engage in ongoing field studies and monitoring projects along the banks of four local rivers to study the overall ecosystem of the Guadalupe Watershed: the Guadalupe River, Guadalupe Creek, Los Alamitos Creek, and Los Gatos Creek, all of which are urban creeks running adjacent to participants' schools and through the communities in which they live. High school students work in small groups to teach and mentor small groups of elementary school students in conducting water quality tests, developing basic field study techniques, and pursuing inquiry-based science investigations. Through these rich experiences, the overall goal of the BioSITE program is to advance students along their learning trajectory, fostering positive science identity and the development of wide-ranging skills, knowledge, and tools to tackle the environmental challenges facing the world.

There are currently multiple versions of BioSITE in operation:

1. A yearlong program organized as an elective biology course at Pioneer High School
2. A yearlong program with Downtown College Prep High School in which program

¹ The Research Group at the Lawrence Hall of Science responds to the need for evidence-based educational materials, programs, practice, and policy. The Research Group contributes to excellence, equity, and innovation in science and mathematics education by: conducting applied research, evaluating the quality and impact of educational materials and programs, and developing assessments that measure knowledge and learning in science and mathematics. We specialize in evaluating programs that feature hands-on, inquiry-based science and mathematics for learners of all ages. The Research Group works in and across multiple settings including formal (in schools, districts, etc.), out-of school (afterschool, camps, communities), and informal (science centers, media, home). Team members have diverse backgrounds, professional experiences, knowledge, and skills. educational materials, programs, practice, and policy. The Research Group contributes to excellence, equity, and innovation in science and mathematics education by: conducting applied research, evaluating the quality and impact of educational materials and programs, and developing assessments that measure knowledge and learning in science and mathematics. We specialize in evaluating programs that feature hands-on, inquiry-based science and mathematics for learners of all ages. The Research Group works in and across multiple settings including formal (in schools, districts, etc.), out-of school (afterschool, communities), and informal (science centers, home). Team members have diverse backgrounds, professional experiences, knowledge, and skills.

components occur at CDM

3. A year-long program organized within two biology courses at Leland High School, and a similar program in partnership with Independence High School
4. In addition, CDM staff assisted Los Gatos High School in establishing their own BioSITE program, which the school now runs independently after three years of partnership.

In these versions of BioSITE programs, high school students teach and mentor elementary students to conduct scientific activities. CDM also runs a condensed version of BioSITE called the ACE (After Class Experience) program, in which CDM staff members teach fourth grade students similar material to that taught in other iterations of the BioSITE program but with fewer field visits.

The Children's Discovery Museum has been operating the BioSITE program in its existing form for 20 years. Its flagship site is Pioneer High School (PHS) in the San Jose Unified School District; this site is the focus of the BioSITE summative evaluation study. At PHS, BioSITE is offered as a field science elective course for tenth grade students that incorporates a teaching and mentorship component for fourth grade students from local elementary schools. After describing the program and summarizing relevant literature to provide context, this evaluation report summarizes research questions, study methodology, findings, and recommendations to address the research questions with the goal of providing CDM staff with insight about the impact of the BioSITE on its high school student participants and on participating fourth grade teachers and students.

Program Description: BioSITE at Pioneer High School

On a given day in the PHS BioSITE program, students can be found knee-deep in Guadalupe Creek, a creek located on the outskirts of their school campus. Collaborating with their peer teaching partners, small groups of two to three high school students engage their fourth grade students in various science units that include learning about elements of the salmon lifecycle, characteristics of macroinvertebrates, and the implications of water quality for local ecosystems (to name a few). The high school and fourth grade students collaboratively engage in hands-on exploration of the features and organisms in their local environment, drawing on visuals and other teaching materials that the high school students created for that day's lesson.

Guided by their high school mentors, fourth grade students practice core scientific skills such as observation and water testing, play educational games focused on that unit's theme, and make sense of the data they collect and document in their field journals to construct an evolving portrait of the health of their local watershed. On classroom days, groups of high school students engage in critical reflection about the successes and challenges of their last teaching day, work collaboratively to develop the activities and materials for their next lesson,

and, guided by the course instructors, engage in group exploration of the topics they will teach to their fourth grade mentees.

Over the course of the year, the PHS BioSITE high school students work in small groups to learn scientific content and to prepare and teach lessons to fourth grade students. They focus on field science practices such as water quality monitoring and science content in the context of the Guadalupe watershed ecology at their local river site. The year begins for high school students with over one month of learning how to be a teacher and mentor and initial science content before they begin their first unit of teaching (of a total of seven units). Each unit begins with two to three weeks of learning science content specific to the unit and one day of field training with the activities that the students will use on the river site. The following week, students write their lesson plans for the unit and carry out their first of three teaching days on that topic; each of the teaching days (also called field days) is spent with a different group of fourth grade students from three different elementary schools. The high school students then begin learning science content and concepts for the next unit while continuing to teach the previous unit to their students.

This cycle repeats through all seven units over the course of the school year. These units include: watersheds and journaling, riparian communities, water quality (a topic that, once introduced, continues as a theme throughout the course), birds (concentrating on owls), fish (concentrating on salmon), macro-invertebrates, and environmental stewardship. In total, high school students spend a total of 21 days (31.5 hours) teaching the fourth grade students. In addition to the above activities with the elementary school students, the high school students also complete an independent river-mapping project, which entails field research at the river site.

As a result, each elementary school class receives seven days of instruction by high school students at the river site. A total of 6.5 elementary school classes and 180 elementary students were served by the PHS BioSITE program in the 2012-13 program year. After each field day, the fourth grade students are expected to complete journal prompts in their classroom reflecting on the experience of the BioSITE field day and the content they learned. During the 2012-13 program year fourth grade teachers were also offered the option of completing a whole-class project with their students related to the BioSITE course. Teachers could design their own project or choose from a variety of projects pre-designed by CDM staff. Titles of the 2012-13 projects included Pointilism, Journaling, Cube Journaling, River of Words (ROW), Buddy Watershed, Mapping, and Schoolyard Habitat. Not all teachers chose to complete a whole-class project.

The BioSITE course at PHS has been co-taught for the last ten years by Robert Zaccheo, the current Science Department chair, and Biret Adden from Children's Discovery Museum. Mr. Zaccheo and Ms. Adden collaborate to plan and deliver the year-long curriculum. Mr. Zaccheo teaches the high school students science content at the tenth-grade level and trains them in mentoring younger students and in writing lesson plans; Ms. Adden also provides guidance in working with fourth grade students and models how to teach the science content at a level appropriate for fourth grade students. Assisted by Ms. Adden's field observations, Mr. Zaccheo conducts all evaluation of high school student performance, and Ms. Adden prepares and maintains equipment and field activities, and coordinates partnerships with elementary schools.

BioSITE has evolved over the years into the current program format. The program always focused on teaching and mentorship of fourth grade students due to the alignment of BioSITE content with fourth grade science content standards. The program was initially taught by college students, but eventually transitioned to high school student teachers and the partnership with PHS through its service learning focus. BioSITE at PHS initially took place embedded within a biology course and after several years became an independent elective course. The current PHS BioSITE teacher, Mr. Zaccheo, began teaching BioSITE in 2002, a few years after it became an independent course. Several years later, BioSITE staff instituted an application process for the course, which marked a turning point in the student composition of the class. Before the application process was instituted, the course was made up of a wide range of students who demonstrated varying levels of commitment to the course; after the application process was instituted, the course began to attract higher-achieving students, many of whom are at the Honors/Advanced Placement level. BioSITE attracts significantly more female students than male students—the 2012-13 student population was made up of 27 girls and 9 boys. This is notable given the discrepancy of girls and women in science careers and fields of study.

Through these varied experiences, activities, and components, the BioSITE course aims to help students advance along their science learning trajectory by providing them with a complex matrix of opportunities through which they develop their positive science identity and the skills, knowledge, and tools to address environmental challenges. Focused on this goal, CDM staff retained The Research Group in efforts to examine the impact of participation in the BioSITE program on the various groups of stakeholders involved. Data were collected during the 2012-13 school year, which was considered a fairly typical program year according to program staff.

In preparation for the evaluation study, staff from The Research Group conducted a brief literature review to better understand BioSITE program components and to develop and refine a logic model for the program. The following section summarizes the literature review and presents the logic model that was the result of the process and that guided the identification of outcomes for the summative study.



Literature Review

To help inform the study and situate the BioSITE program within the research literature, the evaluation team conducted a literature review of program elements central to BioSITE program design including (1) service-learning with the intent to “make a difference,” and (2) cross-age teaching and mentoring. In addition, research relevant to the following BioSITE program goals was also reviewed: (1) environmental conservation and stewardship, (2) positive youth development and (3) positive science identity. In the program, these components make up the program’s overarching goal to develop a cadre of individuals with a positive science identity prepared with skills, knowledge and tools to tackle the environmental challenges facing our world.

Service-Learning

As an instructional strategy utilized in classrooms and community-based programming, service-learning has been a growing educational phenomena since 1990 when it was first introduced through federal legislation and funding. In 1984, an estimated 2% of K-12 schools nationally offered service-learning; currently 24% of K-12 schools (and 35% of high schools) now report offering service-learning, engaging an estimated 20,400 K-12 schools and 4.2 million students (Corporation for National and Community Service, 2008).

Various elements of service-learning experiences make them unique. For example, they combine meaningful service activities that fill recognized needs in a community with linkages to the academic curriculum that are specifically designed to meet particular learning and curricular goals (RMC & NYLC, 2008). In the case of BioSITE, the high school students teach science content and field-based data collection practices (e.g. testing water quality) to fourth grade students while promoting environmental conservation and stewardship of their local watershed. Another element of quality service-learning experiences incorporated into the BioSITE program is youth voice, in which the high school students are involved with the design and implementation of the service-learning activities, including creating lesson plans for their fourth grade students. In addition, the course includes ongoing reflection and monitoring of progress by the high school students and occasionally the fourth grade students through verbal and written reflection before, during, and after the activity. Literature suggests that service-learning opportunities may support a wide range of personal, social, civic and academic outcomes (Billig, 2000; Eyler, Giles & Gray, 1999; Gray, 1996; RMC Research, 2002/2007); this is explored further in report findings. Research also indicates some reasons why service-learning programs may work well to engage youth in these various areas of learning and development, particularly in science and youth development:

Contextualized, Authentic Learning Experiences: The National Research Council suggests reforming science curricula to foster students’ capacity to make connections between classroom science and beyond the classroom, in part, by making learning relevant to the students’ experiences, cultures, and long-term goals (NRC, 1996; NRC 2003; NRC, 2007). This contextualized approach is thought to be particularly valuable for learners who are less likely to persevere through school tasks that lack intrinsic meaning. Constructivist approaches to learning, called variously problem-, inquiry-, and project-based learning can help students find intrinsic meaning in learning activities. In

the case of service-learning, students' experiences are based in the realities of their local circumstances as students conduct community-based service on particular social issues in ways that are integrated with their academic curricular content. The work that students conduct is designed to have real consequences for students' communities. Authenticity in service-learning is considered an important component because it supports students' full investment in tasks (Slavkin, 2004). Students are motivated to contribute and this pragmatic desire supports completing mundane tasks necessary to achieve long-term goals and struggling with complex problems. But because these tasks are part of a purpose greater than getting a grade, students are more likely to persevere. Service-learning can provide contexts with genuine opportunities to use science learning toward personal and communal goals.

Collaborative and Social Learning: Collaboration is critical to learning how science works, particularly the nature and practices of science, because it provides opportunities for meaning-making through discourse (Brown, 2004; McNeill & Pimentel, 2009; Nystrand, Gamoran, Kachur & Prendergast, 1997; Rosebery, Warren & Conant, 1992). Service-learning projects offer opportunities for group or cooperative learning that would support collaboration in science learning environments as students work together to plan and implement activities.

Personal Relevance: Science education research also suggests that attention to increased personal relevance of STEM (Barton, 2001; Clewell, Anderson & Thorpe, 1992; Kahle, Meece, & Scantlebury, 2000) and a focus on STEM as fields that can benefit others (Noddings, 1992; Oakes, Gamoran & Page, 1992) is helpful in supporting student learning, particularly reaching students traditionally underrepresented in science, including girls and students of color. This is supported by the high number of female students in the BioSITE course. Service-learning projects, with their emphasis on the elements of youth voice and meaningful service, provide robust opportunities for students to create personal connections with STEM content, which may increase their engagement in STEM learning overall.

Cross-Age Tutoring and Mentoring

Cross-age tutoring and mentoring matches older youth with younger youth, in which the older students act as teachers and mentors to younger students (Hall & Stegila, n.d.; Dubois & Karcher, 2005). In the case of BioSITE, high school students prepare and present lessons to fourth grade students, facilitating science activities and discussions. Research on cross-age tutoring suggests a variety of benefits for the tutors and tutees, including moderate improvement in academic skills and attitudes toward the content area for both groups (Cohen, Kulik & Kulik, 1982; Greenwood, Carta, & Hall, 1988), as well as social skills development (Greenwood, Carta, & Hall, 1988; Foot, Shute, Morgan & Barron, 1990). Academic benefits are attributed to practice and communication, (Gaustad, 1993) and students' self-esteem increases through social interaction and contribution to classroom learning (Karcher, 2009), resulting in a more cooperative classroom and an improved school atmosphere (Gaustad, 1993; Gerber & Kaufman, 1981; Topping, 1988). The inclusion of cross-age tutoring and mentoring appears to yield a range of outcomes to support academic, personal and social development.

Environmental Education

Environmental education initiatives have expanded over the last 40 years, as concerns for environmentalism and sustainability have captured the global attention of youth, media, policymakers and the general public. As a science elective course, BioSITE falls within a tradition of school-based environmental education initiatives that engage youth directly in environmental issues and action (e.g. Wals, 2007), seek to foster environmental stewardship and literacy (e.g. Ardoin, Heimlich, Braus & Merrick, in press) and to promote conservation behaviors (e.g. Heimlich and Ardoin, 2008).

Positive Youth Development

Recent work by groups such as the Coalition for Science After School (Coalition for Science After School, 2007) and others suggest that through the integration of positive youth development (PYD) principles, the potential for science learning expands. The PYD framework has evolved over the last decade (Damon, 2004; Eccles & Gootman, 2002; Lerner, 2005) to include the “Five Cs” of competence, confidence, connection, character, and caring (Lerner, 2005). These characteristics emerge when youth are aligned during their adolescence with resources or developmental assets in their families, schools, and communities (Benson, Scales, Hamilton, & Sems, 2006). In both youth development and inquiry-based, hands-on science learning, students are at the center of the learning environment, developing their skills, building confidence and competence in their scientific practices, and working with others to make sense of their experiences. Science learning experiences such as BioSITE that focus on building high school students’ confidence and competence in teaching science knowledge and practices to younger students provide important opportunities to nurture both science and youth development outcomes.

Positive Science Identity

The concept of “science identity” has been defined in the literature in a variety of ways. Many definitions share some fundamental commonalities like interest in science, but also contain important distinctions. For example, definitions of science identity differ in their relative focus on future study or careers in science (Archer, DeWitt, Osborne, Dillon & Wong, 2010; Aschbacher, Li & Roth, 2009; Polman & Miller, 2010); their explanations of how identities are formed and influenced by personality, social norms, experiences, and interactions with others through various communities of practice (Polman & Miller, 2010; Shanahan, 2009); their ideas of science identity as separate or part of the individual’s broader identity that includes aspects of one’s race, gender and class and their respective social stereotypes (Archer et al, 2010; Aschbacher et al, 2009; Kozoll & Osborne, 2004); their conceptualization of science identity as fixed or fluid and changing (Aschbacher et al 2009; Kozoll & Osborne, 2004; Polman and Miller, 2010; Shanahan, 2009); and their conceptualization of science identity as something that is innately positive, versus the ability to have a negative or positive identification with science (Polman and Miller, 2010).

The definition of what it means to have a “positive science identity” is also contested. For example, Aschbacher et al (2009) define science identity as the sense of who students are, what they and meaningful others believe they are capable of, and what they want to do and become with regard to science. Having a science identity means thinking as someone who does science. Shanahan (2009) defines one’s identity in science learning as who we think we must be to

engage in science. For Polman & Miller (2010), a positive STEM identity reflects a positive trajectory of identification.

Environmental Stewardship and Agency

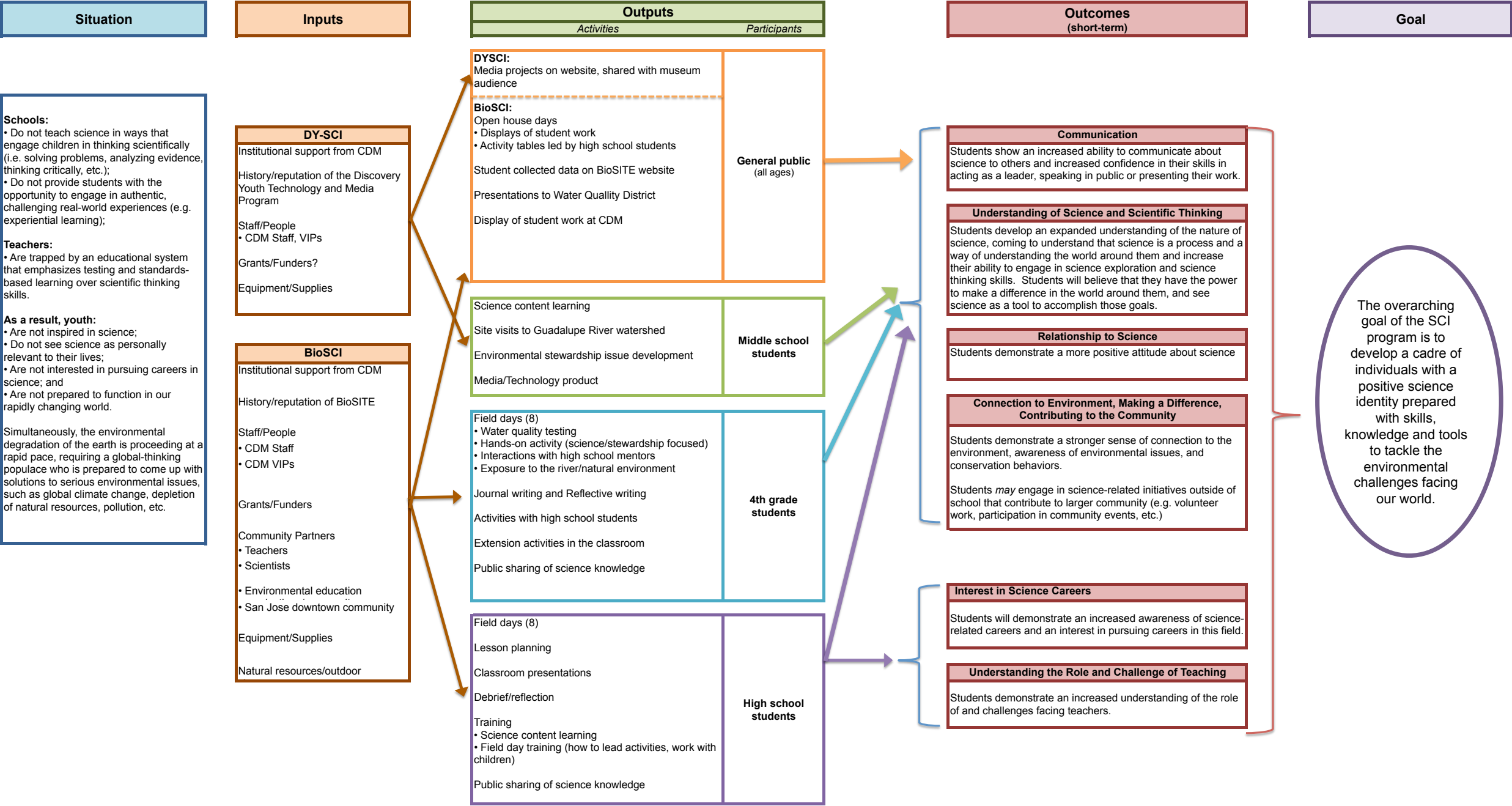
Given CDM's interest in developing environmental awareness and stewardship, other studies that focused on "relatedness" or "connectedness" to nature were also reviewed. Several of these studies were also selected because of their focus on instrument development related to environmental literacy and stewardship. In three studies (Powell, Stern, Krohn & Ardoin, 2011; Stern, Powell & Ardoin, 2008, 2010), the concepts of environmental and community responsibility, character development, and leadership/empowerment combined to make up a "positive identity." Someone with such a positive identity is defined to care about and feel self-efficacy to take action to protect their environment, to feel empowered and have a strong sense of self-responsibility, leadership abilities, and a positive relationship toward school. According to these studies, developing a sense of agency through interactions with others or contexts is an important part of developing one's positive identity (Powell et al, 2011; Stern et al, 2008, 2010). Positive identity is important to foster when young, and then becomes more stable, though the focus is primarily in the present with some reference to short-term goals (Stern et al, 2008, 2010).

Based on this literature review, the evaluation team worked collaboratively with CDM staff in early 2013 to refine a logic model to clarify what aspects of the program may support the development of positive science identity and the knowledge and skills needed to address today's environmental issues. The logic model that was the result of the process and that guided the identification of outcomes for the summative study is presented below.

The model is organized around six key outcomes-- students' understanding of science and science thinking, their relationship to science, their connection to the environment, making a difference, and contributing to their community, their communication skills, their interest in science careers, and their understanding of the role and challenge of teaching. Taken together, these outcomes comprise CDM's conceptualization of positive science identity and the knowledge and skills needed to address today's environmental issues. Through BioSITE CDM staff endeavor to move individual students one step further on their paths toward attaining this set of knowledge, skills, and dispositions.



SCI Programs
Discovery Youth (DY-SCI) and BioSITE (BioSCI)
Children's Discovery Museum of San José



Evaluation Questions

Originally following the CDM logic model, the summative evaluation study sought to answer the following questions:

1. In what ways, if any, does participation in the BioSITE program influence high school students' positive science identity, and their development of skills, knowledge, and tools to tackle the environmental challenges facing our world?

In particular, how does the program influence students' understanding of science and science thinking, their relationship to science, their connection to the environment, making a difference, and contributing to their community, their communication skills, their interest in science careers, and their understanding of the role and challenge of teaching?

2. In what ways, if any, does participation in the BioSITE program influence fourth grade teachers' instruction and their students' positive science identity?

Sample and Methods

The evaluation team used mixed-methods to address the study questions, including surveys of the high school students and fourth grade teachers, individual high school student interviews, focus groups of fourth grade teachers, and observations of high school and fourth grade students to document potential program outcomes. Extensive data collection took place between September 2012 and February 2014. Details about each of the data sources are described below, and copies of all data collection instruments are included in Appendix F.

In examining the impact of their participation in BioSITE, the following data were collected:

- **Pre- and post-surveys of the tenth grade class** at Pioneer High School were administered using iPads in August 2012 and in May 2013, resulting in a matched sample size of n=362. Students in special education and those who did not complete a science course in 2012-13 were excluded. Survey questions included fifty-five closed-ended items in eight scales that assessed understanding of science and science thinking; relationship to science; connection to the environment, making a difference, and contributing to the community; communication skills; interest in science careers; and the role and challenge of teaching. A single open-ended item was also included in the post administration only: "What, if anything, makes science class engaging and meaningful to you?"
- **Pre- and post-course interviews with twelve tenth grade BioSITE students:** Students were selected by Mr. Zaccheo to represent a range of students who participated in BioSITE. Four male students and eight female students were interviewed. Interviews were conducted by evaluation team staff in the fall of 2012 and in the late spring of 2013. Interviews lasted approximately 15-30 minutes, and covered students' expectations (in

the pre interview) and reflections (in the post interview) about the BioSITE course; connection to the environment and pro-environmental behavior, making a difference, and contributing to the community; communication skills; interest in science careers; and the role and challenge of teaching.

- **Post and retrospective pre interviews with six tenth grade non-BioSITE students:** In addition, Mr. Zaccheo recruited six tenth grade non-BioSITE students for interviews from his non-BioSITE biology classes who were comparable to BioSITE students in academic motivations and interest in science. Three male students and three female students were interviewed. Interviews lasted approximately 15 minutes, and covered students' expectations (in the pre interview) and reflections (in the post interview) about their science course; connection to the environment and pro-environmental behavior, making a difference, and contributing to the community; communication skills; and interest in science careers.
- **Journal responses from BioSITE students:** Students' application essays and first semester reflections were reviewed as qualitative data sources. Additionally, over the course of the year the entire BioSITE class, made up of nine male and twenty-seven female tenth-grade students, responded in writing to questions intended to gather data for the summative evaluation. Some questions were asked both at the beginning and the end of the year. Questions included:
 - *Administered October 2012*
 - How does observing nature affect the way you think about the environment?
 - What do you think of when you think of a scientist? (3-5 words/phrases or ideas)
 - Do you see yourself as scientist? Why or why not?
 - Why is it important to make a difference to the environment?
 - In what ways can you personally make a difference to the environment?
 - *Administered April 2013*
 - Describe how your ideas about science have changed by doing water quality testing.
 - What do you think it means to be a scientific thinker?
 - How can learning to think like a scientist benefit other parts of your life?
 - What do you see as the benefits to you of teaching the science concepts of BioSITE to elementary students?
 - *Administered May 2013*
 - Why is it important to make a difference to the environment?
 - In what ways can you personally make a difference to the environment?
 - In what ways, if any, has spending time outdoors this year affected the way you think about the environment?
 - What are the challenges to helping the environment in your everyday life?
 - What do you think of when you think of a scientist? (3-5 words/phrases or ideas)
 - Do you see yourself as a scientist? Why or why not?

- What do you see as the benefits to your elementary students of participating in the BioSITE program?
 - *Administered June 2013, at the end of the school year*
 - In what ways, if any, has learning about science in BioSITE this year influenced the way you think about the environment?
 - What do you see as the connection between science and the environment, if any? Has your opinion about this changed since participating in BioSITE?
 - We have seen many changes in each of you as the year progressed through BioSITE. What changes, if any, have you seen in yourself?
 - If you were in a job interview with someone who didn't know anything about BioSITE, how would you describe the program and why it is important to you?
 - If you were in charge of running BioSITE next year, including training the high school students, what would you do differently?
 - What pieces of advice would you give to the BioSITE Facilitators of next year?
- **Retrospective surveys of BioSITE alumni.** In response to a ten-year BioSITE alumni reunion event planned for December 2013, evaluation team staff conducted two online retrospective surveys of BioSITE alumni from the last ten years of the program for which a method of contact was available (295 students). The first survey (N=38), was primarily intended to collect alumni contact information, and was distributed via email and the Facebook page for the alumni event. It collected data about students' education, employment and activities since taking the BioSITE course. After the reunion event, the evaluation team distributed a second survey (N=69), which was also distributed via email and the Facebook page for the alumni event. This survey asked about the BioSITE course's influence on students' understanding of, relationship to and interest in science and the environment, communication skills, social skills, and development as people, and career goals. It also addressed students' education, employment and activities since taking the BioSITE course, as well as their goals in these areas.
- **Observations and field notes of BioSITE classes and field experiences:** Evaluation team staff observed six teaching days over the arc of one curriculum unit and one BioSITE open house at the Children's Discovery Museum to observe students' presentations of learning.

To examine the influence of participation in BioSITE on fourth grade educators and students, the following data were collected and analyzed:

- **Fourth grade elementary teacher online survey.** Fourth grade teachers participating in BioSITE were invited to complete an online survey (N=25) administered in April 2013. The survey was distributed via email by the BioSITE program manager. Survey questions included forty-two closed-ended items and seventeen open-ended items that assessed the BioSITE program's impact on fourth grade students' understanding of science and science thinking, relationship to science and the environment, and communication skills.

The survey also assessed the program's impact on teachers, the usefulness of BioSITE program components, and teachers' experience with the share project component of the program.

- **Fourth grade elementary teacher focus group.** A focus group of six participating teachers who worked with Pioneer High School students was conducted in May 2013. Focus group questions addressed the BioSITE program's impact on fourth grade students' understanding of science and science thinking, relationship to science and the environment, and communication skills. Questions also gauged the program's impact on teachers, the usefulness of BioSITE program components, and teachers' experience with the share project component of the program.
- **Fourth grade elementary student journal excerpts.** Over the course of the year fourth grade students participating in BioSITE responded to a total of eighteen questions to reflect on their experiences and the content they learned in the course. The BioSITE program manager selected approximately one journal response per student for the evaluation team to review.
- **Fourth grade elementary student survey.** As part of the summative evaluation, the evaluation team drafted a pre and post survey to administer to fourth grade students participating in the BioSITE program. The draft survey included twelve closed-ended items that assessed students relationship to science, relationship to the environment, and communication skills. The survey also included two open-ended questions to be included in the post administration: "What was the best thing about the BioSITE program?" "What did you learn from being in the BioSITE program?" This draft survey was not administered during the 2012-13 program year; CDM staff intend to pilot and refine the survey during current or future program years.
- **CDM staff interviews:** Evaluation team members also conducted interviews with Biret Adden and Jenni Martin of CDM and Rob Zaccheo of PHS to document BioSITE program history, goals and context. Interviews lasted approximately one hour.

Summative evaluation findings are presented below and are organized by stakeholder group. Each section describes findings in relation to goal outcomes.



Findings: Impact on 2012-13 High School Students

This section focuses on the variety of influences that students reported as a result of their participation in BioSITE. Findings related to communication of science are reported first as an important yet typically under-examined outcome of science education programs. This is followed by findings related to students' connection to and relationship with the environment, a key emphasis of the course. Rounding out this section are findings related to students' relationship with and understanding of science and science thinking. These findings draw from the following data sources: a pre-post survey of the entire PHS tenth grade class (n=362), interviews with BioSITE students (n=12), interviews with non-BioSITE students (n=6), four sets of journal responses from the entire BioSITE class (n=36), and observations of BioSITE classes.

Overall, BioSITE provided high school student participants with important opportunities to deepen and enhance their engagement with science and science education. BioSITE students entered the course already positively inclined toward science and the environment; as a supplementary elective science course, BioSITE served to move each student forward on their individualized pathway toward becoming scientifically literate citizens equipped to take action on environmental issues. Especially pronounced were student outcomes related to communication of science and students' connection to the environment.

Communication & Understanding Role and Challenge of Teaching

BioSITE in general, and the teaching of fourth grade students in particular, significantly contributed to students' communication skills and personal development as individuals. Students reported a wide variety of influences that matched their particular needs as individuals. In end-of-course journal prompt responses, 94% of BioSITE students mentioned a way in which they have changed as people as a result of the course. Students' responses of impact were grouped conceptually and are summarized below:

- Improved interactions with children
- Improved teaching ability
- Increased confidence with public speaking, increased patience with fourth graders, increased respect for nature
- Increased confidence or more outgoing
- More prepared or have increased discipline, have better time management, a better sense of responsibility, or a better work ethic
- Better at group work
- Improved leadership skills, increased respect and appreciation for teachers, increased curiosity or interest in science and environment
- More comfortable around others, have increased motivation to help the environment, more interested in learning, improved communication skills, more aware of or curious about their surroundings, more enthusiastic/involved, more flexible with plans, or grew as a person
- Increased motivation to work with kids
- Increased motivation to teach others

- Improved creativity
- Improved thinking skills
- Increased motivation to do more volunteer work
- The student can ask better questions
- The student realized things about him or herself
- BioSITE caused a potential career change
- BioSITE caused them to be a better listener
- BioSITE taught them to think on their feet and adapt to new situations

BioSITE student responses are exemplified by the below quotes:

I have become more confident in myself and more interested in learning. I have learned how to better ask questions and I also have more respect and appreciation for my teachers because I know what they go through.

I have become more patient and enthusiastic about everything. And now, I'm always seeing ways I can help the environment.

Post-interviews with BioSITE students reinforced the course's influence on students' communication skills and growth as individuals as 75% of interviewed students mentioned a way in which BioSITE improved their communication skills. In addition, BioSITE students grew in specific and personalized ways; in interviews, they mentioned the following influences:

- Improved ability to speak publically
- Improved confidence
- Learned how to work together in a group
- Deepened understanding of the mechanics of science communication
- Caused a realization of their aptitudes, weaknesses, and interests
- Increased openness
- Increased comfort around others
- Increased comfort interacting with others
- Increased comfort sharing ideas
- Grew as a person
- Realized how to improve in the future
- Learned about own thought process
- Increased ability to see from multiple perspectives
- Social bonds and teaching helped improve ability to see from others' perspectives
- Increased maturity

These changes are exemplified by the below quotes:

Now I have a lot more confidence than I did before. [...] Confidence in myself and my abilities to talk to other people and be comfortable around other people. And not be so reserved I guess, being a lot more open. . I guess adding along to

that, I also started working at my dance studio teaching the younger kids. And before I knew about this about a year ago, but I was really scared at first because I had never had experience. But BioSITE has helped tremendously with being able to speak out loud and not be afraid to say what I need to say. And just, I feel a lot more comfortable working with the kids now. I know if I didn't have that experience it would be a lot harder for me now.

I see that I've matured, and grown a lot, definitely grown smarter [...] [and in] becoming an adult, having a mindset of other people, other things, the future definitely, and definitely the present. [...] It helped me with the ability to put myself into someone else's shoes, and um, definitely showed me that I have the ability to make a difference and also teach. And influence other people, kids.

Interviewed students also reported several ways in which the BioSITE course helped them to understand the role and challenges of teaching. 33% of interviewed students asserted that, in dealing with the challenges of teaching the fourth grade students, they developed empathy for their own teachers, recognized the amount of work that goes into teaching, or felt increased respect for teachers. 17% of interviewed students reported that the teaching experience caused them to feel like an expert or to feel accomplished.

Additionally, students also mentioned the following impacts: The teaching experience...

- Caused guilt about bad behavior [in school]
- Caused increased maturity around school
- Caused a realization of the value of learning in context
- Caused increased consciousness of opportunities like BioSITE
- Caused a realization that teaching can happen anywhere
- Caused a lot of learning for the student
- Caused the student to have more patience in school and home
- Increased the student's confidence in working with kids
- Sparked an interest in children with disabilities (due to an experience teaching an autistic child)
- Caused a realization that the student is not a good teacher
- Caused the student to learn that they are not patient with kids
- Made the student more comfortable learning science
- Made the student more interested in learning in general

This finding is exemplified by the following quotes:

I just kind of learned how my thought process goes, and in terms of teaching the kids, I've learned a lot about myself while teaching them. I honestly have learned more than they have throughout this experience, because um, of like, the impact it's had on me. And I also have like, a lot more respect for my teachers now, because I know what it's like when kids don't listen.

I grew as a person, between knowing about the environment, working together in a group, knowing that I can make the difference just as myself, and just little things can spread. [...] You could understand what your teacher is going through because you could see the rowdy kids in the class and you could tell that it was annoying because you had to hear it. But then once you actually have kids being rowdy to you, as you're trying to teach something, it kind of turns this little light bulb in your head, like, oh, did I do that to one of my teachers before? And you just kind of feel bad. And then, it just kind of makes you more mature about situations.

Connection to the Environment, Making a Difference, Contributing to the Community

Based on student journal responses, all BioSITE students entered the class interested in and concerned about the environment, a status they maintained throughout the year. Augmenting this, BioSITE deepened, expanded, and empowered students' relationships with the environment. The program was especially influential in teaching students that they can make a difference in the environment as an individual, in deepening their commitment to the environment and motivation to make change, and increasing their awareness and knowledge of the environment and the degree to which they noticed their surroundings. In their responses to journal prompts early in the year, BioSITE students mentioned a wide variety of reasons why it is important to protect the environment. Students' responses were grouped conceptually; they mentioned the following topics in response to the below prompt:

Why is it important to make a difference to the environment?

- So that it is preserved for future generations
- Because we live in it
- Because it is a big part of our lives or influences our lives
- Because we need to protect water and wildlife
- So it doesn't disappear
- Because it is peaceful and beautiful, and a home to animals
- Because small things can have chain reactions
- Because everything is interconnected and shared
- Because the environment supports life, is very fragile, is a food and water source
- Because it will cause people to have a better life
- Because it is a part of us

Before taking BioSITE, student concerns about the environment and things that one could do to help spanned a wide variety of topics. Most also already engaged in some pro-environmental behaviors prior to participating in BioSITE. Concerns and actions persisted through the year. Student concerns expressed in pre-interviews included: chemicals in water, industrial smoke, rivers, global warming, trash, pollution, mercury, carbon dioxide, affecting future generations, and deforestation. Pro-environmental conservation behaviors that BioSITE students already engaged in prior to taking the class included: planting trees, carpooling, teaching kids about

environment, monitoring, conserving water, turning off lights, taking shorter showers, and avoiding plastic bags.

BioSITE reinforced for students the power of teaching and spreading awareness in environmental conservation. Additionally, in responses to journal prompts late in the year, the number of mentions of certain items increased-- ideas of the interconnectedness of ecosystems and organisms grew in prevalence, as did the idea that small actions can have effects. Mentions of the power of teaching or spreading awareness increased from seven mentions (19% of students) in the pre-course prompt to fifteen mentions (42% of students) in the post-course prompt, and the fact that small things can have a chain reaction and that organisms depend on one another increased from five mentions (14% of students) in the pre-course prompt to twelve (33% of students) in the post-course prompt. Post-interviews also showed small increases in the number of students who reported that telling other people or teaching children was a way to help the environment, and who mentioned watershed-related actions to help the environment (“pulling riparian vegetation”).

Despite already positive orientations toward the environment and making a difference, as evidenced by journal responses almost every student in the class reported that BioSITE affected the way they think about the environment. 53% of students overall reported that they learned how to make an impact on environment (as individual) or about the human impact on the environment, and 44% reported a deeper understanding and awareness of environment, or that they notice more in environment and know more about what they are seeing. 25% said that the class increased their motivation to make a change in their behavior or be more careful. 17% of students said that BioSITE gave them more appreciation for the environment or taught them the idea of the importance of the environment and caring for it. Smaller portions of students mentioned each of the following:

- Connected with environment in new way
- Increased awareness of role in environment
- Caused a desire to interact more with nature
- Strengthened ideas about/interest in environment
- Realized how easy it is to study the environment
- Learned that everything is important, has its specific role, and that everything is connected
- Now feel prepared to educate others
- Caused a more positive mindset about environment
- Feel more comfortable in environment
- Had a positive, hands-on experience with science

Only 14% of students said that their relationships with the environment did not change, because they have always loved and respected nature. Student responses were exemplified by the below quotes:

Learning about science in BioSITE has shown me how much more attention I need to spend on the environment. It has shown me how the environment is connected with every living thing. BioSITE has definitely made me more environmentally aware.

It has really increased my awareness. This class has really shown me that everything-even the little things-can make a difference. It has helped me to be a lot more environmentally conscious.

I think about the environment differently now because I know the little things I can do to help the environment. I know the different types of water quality that affect our waters, and how we can help.

The results of post-interviews with BioSITE students reinforced BioSITE's power to deepen students' relationships with the environment. 92% of interviewed students said that BioSITE taught them they can make a difference in the environment as individuals. 58% of interviewed students reported that BioSITE deepened their commitment to the environment, and 50% reported that the course deepened their knowledge of the impact of their actions. Among other impacts, smaller numbers of students also reported that BioSITE increased their awareness of the environment and pollution, caused proactivity and increased vigilance around their personal behavior, taught them new ways to make a difference, taught them how everything is interconnected, caused awareness that the earth is constantly changing, increased their appreciation of and respect for the environment, and caused them to understand themselves as part of the environment. These influences are exemplified by the below quotes:

Before, if someone was like, oh pick up your trash, it's going to get into the ocean, I'm like, okay, how is it going to get from our school all the way to the ocean. And now I know, the rain will carry it to the gutters, and then it goes down and goes to the river, and I know all the stuff, then it goes to the bay. So I kind of know how everything works, and I have more appreciation of the environment. [...] It's especially important to learn about the environment because everything is connected. So it makes kind of more sense in how it applies to me.

In BioSITE, we learned that the little things we do cause chain reactions right? So just by save-- conserving water or by picking up litter or trash that we see, can make a really big difference. And I feel like if more people had that mindset then our world would be a lot cleaner.

And I think even though I'm just one person, I can do a lot. I can start something; I can do a foundation, or anything. We could plant more in the environment and just help it more...I respect it way more. And I just feel now I have all this

knowledge about it, I feel like I am helping. Like I should be helping and I am helping.

Understanding of Science and Science Thinking

Participating in BioSITE expanded and deepened high school students' already complex understanding of science. In addition to teaching students new science content, the course reinforced students' thinking about science, and also made some students' ideas more complex, connecting their ideas of science to their views of the environment and helping them to move away from "stereotypical" views of science.

When responding to a journal prompt early in the year regarding what comes to mind when thinking of a scientist, 55% of all BioSITE students mentioned more "stereotypical" ideas of science in their response. Examples included, "when I think of a scientist I think about people who invent new machines, using different chemicals, and doing all kinds of experiments," and "Lab coat. Explorer. Lab Tubes." However, many students mentioned more than one idea about science in their response, as 86% of BioSITE students described non-stereotypical ideas of science, including the notion that scientists are curious and that scientists want to know more about our world and make it better.

Results differed slightly when examining interviews conducted with a subset of BioSITE students. It is important to note that the journal prompt described above was administered before the course unit on "breaking the stereotype [of science]" was taught, while the student interviews occurred AFTER this unit was taught. Therefore, the journal prompt findings can be taken as more accurate representations of students' understanding of science and science thinking at the beginning of the BioSITE course.

Though interviewed students did not initially consider themselves experts in the BioSITE science content, early in the course these students had relatively complex understandings of science and science thinking. In interviews conducted early in the school year, when asked to "get a picture in their head of what it means to do science," the majority of interviewed BioSITE students suggested something broader than "stereotypical" ideas of science (e.g. lab coats, chemistry, beakers, Albert Einstein, working in a lab). Experimenting and observing were the most common responses in early-in-the-program interviews. Students also reported a wide mix of ideas about what science thinking is, including the idea of "thinking out of the box," "deep thinking," using multiple perspectives, and being curious. In early interviews, BioSITE students also expressed relatively complex understandings of the relationship between science and the environment. For example, students reported that science and the environment are interconnected, that science is used to explain the environment, that science can be used to check environmental health, that one can use science to make a positive change in the environment, and that one can use observations in the environment to inform science. Some examples of students' responses in pre-interviews are below.

[Doing science] means to experiment and...it doesn't happen...it takes a long period of time. It's an ongoing process where you're comparing things... So it's hands-on, you're observant, you're observing things. So always have a big journal to write down and compare all your discoveries or what's going wrong.

[Science thinking is to] be more cautious of your surroundings and really pay attention to the little details.

At the end of the year, interviewed students' complex ideas about science and science thinking had largely persisted when compared to their interviews at the beginning of the year. Augmenting this, half of interviewed students indicated that BioSITE influenced their understanding of science and science thinking, and student journal entries indicated increased breadth of ideas regarding "what comes to mind when thinking of a scientist," and decreased mentions of stereotypical ideas of science.

In journal entries, the number of different responses about what comes to mind when thinking of a scientist increased from pre to post, and the percent of students who mentioned stereotypical ideas of science decreased by half to 28%. Additionally, during the end-of-year interviews, 50% of interviewed students reported that participation in the BioSITE program influenced their understanding of science and science thinking. 33% of interviewed students mentioned that they learned content or learned about the environment; 17% mentioned that the course reinforced their idea that science is/can take place anywhere; and 17% students also mentioned that BioSITE broadened their understanding of different types of science. Examples of student responses are below:

Especially after this class I've noticed a lot of more things now I guess. Not just in the environment, but just in general. I feel like also in my other classes, it's helped me observe more things [...] I mean I obviously knew that... a typical scientist wasn't just a person in a lab coat or whatever but, even now more so I think, I understand that science can just be anywhere.

I think it's confirmed [my ideas about science] a lot. It just pretty much ... BioSITE helped me get some more information to back it up. It kind of answered some curiosity questions about the environment or the way things are. I mean one of the things we talked about are macro-invertebrates. I didn't even know what those were until we learned about them.

Participating in the BioSITE program also made some students' understandings of the connection between science and the environment more complex. In total, 58% of interviewed students' expressed ideas of the connection between science and the environment became more complex over the course of the year. For example, several students mentioned science's usefulness in determining environmental health and making positive change in the pre-survey,

and in the post-survey added that science can help explain the environment, or that science and the environment are intertwined.

Relationship to Science

At the beginning of BioSITE, the majority of students liked or had positive relationships to science, felt as though they were good at science and could do science thinking, and felt that science was important to them. BioSITE served to *augment and reinforce* some students' already positive relationships with science.

Each student had a personal explanation of their relationships to science and the degree to which they saw themselves as scientists. Some examples of categories of reasoning include:

- Due to science career interests
- Because [science is] part of the student's everyday life
- Because the student perceives themselves to be "made up of" science (e.g. organs, cells, etc.)
- Because the student is very observant or likes problem solving
- Because it helps the student with daily routines (i.e. ability to predict the weather) or contributes to advances that impact their life
- Because the student feels themselves to be a science-type person.

Two examples of students' personalized responses follow:

[Science is an important part of who I am because] I think science...since it just interest me, it... I think it also helps in your other subjects too, to notice other things, and not just science but everyday life or anything else.

[Science is an important part of myself] because when we go camping, we're always around nature, which is science. So you have to understand what effects. Even camping, it does affect the nature.

According to journal prompt responses, many students were somewhere in the middle—they did not fully see themselves as scientists, but they also saw some ways in which they were science-like. As one student stated:

I see myself as a scientist a little, but not for my profession. I just don't picture myself as the working in labs, discovering and looking at fossils kind of gal. I do however care a lot about the environment.

At the end of the BioSITE year, 50% of interviewed students described ways in which their positive relationship with science was augmented. They mentioned increased motivation to learn more about science, the realization that science is important to them, increased interest and comfort learning science, increased interest in learning things in general, increased appreciation

of science, and increased confidence in asking questions and making observations. These impacts are exemplified through the below quote:

I've always loved science but I think it's also encouraged me more. Just gave me a little extra push... I think I've become more of a scientific person.

Interest in Science Careers

BioSITE students had wide ranging career interests. BioSITE reinforced some students' career interests, but the course did not seem to have a major effect on their aspirations. As evidenced by interviews, students' career aspirations seemed to change rapidly; 33% of interviewed students reported distinct career aspirations at the beginning and end of the year, but did not express recognition that this change had occurred.

Among interviewed BioSITE students, the most popular careers were medicine (42%), scientist (25%), and teaching (17%). In post interviews, 33% of interviewed students reported that BioSITE reinforced their career aspirations, and 17% of students said that BioSITE caused or increased their interest in a science career. One of these students reported a desire to be a scientist at the beginning and the end of the year, but said that BioSITE prompted the interest in a science career. This finding is exemplified by the quotes below:

I think overall it was a really good experience for me. Um, it really...like, I didn't know what I wanted to do before, like, in terms of college. But now I really decided that I really want to go into something related to science.

I mean I've pretty much been the same. I want to do something science-oriented because I love the subject. I want something to do with like, communicating to people, kids are really fun. But I can also deal with adults. Kind of just, made my depth of what I want to do more strong.

In Context: Findings About High School Students

As the previous section has indicated, BioSITE students entered the class already positively oriented toward science, teaching, and the environment. By supporting students on their individual learning paths, BioSITE facilitated students to progress further in their learning trajectories in individualized ways. Through participating in BioSITE, students became more global citizens with stronger connections to their environment and who felt confident and empowered about themselves as learners, leaders, and contributors.

In the pre/post survey on science identity scale, BioSITE students' responses did not show statistically significant change over the course of the year for any of the constructs tested.²

² Survey results are included in Appendix C

However, BioSITE students consistently scored higher (more positively, closer to “Agree”) than their peers in other science classes. This suggests that students in the BioSITE class entered the class already feeling positively towards the constructs tested, and that their positive orientations may have caused them to “self-select” for the BioSITE course. This idea is reinforced by the students’ application essays, in which:

- 89% of successful applicants mentioned experience with or liking children
- 44% of successful applicants mentioned liking science
- 36% of successful applicants mentioned an interest in/care about conservation
- 33% of successful applicants mentioned liking or appreciating nature
- 17% of successful applicants had career aspirations to be a teacher

This finding, indicating a potential “ceiling effect” (in statistical language) suggests that it would unlikely for students’ responses to increase when they are already quite positive at the beginning of the course regarding their understanding of science and science thinking, their relationship to science, their connection to the environment, making a difference, and contributing to their community, their communication skills, their interest in science careers, and their understanding of the role and challenge of teaching, as measured by the survey.

However, as indicated in the above findings from interview and journal entry data, each student in BioSITE entered the class with a different profile of needs, strengths, and weaknesses, and participation in BioSITE supported development according to these various needs. This observation may help to explain the lack of gains across the group observed in survey results, and to reveal BioSITE’s impact on students.

Additionally, 17% of high school BioSITE students also participated in BioSITE as a fourth grader, indicating BioSITE’s potential to serve as a tangible pathway in students’ engagement with science. Three of these students were interviewed as part of the summative evaluation study. All reported positive experiences as fourth grade participants, and two claimed that their fourth grade experience motivated their interest in science. One student asserted, “I really wanted to give back [...] I thought it was really fun and it really got me into the environment, and that’s really what interested me in science and biology.” Another student claimed that the fourth grade BioSITE experience sparked his interest in science and the environment, and caused him to begin to think of himself as a scientist. These students’ strong positive associations with the fourth grade BioSITE experience, combined with the significant portion of students who participated in the course while in elementary school, support the idea of a science education pathway -- that encountering BioSITE at a young age could initiate a positive engagement with science and the environment that continues through participation in the high school component of the course.

Comparison interviews with non-BioSITE students about their experience in regular science courses at Pioneer High School reinforced the positive influence of the BioSITE course on students’ communication skills and relationships with the environment. Non-BioSITE students’ reflections on their views about science also reinforced the idea that BioSITE students entered the course more positively inclined towards science and the environment than their PHS peers. As part of the summative evaluation study, the research team interviewed six representative students who did NOT participate in the BioSITE course. In

comparison to the 75% of interviewed BioSITE students who asserted that the course influenced their communication skills, only 17% of comparison group students gave a similar response, mentioning that they learned group work in science class. Additionally, compared to the 92% of interviewed BioSITE students who said they learned, through the course, that individuals can make a difference in the environment, 50% of comparison group students expressed skepticism that individuals can make a difference -- views that persisted over the year. In addition, compared to the wide range of environmental behaviors named by BioSITE students, picking up trash and doing community service were the most often cited ways of making a difference by comparison students, and only one student mentioned teaching others or teaching children as a strategy to make a difference in the environment.

Comparison group students also reported more modest impact on their relationship to the environment as a result of their participation in their non-BioSITE science classes. 66% reported that their science class deepened their knowledge of the impact of their actions, and 33% reported that the course caused more awareness of the environment and pollution. Smaller amounts of students mentioned that they learned new ways of making a difference, that their course caused increased concern about the environment, and 17% said their course had no influence on their relationship to the environment. Comparison group student responses are exemplified by this quote:

Because in (his teacher's) class, we watched this video about like all the pollution and everything and like all the recycling and stuff and...I've learned like a lot more about it and it's made me like now, I'm always like, want to recycle everything.

The comparison group interviews also reinforced the idea that upon entering the course, BioSITE students may have differed from their tenth grade peers in other important ways. For example, interviewed non-BioSITE students had more stable career interests—only one out of six interviewed students reported a changed career interest from the beginning to the end of the year, a change they attributed to their science class. At the beginning of the year, comparison group students also engaged in a much narrower variety of pro-environmental activities than BioSITE students: picking up trash and community service. 33% of interviewed students from the comparison group did not report engaging in any pro-environmental activities. Comparison group students also reported a much narrower set of environmental concerns such as diversity, the destruction of nature, and air pollution.

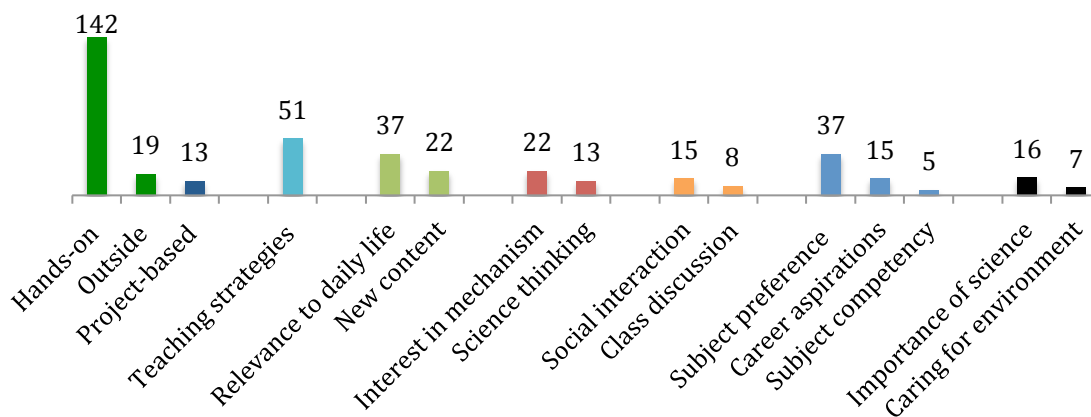
Across all data collected, high school students reported positive opinions of the BioSITE program; they found it to be a productive and new experience. They also provided specific recommendations about ways the program could improve. Students reported that they experienced better comprehension about science concepts and practices in BioSITE than they did in other classes. Students also reported that they had never done anything like BioSITE before, and that it was engaging, as illustrated by the quotes below. (Specific student recommendations regarding program improvement are included in Appendix B.)

I think I grasped the lessons a lot better in this class because, since we have to plan different things for it, and we spend each week learning something new, and

we worked a lot with them then, it becomes a lot easier for me to grasp. And then teaching other people about it, it just makes it a lot to learn.

Definitely one of the best experiences school-wise that I've been, and one of the best electives I've ever been able to participate in.

BioSITE provided students with the types of experiences students say make science class “engaging and meaningful.” As part of the summative evaluation, the evaluation team conducted a survey of the tenth grade class at PHS³. The survey contained an open-ended question, “What, if anything, makes science class engaging and meaningful to you?” Student responses were coded into categories, and a summary is represented in the figure below. The frequencies represent the number of mentions; some students provided more than one idea.



The BioSITE course provides students with many of the elements they find to be meaningful, as evidenced by interviewed students’ positive comparisons between BioSITE and other science classes.

67% of interviewed students mentioned that BioSITE is more hands-on than other classes, or that it was better than other classes because it takes place outside. This corresponds to the survey finding that a high number of PHS sophomores in general find hands-on activities that are project-based or that take place outdoors to be engaging and meaningful. Examples of BioSITE student comparisons are below:

We were a lot more interactive with the things we do, obviously since we’re outside a lot. We get to physically see what’s happening, we’re not just being taught it. So, I think, yeah, that’s a lot of the differences.

³ The evaluation team gave a presentation to PHS staff regarding the results of this survey in October of 2013. The slides used in this presentation can be found in Appendix E.

But it's definitely different [from other classes] because you get to do a lot more hands on activities and just learn different, like, ways, and different ideas of how to teach it and like, spread the, I don't know, different ideas.

67% of interviewed students said that BioSITE is better than other science classes because students apply the concepts they learn or because students are actually “contributing to something,” and 33% of interviewed students said that BioSITE is more relevant to everyday life than other classes. 25% of interviewed students said that they experienced improved comprehension of the material due to the application of concepts in BioSITE. This characteristic of BioSITE corresponds to PHS sophomores' preference for new material that is relevant to students' lives. Examples of BioSITE student comparisons are below:

I'm in chemistry right now, and I'm like okay, I don't really need to know how to balance chemical equations, but this is something that's about my world around me. And it's something that I'm more interested in. So I feel like it's more relevant.

67% of interviewed students said that BioSITE lets students experience the process of science, or characterized it as “going out and experiencing the real thing,” as compared to “sitting there and having the teacher tell you things” in other classes. 33% of interviewed students said that BioSITE is better because it involves real data and experiments, and 33% of interviewed students said that BioSITE goes into more depth or involves deeper thinking than other classes. This corresponds to the survey finding that PHS sophomores find a focus on figuring out how the world works (mechanism) and science thinking to be engaging and meaningful. Examples of BioSITE student comparisons are below:

[In BioSITE we] actually relate it, and we get to try to solve the problems and get the data ourselves and see what's going on with this problem rather than just learning about it, okay let's look at these results—we get to go and do it ourselves.

Definitely, you learn more in depth about things in the environment. Like we go more in depth into fish, plants, things that surround the river. And also the chemical tests we do every time we go out.

Interviewed students claimed that BioSITE allows for more social interaction than in other classes, BioSITE is more community/group oriented than other classes, and there is more group work in BioSITE. This BioSITE characteristic corresponds with PHS sophomores' desire for opportunities to interact with peers in science class. Examples of BioSITE student comparisons are below:

At least in my chemistry class right now, most of the time it's ... writing notes on the board and we're taking notes on it, or he has problems up. But, this, after every teaching day we reflect on stuff and we have to get in our groups a lot, and do stuff like that. There's a lot of group projects too, so it's, you know, a lot of interaction, social interaction too.

67% of interviewed students reported a way in which BioSITE content differed from that of other classes. Interviewed students mentioned that BioSITE includes field research focused on the outdoors instead of lab work; that BioSITE focuses on how to improve the environment while other classes focus on what has already been discovered in science; that the environmental content focus of BioSITE is different than other science classes; and that the content in BioSITE was more important than the content in other classes. This corresponds with the survey finding that PHS sophomores value opportunities to focus on the topics of nature, the environment, and environmental conservation. Examples of BioSITE student comparisons are below:

I'm used to sitting in a classroom, getting a lecture and having to take notes. And ... we're still sitting in a classroom sometimes, but it's more hands-on activities, we play games, and we do different activities and research stuff. It's just more, in depth, and I feel like it's more important stuff.

[In other science classes] it's more focusing on what's been studied, not, in a helpful way to make things better, it's just focused on what's already been discovered, and not discovering new things.

Summary of Findings: Impact on 2012-13 High School Students

BioSITE gave high school student participants important opportunities to extend and deepen their engagement with science and science teaching and learning. Students entered the course already positively oriented to the environment and science; as an elective course, BioSITE helped students progress on their pathways toward becoming equipped to take action on the environmental issues facing our world. The course had particularly strong influences on students' skills related to science communication and their connection to the environment. Additionally, PHS sophomores overall reported characteristics that make science class meaningful and engaging to them, and BioSITE contained and emulated many of these elements. This supports the overall findings that students who took BioSITE experienced the program as meaningful and engaging.

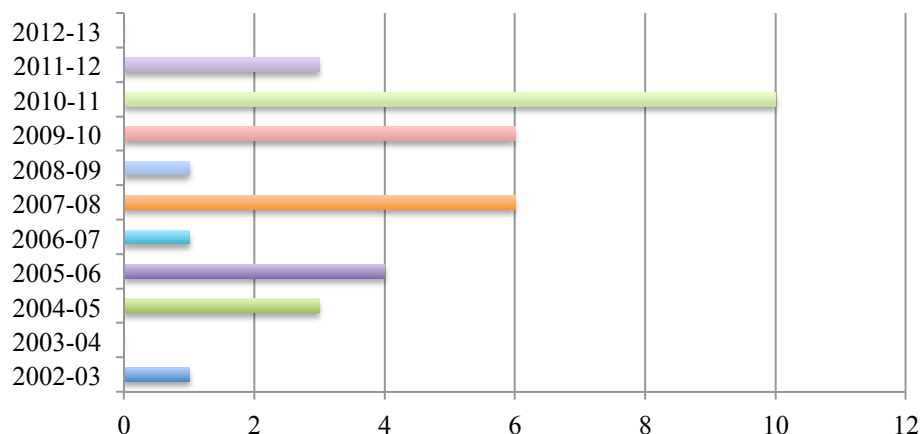
Findings: Potential Long-Term Impact on High School Students

Findings in this section draw from data collected from BioSITE alumni through online surveys (n=69). Data collection with alumni was enabled by Robert Zaccheo's ten-year anniversary teaching the BioSITE course. This anniversary coincided with the data collection period for the summative evaluation, and was commemorated by an event that drew BioSITE alumni from the last ten years. The unique occurrence of this event allowed the evaluation team to collect the contact information of BioSITE alumni and reach out to them for a voluntary online survey regarding their experience in the BioSITE program.

BioSITE's impact on high school students related to their growth as people, relationship to and understanding of science, and relationship to the environment appeared to persist after they finish the course. Student gains on their pathways toward becoming scientifically literate citizens equipped to address environmental issues appear to be maintained after participating in the course.

Respondents to the BioSITE alumni survey (n=69) were distributed across eight years of the program, spanning from 2004-5 to 2011-12. This represents a 23% response rate when considering the total population of BioSITE alumni invited to attend the alumni event (295 students). This survey sample included students over the age of 18 who took the course during the last decade (2004-5 to 2013-14). The current program year (2013-14) was not invited to take the survey because the students in this course are under age 18. One student who participated in the course in the 2002-3 year also responded to the survey, but this student was also engaged as a course instructor in more recent years. As this was a voluntary survey, this sample likely represents those students who felt positively about their experience. The sample composition is described in the figure below:

If you can remember, please tell us the school year you took BioSITE:



BioSITE alumni reported very positive reflections on the BioSITE program both in terms of their experience in the program and its effect on them. They framed BioSITE as a formative experience in their lives, with various and wide-ranging impacts. Alumni also provided specific recommendations to improve the program. As exemplified below, open-ended comments contributed by alumni on the survey reinforced the various ways that BioSITE influenced students. Specific alumni suggestions regarding program improvement are included in Appendix B.

BioSITE positively influenced students' interest in and commitment to the environment:

Students reported that BioSITE increased their interest in or awareness of the environment, their awareness of human impact on the environment and how to help, and their understanding of and interest in how to use science to help the environment. Student responses were exemplified by the below quotes:

The program definitely made me realize my impact on our environment and how educating our community can increase others' understandings as well. It definitely gave me new insight on the environment; I never knew macro-invertebrates existed until BioSITE!

Stronger understanding of and interest in my ability to use science to understand and benefit the environment.

BioSITE positively influenced students' interest in community service and teaching: Alumni commented that BioSITE increased their interest in teaching. They also reported that the course improved their teaching ability and confidence in their ability to teach, increased their interest in community service and service learning, and taught them how to learn through teaching, as indicated in the students' responses below:

BioSITE helped me confirm two of my greatest passions in life: helping others, and learning. BioSITE helped me learn how to learn through teaching, which has proven to be the most rewarding and effective way for me to do so. Organizing material from the angle of lesson planning, whether the lessons are real or imaginary, is some of the most fun I've had in school, again, which I have BioSITE to thank for.

BioSITE was my first step into community service and it really opened my eyes to it. Over the course of my sophomore year I continued to do service along with BioSITE and then after the year was over I joined Pioneer's Service Learning class which focuses largely on community service. Now, in college, I am majoring in film, so BioSITE didn't influence me there, but it did help me with my film focus. Because of BioSITE, I want to focus on documentary films so that I can try

and make a difference in my community. Whether it's about the environment or poverty, I want to make a change that I wish to see in the world.

BioSITE helped students to develop as individuals: Students reported that taking BioSITE improved their leadership, presentation, speaking, communication, and organizational skills. They also asserted that the course improved their teamwork skills and ability to work with peers, increased their confidence, and caused them to feel more respect for teachers.

Participating in the BioSITE program made me a lot better at working with my peers and younger kids. It also made me realize that teaching isn't as easy as some teachers make it look and it made me respect my teachers even more.

Working with younger students, students my age, and Mr. Zaccheo helped me improve my communication skills a lot and taught me how to work with different kinds of people.

BioSITE reinforced and broadened students' job/career plans: Alumni reported that BioSITE increased their interest in careers and activities related to science and the environment, teaching, helping others and community service. One student reported that the course opened him/her up to the idea of employment at CDM. Student responses are exemplified in the following quotes:

Participation in BioSITE exposed me to environmental education which I still consider to be a potential future career opportunity. It lead (sic) me to a volunteer position within the education department of a zoo where I am now employed! More specifically, I found a new interest in ecology (especially native ecology) which lead (sic) to an interest in animal behavior and the effect of ecology on behavior/evolution.

... It got me into Clean Streams Clean Bay, on service learning conferences across the united states, into an environmental studies major/education minor, back to BioSITE as a paid instructor, back to grad school to earn my teaching credential, and now I am a middle school science teacher. It helped me realize that I not only loved learning/teaching science, but also that I had a knack for helping adolescents see what they are capable of achieving in school.

BioSITE offered students positive role models in the program staff:

I love BioSITE. It was where I got to meet Biret and learn more about the Guadalupe River. Biret is an amazing person and Mr. Zaccheo is pretty interesting...both are equally amazing and I'm happy that I got to be part of this. I will always look up to them both. They have been great teachers, advisers, and

some day I hope to have at least half of the dedication and love that they had in my year as a BioSITE student.

Employ dedicated people like Mr. Zaccheo and Biret. BioSITE would not be the same without them.

BioSITE offered students a positive experience with science:

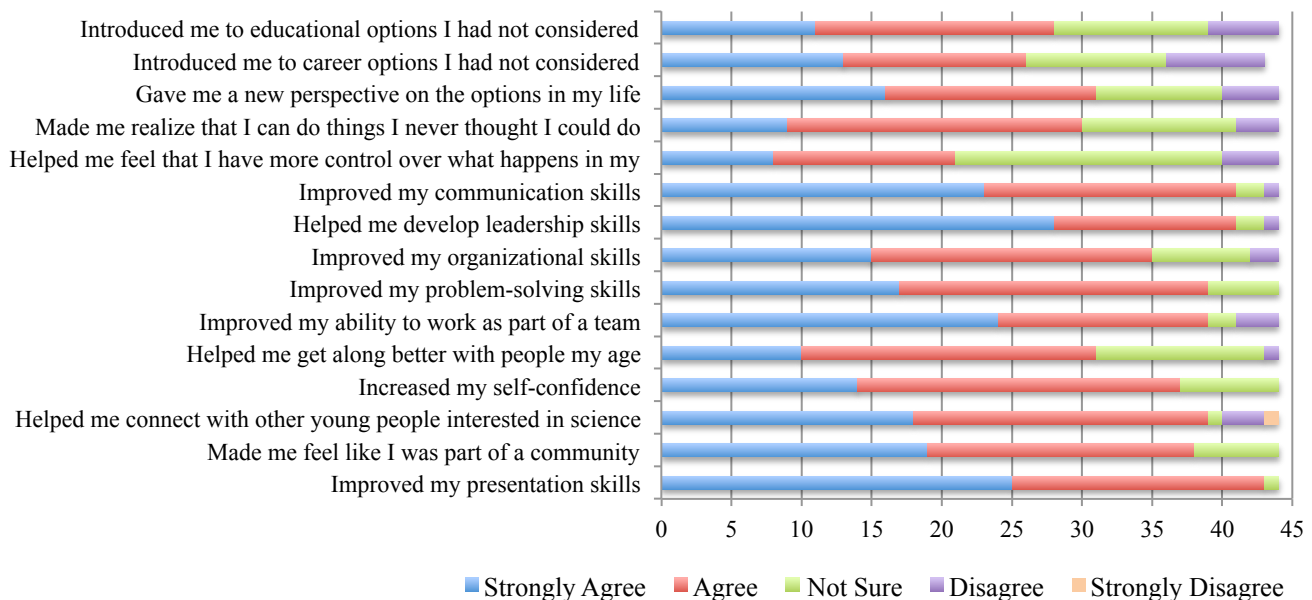
I'm very glad I was able to have the chance to be in this class. It was cooler than even what I had heard it being.

I love the outdoors and teaching, so this class was able to combine both. The hands on learning with being actually in the river makes it so much more meaningful than learning from a textbook.

The positive nature of these findings are likely influenced by the fact that survey respondents were a self-selected group; however, they directly parallel and reinforce the findings related to the 2012-13 BioSITE class that are already documented in this report.

BioSITE alumni reported that the course broadened their career options and helped them to develop as people. They reported particularly strong influence on their development of leadership and communication skills, their ability to work as a team, and their presentation skills. These findings are reflected in the figure below:

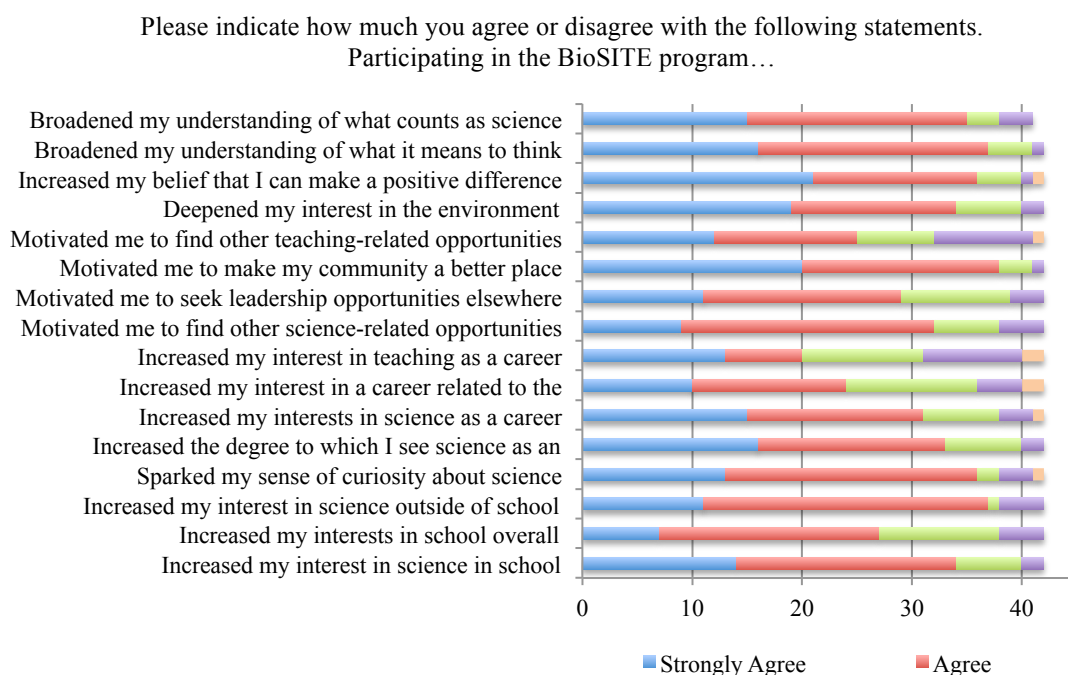
Please indicate how much you agree or disagree with the following statements.
Participating in the BioSITE program...



Alumni indicated that BioSITE had a strong impact on their development as people, across a wide range of possible impacts. Of the 44 total respondents who answered the above questions, 97.7% either strongly agreed or agreed that BioSITE improved their presentation skills. 93.2% either strongly agreed or agreed that the course improved their communication skills, and 93.1% agreed or strongly agreed that BioSITE improved their leadership skills.

88.6% of respondents responded that they strongly agreed or agreed that BioSITE helped them connect with other young people interested in science, and that the course improved their problem-solving skills and ability to work as a team.

BioSITE alumni also reported that BioSITE positively influenced their relationship to science and the environment—they noted particularly strong influence on their belief that they can make a positive difference in the environment, their interest in the environment, and their motivation to make their community a better place. These findings are reflected in the figure below.



Alumni indicated that BioSITE positively influenced their relationship to science and the environment, across a wide range of possible impacts. Of the 42 total respondents who answered the above questions, 90.5% agreed or strongly agreed that BioSITE motivated them to make their community a better place, and 88.1% agreed or strongly agreed that BioSITE broadened their understanding of what it means to think scientifically, and that the program increased their interest in science outside of school. Respectively, 86% of respondents agreed or strongly agreed that BioSITE sparked their curiosity about science, increased their belief that they can make a positive difference in the environment as an individual, and broadened their understanding of what counts as science.

BioSITE alumni have especially strong positive memories associated with the teaching components of BioSITE. As part of the survey, BioSITE alumni were asked about their favorite

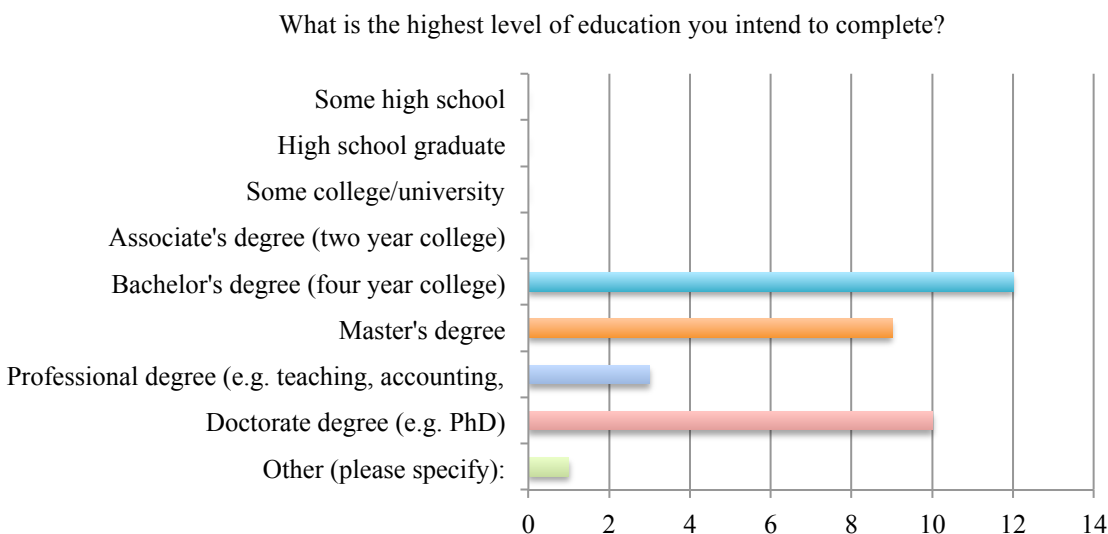
BioSITE memory. 32 respondents (46% of total respondents) answered this question. 47% of these students' favorite memory revolved around teaching the fourth graders and seeing them learn and enjoy themselves. 16% focused on the class community and bonding within high school teaching groups. Other students' favorite memories pertained to the hands-on learning, service learning, and outdoor learning components of the course, the teamwork they experienced in the program, the field trips and lessons, and unexpected encounters with nature. Student responses were exemplified by the following quotes:

A group of kids I had that felt a special connection with me--they hugged me before leaving each time I met with them. It was the first time I ever felt looked up to and realized I could positively influence the actions and interests of others.

Having a classroom outside. It was a great way to learn. The whole hands on learning thing, learn by doing, and service learning is incredible.

Being able to see the kids become excited about the environment and proud of themselves and what they were learning.

Nearly every BioSITE alumnus that responded to the survey reported that they intend to complete college or a graduate degree. This reinforces the idea that BioSITE attracts high-achieving students and also may support the idea that BioSITE positively affects students' educational intentions. This finding is explicated the figure below:



BioSITE alumni reported that the course had moderate influence on their career choices. 24 survey respondents answered this open-ended question, which asked about BioSITE's influence on alumni career choices. Among those who did, 87% reported that BioSITE influenced their career choices (representing 30% of the total number of alumni who took the

survey). 33% of respondents reported that taking BioSITE increased their interest in science as a career, and 25% reported that the course increased their interest in a career teaching or working with children. 33% reported that taking BioSITE increased their interest in a career related to the environment or helping the environment. Students also mentioned other BioSITE influences on their career choices:

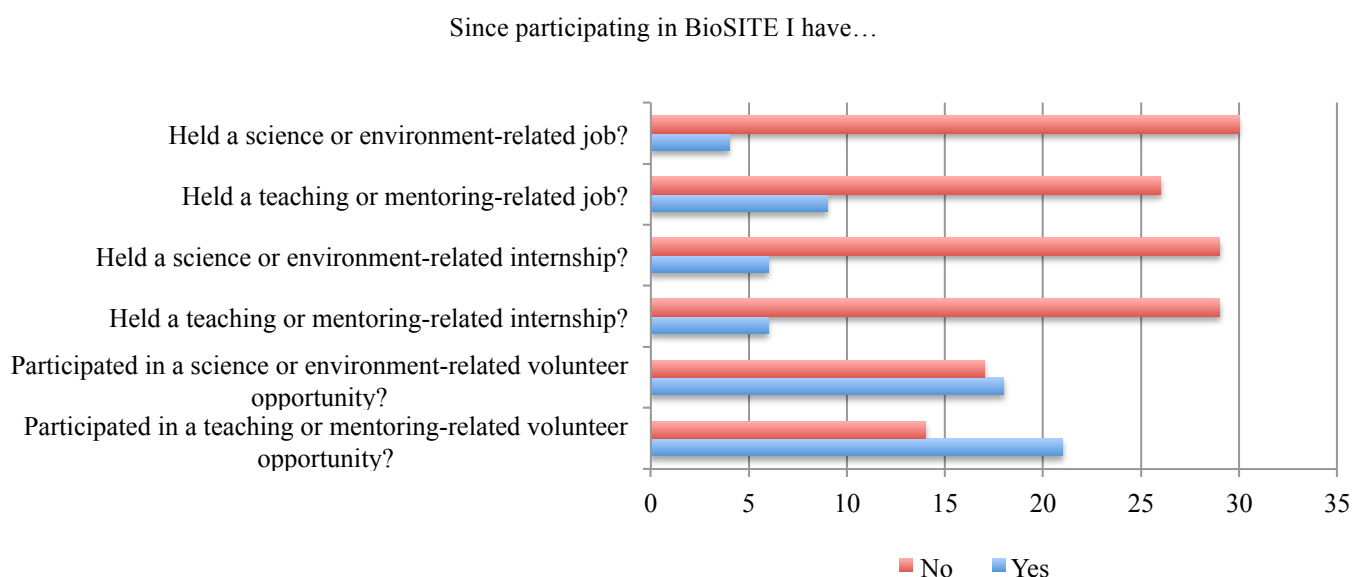
- Reinforced pursuit of science as a career
- Increased interest in a science education career
- Increased interest in a career that focuses on the relationship between humans and environment
- Influenced school choice because taught to value hands-on learning
- Realized didn't want to be a teacher
- Demonstrated all things I didn't know
- Increased interest in nonprofits

13% of students who responded to this question reported that taking BioSITE did not influence their career choices.

BioSITE alumni have wide-ranging career aspirations. A significant portion of alumni had participated in a science, environment, or teaching-related activity since taking the class.

Of the 31 alumni (45% of total survey respondents) who answered a question regarding their desired career, 32% mentioned a science-related career, 19% mentioned an environment-related career, 35% alumni reported a teaching or youth-related career, and 35% reported a career unrelated to a topic central to BioSITE.

In questions regarding students' jobs and activities since participating in BioSITE, alumni were most likely to have participated in a teaching or mentoring-related volunteer opportunity, followed by a science or environment-related volunteer opportunity. Smaller numbers of students reported holding jobs or internships related to teaching, science, or the environment. This finding is explicated in the figure below:



Though only 50% of survey respondents answered the above questions, these findings reinforce the idea that teaching is a strong area of interest for BioSITE students, one that persists after participation in the course.

Summary of Findings: Potential Long-Term Impact on High School Students

Based on preliminary data collection through the alumni online survey, there is evidence to suggest that the BioSITE course's impact on high school students related to their communication skills, relationship to science and the environment, and understanding of science persist after they finish the course, and that BioSITE may have influenced some students' choices of college majors and careers. Additionally, BioSITE alumni reported very positive experiences and memories related to the course. As addressed in the Recommendations section, further investigation into outcomes for BioSITE alumni is thus recommended, to confirm and provide further context around these findings.



Findings: Impact on Fourth Grade Students

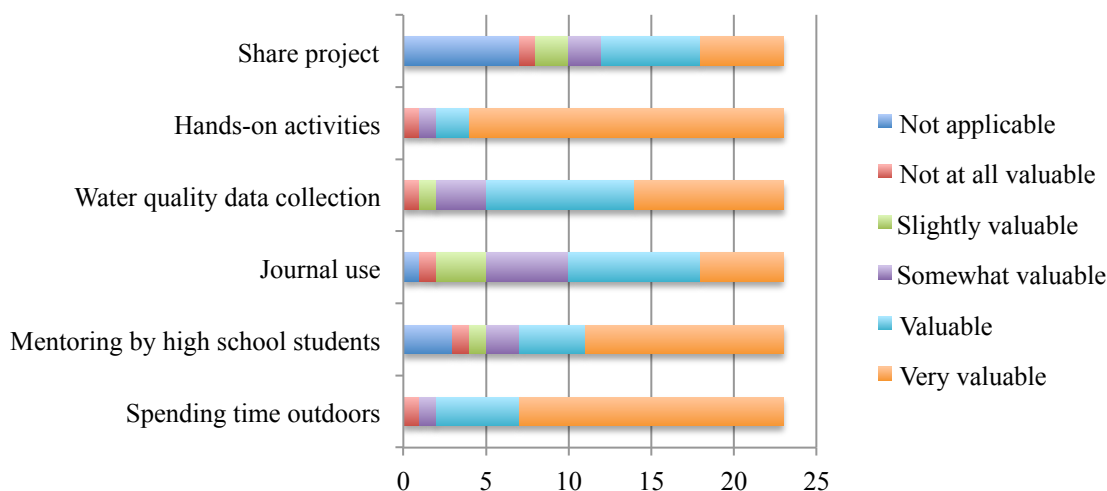
This summative evaluation did not involve intensive data collection regarding program impacts on fourth grade students, as the identified focus of the evaluation was the high school participants. Data collection related to fourth grade students for this study involved an online survey distributed to fourth grade teachers involved in the BioSITE program (n=25), a focus group conducted with six fourth grade teachers, and a review of selected fourth grade journal responses from the 180 fourth grade students who participated in 2012-13. Additionally, in the course of the year, high school BioSITE participants responded to a journal question regarding fourth grade student experience in the program. This data is included in the below section as are relevant results of interviews with three high school BioSITE participants who also participated in the program while in fourth grade. The findings detailed below suggest that a more detailed study of the experiences and potential outcomes for fourth grade students and teachers would be valuable for CDM staff to better understand the implementation and potential impact of BioSITE.

Fourth grade participants in BioSITE are located at the beginning of their pathway toward becoming scientifically literate citizens equipped to tackle environmental issues. As such, this represents a critical moment at which to activate their relationship to science, the environment, and their community. According to fourth grade teachers, by engaging students in hands-on science in an outdoor setting and providing positive role models, BioSITE positively influenced fourth grade students' connection to the environment, perception that science is "cool," and comfort in some foundational science skills. Due to the critical juncture at which the fourth grade students experience BioSITE, the program has potential for additional impact in this area.

84% of the fourth grade teachers who participated in the BioSITE online survey (21 of 25 survey respondents) reported that the BioSITE experience was valuable or very valuable for their students. Their reasons centered on the fact that PHS students prepared and provided hands-on science experiences for their students in an outdoor setting, serving as valuable mentors and positive role models in science engagement for younger students, and fostering engagement in science and environmental awareness. As illustrated by the teachers' survey responses in the figure below, these findings are consistent with some of the articulated outputs and outcomes in the CDM logic model, including:

- Exposure to the natural environment
- Engagement in hands-on scientific practices such as water testing
- Gathering, analyzing and presenting data with the high school students

How valuable do you think the following components of BioSITE were for your students?



As illustrated in the above figure, fourth grade teachers reported that they found the hands-on activities, the time spent outdoors and the mentoring of their students by high school students to be the most valuable components of the BioSITE program. Teachers in the focus group elaborated on the value of hands-on experiences for their fourth grade students, highlighting the engaging nature of hands-on work, the value of learning in an outdoor environment where students can move around, and the fact that hands-on learning using real tools increases students' interest in figuring things out on their own:

Hands on activities [are] also, I believe, very valuable—being out there, even using those goggles for the first time, any equipment they work with that they have not seen before or don't know the purpose of, was very valuable...It's them wanting to not only have that experience at the river, but bring that into the classroom and me not being able to provide it...They wanted to see things on their own and investigate. I guess that was the main part, the fact that they were investigating what that was, and then looking at the chart and finding out what was it exactly. The part of, "don't tell me, I want to find out." Or "don't tell me, I want to know what it is." That's how I realized... I really like that. The reason I remember this is that I was with one of the groups, and I was like, "oh, let me see," I was trying to help them, and he turned and said, "no, no, no, let me figure it out." And I really liked that.

Teachers also explained the importance for fourth grade students of spending time outdoors learning more about their neighborhood and watershed. They asserted that for many students, BioSITE was the first time students engaged with the natural environment in a scientific manner, and mentioned the power of the outdoor setting for eliciting student stories and the value of BioSITE in linking science to students' lives:

One of the things that struck me was the spending time outdoors, the conversations that came up before we went: are we going to get to go in the river? What are things going to look like?, and then when I walked with the kids to the river spot, all these stories would come out of them...like about going camping, or the picnic someone took and threw the rock in the water...all of these stories came from being out in the environment—kids that don't usually have a lot to tell me. So it was just interesting being out there, just that part.

It was extremely valuable for my students, partly because a lot of them live where the river is—there's a fence and then they live in these houses—they can see their houses. And so some of them have walked back there, they have seen it, and now they know so much information about the river, that they can tell their parents and they feel like a part of it. And I heard students using vocabulary and understanding it—like if I had taught it I don't think they would have really understood it—like saying rate of flow, and turbidity. They could probably easily explain what it is in their own terms because they've seen it so much.

Educators who participated in the focus group explained why the high school student mentors and “pairing of older and younger students is SO valuable,” asserting that the fourth grade students look up to the high school students and think that they are “cool,” encouraging them to listen, that the two groups are close enough in age that they respond well to each other, and that the high school students serve as valuable external sources of positive reinforcement. Educators also mentioned the value of the repeat visits to the river site:

The children were able to interact with high school students in a very positive way. The children were able to have five visits to the same site so I think they began to get into a pattern of exploration. The children were given activities to do that seemed important to them and for which they could be successful. I think their self-esteem and self-confidence has risen as a result.

I see the value in [the high school mentors] because a lot of them have that one person they want to look up to—they either have the adults—the ones that tell them don't do this, the teacher or the parents, and then they see the high school student—it's not an adult, it's not a kid—it's that one person in the middle, and they still show that respect. A lot of positive reinforcement, especially with my students that often get in trouble—and when they get that pat on the back, and that “hey, high five you can do it,” you can just see their different reaction—someone who doesn't even know me thinks I'm awesome. And they just change completely. Having that interaction and giving them that opportunity for someone else to work with them, to give that positive feedback and positive reinforcement was very good for my students.

In addition, two teachers in the focus group reported that parents of fourth grade students also valued their children's participation in BioSITE, requesting that their children be assigned to teachers who were involved with BioSITE and noting that "they don't all get that opportunity."

Last Friday was our fry release day, and so I planned with the 1st grade teacher who also had a tank, and we drove the kids up to the San Lorenzo river, and so we had lots of parents because they helped drive the kids up there, and we had some science rotations up there. But anyway, I had a parent from her classroom come up to me and say how many classes do this BioSITE thing? And I was like two....we only can do two and we have four classes...(and she said) well, I want my child in your class then, because you're here. I want them to come back here and release the fry again when they're in fourth grade, and study all about this.

During the 2012-13 program year, fourth grade teachers were offered the option of completing a whole-class project with their students related to the BioSITE course. Teachers could design their own project or choose from a variety of projects pre-designed by CDM staff. Some of these projects were structured such that fourth grade students were able to present their own science knowledge by leading activities with younger students. Teachers found this element of mentoring and public sharing of science knowledge to be valuable:

Share projects were a very valuable part to my class.[...] They had done it, and Biret came in, and showed the class how to do the project again and they did it—and they said if I knew I was going to be (teaching)—we had told them but they didn't realize what it would entail—"I would have been paying attention more." They did the paper and pens watersheds. They did it with their reading buddies, who hadn't been (to the river), and they were the teachers. So to me it was really interesting that they said I would have paid attention more. Because again, now you have to teach it to someone else, so you really need to understand it.

It is important to note that not all fourth grade teachers implemented these share projects, so the influence of these opportunities on fourth graders was unevenly distributed. The share project component of the program was optional, and some teachers chose not to complete it due to limited or lack of time.

The following excerpts from fourth grade journal responses support the idea that the hands-on, outdoor nature of the BioSITE experience and the mentoring structure were particularly powerful for fourth graders, fostering engagement in science and environmental awareness:

I think it's important for kids to test the water so they can learn. They can tell their parents and teacher and BioSITE leaders.

My favorite memory was when we did turbidity. Turbidity is how clear the river is. It was fun because we got in the river. Then we used tools for the test. We get water then put a liquid and put it in the water and see how dark it gets.

My favorite memory was when I met everyone in my group. I also enjoyed all the leaders in my group and the kids too. I liked it when we studied the different things, the thing I enjoyed the most was when we studied the owl pellets.

Teachers also cited a few concerns that the program could address to further improve the high school student performance as mentors and teachers. The main program component cited as least useful was that journals were used inconsistently by high school students.

Evaluation team suggestions regarding teachers' concerns are included in the Recommendations section, and specific suggestions from teachers to address this issue are included in the Recommendations section. One of the teachers from the focus group explained the implications of this uneven implementation of journal use by the high school students:

I always had a hard time with the journal...I'd want to have a class discussion after BioSITE, there's always a focus, and (CDM staff) would tell me ahead of time that would be the focus. We'd come back and they wouldn't always be able to talk about what they did. Some of them would have notes in their journals and some had zero notes in their journals... So not all the groups were equal, and so...I talked to her about trying to train the high school students a little better as far as teaching and remembering they are kids too, and they are not teachers...I know, I know, but it's so hard because they come back and I can't have a discussion with them because they don't have the information. So it's like ok, um, well, here's the notes I wanted you to have, and some people have it and some people don't so let's all write it down so we all have it, but then the kids that have it are all sitting around bored...we were not on the same page and it was very hard then to use the journal.

Other teachers provided similar feedback on the online survey:

My students were not very engaged with journal use. We used to have afternoon reflections upon arrival to our classrooms but they showed little interest or desire to continue writing on their journal.

The journal needs a lot of follow up in the classroom to be useful; I don't feel the high school facilitators emphasize them enough. They don't make sure students are writing in their journals during class. Maybe they don't see why it's important?

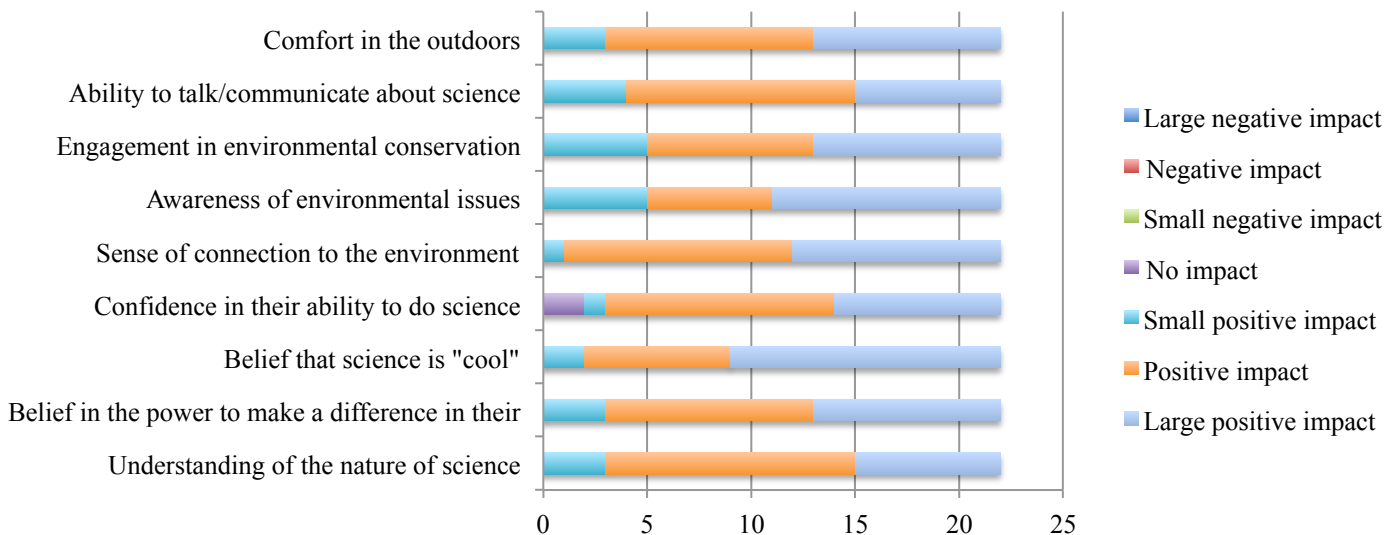
It was frustrating that some students would come back to the classroom with absolutely nothing written in their journals. They couldn't even tell me what the lesson was about... If the mentors won't teach and present the lesson clearly, and have the students copy notes into their journals, then it was just a time to be outside in nature.

Additionally, some teachers asserted that the meaning of the water quality tests did not come through to fourth grade students, and one teacher asserted that the Salmon Survival game is somewhat repetitive. Some teachers also expressed desires for improved behavior from high school students, expressing the idea that their dress code was at times inappropriate. The concern regarding water quality tests is exemplified by the following quote; particular recommendations from teachers to address these issues are included in Appendix B.

I also realize there was a lot of emphasis with the water quality, but I honestly don't think my kids really understood what the purpose of the data collection, the test, is. I see why, but I don't think it was clear on them—why are we taking these tests, what's the impact and the importance.

As reported by the fourth grade teachers through the online survey, participating in the BioSITE program positively influenced the fourth grade students' sense of connection to the environment, belief in science as “cool,” and their comfort outdoors. As illustrated in the figure below, when teachers were asked what impact, if any, participation in the BioSITE program had on their students, the top three outcomes that they reported had a large positive impact were “belief that science is cool,” “awareness of environmental issues” and a “sense of connection to the environment.”

What impact, if any, do you think participating in the BioSITE program had on your students'...



These outcomes for fourth grade students align with elements in BioSITE logic model around fostering a “more positive attitude about science” and a “stronger sense of connection to the environment (and) awareness of environmental issues.” Teachers’ comments on the survey provided more detail regarding their students’ increased environmental awareness and connection to the environment:

I think the children's awareness of nature around them has gone up. They were eager to take a hike with our class before BioSITE this week and eager to point out different aspects of the ecosystem. They spent a considerable amount of time working in their journals both writing and drawing their observations. Science is something they love participating in and their confidence level at approaching science inquiry has increased in other areas besides nature.

I'd often hear students later refer to the environment and that we need to take care of it - many more of my students changed their attitude about science - now it can be interesting and fun - they have a better picture and idea of what science is (nature, environment, etc.)

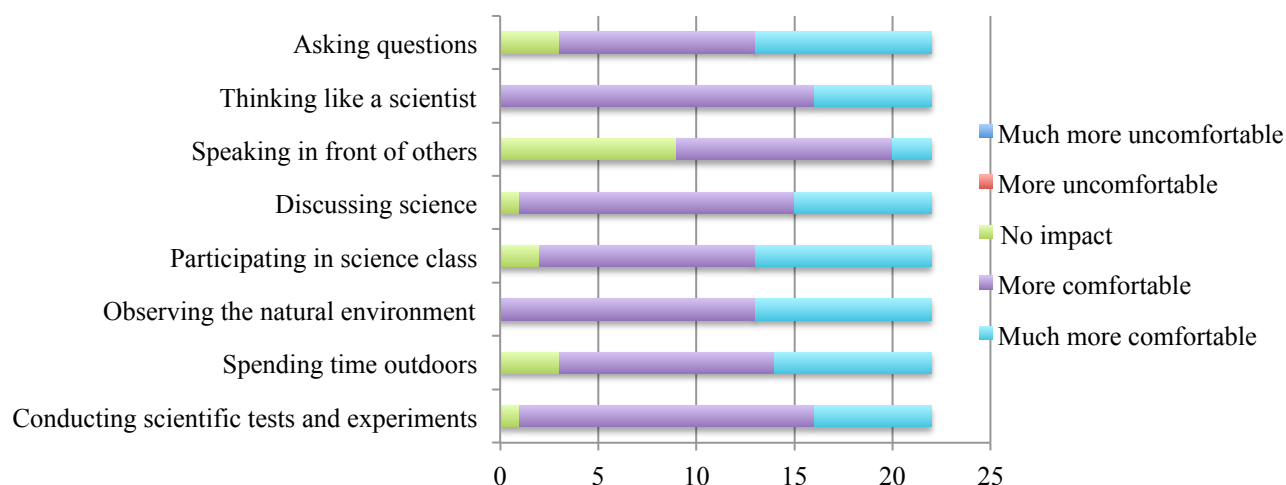
Excerpts from fourth grade journal entries reinforced the idea that BioSITE helped students develop positive relationships to science and view science as “cool.”

I would like to study water testing. Today I got to test the water. When you test the water it is fun.

My favorite BioSITE memory was when we inspected macroinvertebrates. We used this strange magnifying glass to see them up close. It was really fun to see all of these creatures that I have never seen before...There were at least 30 things in the tub.

In addition, fourth grade teachers reported that participation in BioSITE helped fourth grade students become comfortable with several scientific concepts and practices such as “observing the natural environment” and “thinking like a scientist.” This finding is illustrated in the figure below.

What impact, if any, do you think participating in the BioSITE program had on your students' comfort level with the following concepts and practices? After participating in BioSITE students are...



Again, excerpts from fourth grade journal entries reinforces the idea that BioSITE helps fourth grade students to become comfortable with certain scientific concepts and practices:

I would like to know about the trees, what kind they are. I could find out by their leaves.

The bird I observed is the American Coot. The American Coot looked like a duck. It had red eyes, a black body and the color of the wings were greenish. To catch its prey, the American Coot had to go under water. Its behavior was nice. The American Coot was really cool!

I found lots of bones in the pellet. I got 4 skulls, 3 legs, and 15 arms. All I know is that the owl was hungry. The first skull, it wasn't covered with hair so it was easy to find. I think the owl ate that rat just before it spit the pellet.

At one point during the year, the high school BioSITE participants had the opportunity to answer a journal question regarding what they thought the value of BioSITE was for the fourth grade students. Their hypotheses echoed fourth grade teachers' assertions about the value of BioSITE for their students, again focusing on instilling environmental awareness, the idea that science is fun, science skills, the value of hands-on learning, and the importance of role models. Students responses were grouped conceptually and are summarized below (several students mentioned more than one idea):

Environmental Awareness: 50% of high school students in the BioSITE class asserted that BioSITE gave the fourth graders awareness or knowledge about the environment, river,

community, and science. 25% said that the course taught students how to help their environment and community. Smaller numbers of students said the course caused fourth graders to gain respect for the environment, hypothesized that the course would cause students to try to lessen their impact on the environment or spread awareness, and asserted that BioSITE helped students understand that actions have consequences or become aware of their impact on the environment. Other students mentioned that the course caused fourth graders to learn about the importance of testing water quality, have a positive impact on the environment, gain interest in helping the environment, and get to explore the outdoors.

Value of Hands-On Learning Some students asserted that the hands-on element of BioSITE was valuable for students, mentioned the importance of learning outside the classroom, and said that it was important for the fourth graders to physically see what they are being taught.

Science Skills and the Idea that Science is Fun: Students asserted that BioSITE gives fourth graders the chance to be a scientist, and that it teaches them that learning is fun and can happen anywhere. Other students mentioned that BioSITE lets students see that it is fun to get involved in the environment, that science is fun, that science is all around them, and that BioSITE would help students do well in future science courses, and instill scientific thought processes in them such that they grow up to be scientists.

Value of Role Models: Other students called out role models as an important element of BioSITE for fourth graders, said that the course helps students to become well-rounded people and to learn life lessons, and that BioSITE teaches fourth grader to work together and multitask.

An additional data point regarding fourth grade participation in BioSITE relates to high school participants' trajectories. As described earlier, 17% of high school BioSITE participants in the 2012-13 program year participated in the program as fourth graders, and three of these students were interviewed as part of the summative evaluation study. All three students positively reflected on their experience as fourth graders, as exemplified in the following profiles.

Student 1: *"I really wanted to give back [...] I thought it was really fun and it really got me into the environment, and that's really what interested me in science and biology."*

This student's fourth grade experience in BioSITE motivated him/her to participate in the course as a tenth grader, to give back to younger students and to spark other kids' interests in science and the environment. The student remembers the enthusiasm of leaders and reported learning "a lot" as a fourth grader.

Student 2: *"I really enjoyed when we got to do science stuff. And so that was one of the things that we got to do. And it was nice to get a break from the everything else at the school and, I remember I really liked being by the river."*

This student reported that the fourth grade experience in BioSITE caused him to start thinking of himself as a scientist, and sparked an interest in science and the environment. He liked the science material and being at the river.

Student 3: *“I really liked it, going out and actually experiencing it outside instead of just in the classroom talking about it. So it was really cool.”*

This student reported liking the experience of real science at the river and also remembered the enthusiasm of high school leaders.

Summary of Findings: Impact on Fourth Grade Students

Findings from data collected with fourth grade teachers and high school BioSITE students suggest that BioSITE positively influenced fourth grade students’ connection to the environment, perception that science is “cool,” and comfort in some foundational science skills. Data collected indicate that especially influential were the hands-on science opportunities provided to students in an outdoor setting and the existence of the high school student leaders as role models. Fourth grade BioSITE participants are just beginning on their pathway toward becoming equipped to address environmental issues. The BioSITE program has the potential for additional impact at this critical juncture which would entail further examination of implications for program design and evaluation.



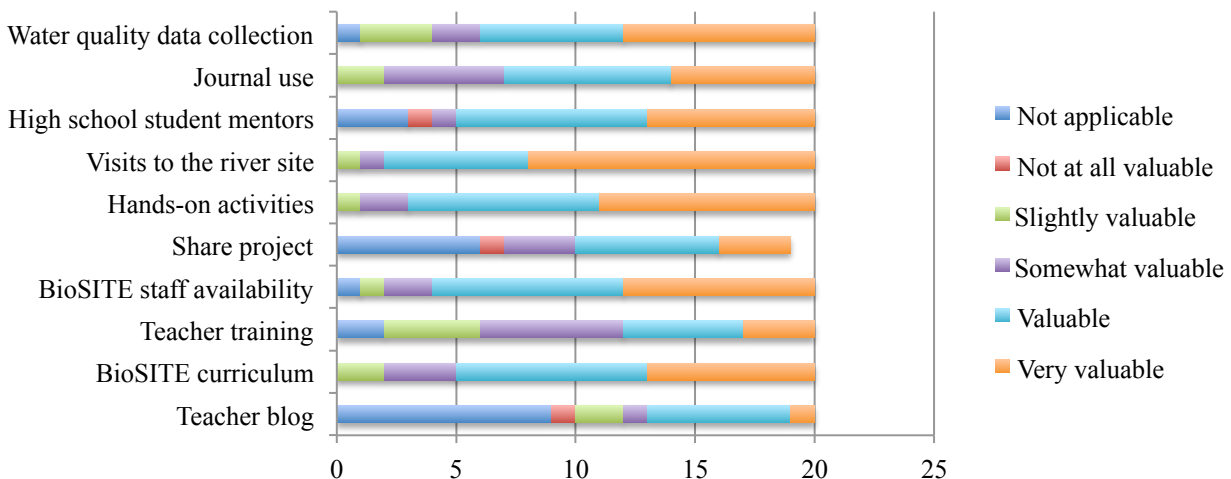
Findings: Impact on Fourth Grade Teachers

Fourth grade teachers were not an explicit set of participants with accompanying inputs, outputs and outcomes articulated in the initial CDM logic model for the BioSITE program. To gain greater understanding of the potential impact of BioSITE, feedback from fourth grade teachers was gathered through an online survey (n=25) and focus group (n=6).

BioSITE provided benefits for fourth grade teachers, especially given their relatively low confidence in teaching science. Of particular value were the river site visits, hands-on activities, and access to BioSITE staff as science content experts. Adjustments to the program have the potential to significantly improve the experience for teachers and to support teachers more intentionally in their science instruction, particularly with the implementation of the new Common Core and Next Generation Science standards.

In addition to perceived positive outcomes for students, fourth grade teachers reported that the BioSITE program provided important enhancements to their science instruction, especially given the relatively low confidence elementary school teachers have in teaching science and their limited access to resources. In particular, teachers cited the visits to the river, hands-on experiences, and access to the BioSITE staff as science content experts as particularly valuable components of the program.

How valuable were the following components of BioSITE for you and your teaching practice?



Teachers in the focus group indicated another set of reasons for their enthusiasm for the BioSITE program: most of the teachers had low levels of confidence or enthusiasm for teaching science, as suggested in the following quotes:

When I was in school myself I never liked science, I didn't understand it, and all we did was only read from the book.

I really love talking to the kids about animals and adaptations, like life sciences. And not so much maybe more like magnetism, and other things I'm not very good at explaining. I like explaining about adaptations, but if I don't know it as well it's hard for me to teach it.

Yeah I don't feel very confident either...I'm guilty of not doing science in my classroom.

Teachers' attitudes about science could be related to the limited instructional time devoted to teaching the subject. Multiple teachers reported that they only teach science in their classroom when it is embedded in English Language Development (ELD) curriculum; one teacher reported teaching about five hours of science per month, and another stated, "Well, BioSITE is a couple of hours [of science] right there..." The following quote reflects the limited instructional time spent on science:

We have whole kits at our school, I forget what they're called. They are kits that go along with their book, so we do the experiments that go along with the book. The kits are in big boxes, so we will pull them out, and I don't do every single one, we get through as much of the book as possible, it's just hard to squeeze everything in—ELD and math and language development have to come first.

Through the survey, fourth grade teachers reported other ways that the BioSITE program influenced their science instruction. Teachers mentioned that they refer to BioSITE activities during other science instruction when they are doing hands-on activities, book-based instruction, and "in a Common Core type of way to support of inquiry learning." BioSITE also reminds them to make time for hands-on activities for their students. One teacher reported using BioSITE as a model to support independent development of similar programs:

It has provided a good example for me to follow should I do the program on my own .i.e., the journal format, the curriculum provided as well as getting other older students (I have coordinated with the local community college to lead a "creek" exploration this upcoming Friday), other teachers and other younger Blackford grads to participate. I am also thinking of utilizing it next year as part of my science program with fifth graders to augment their regular science program.

Fourth grade teachers also provided feedback regarding elements of the BioSITE program that they found less valuable. The inconsistent journal use by high school students, documented in the previous section, made it difficult for the teachers to reflect on the journals with their students back in their classrooms. Additionally, teachers indicated concerns regarding the distribution of BioSITE opportunities at their schools, and expressed a desire for further support in integrating the BioSITE experiences into their classroom instruction, especially to support implementation of the Common Core

Standards. Survey findings also indicated that fourth grade teachers found the teacher training and teacher blog to be of lesser value when compared to other elements of the BioSITE program. Teachers' concerns about the availability of BioSITE opportunities are indicated in the following quotes:

A couple years ago the principle made it very clear: she wanted all the classes at a grade level to have the same field trips, more equity, because some teachers would sign up for something, and then some students weren't going on those cool trips, or second grade had five trips, and fifth grade had one (trip), so she was like okay... let's have it be the same for the same grade level, plan it together. And we were like ummm, sorry, but we can't do that with BioSITE!

I had a parent [...] come up to me and say how many classes do this BioSITE thing? And I was like 2....we only can do 2 and we have 4 classes...[and the parent said] well I want my child in your class then, because you're here.

Suggestions from the evaluation team for how to address the availability of BioSITE experiences and teachers' desire for support in integrating BioSITE with their classroom instruction are included in the Recommendations section. Specific suggestions from teachers regarding how to address these issues are included in Appendix B.

Summary of Findings: Impact on Fourth Grade Teachers

The most valuable components of the BioSITE course for teachers were the river site visits, hands-on activities, and access to BioSITE staff as science content experts. The partnership with BioSITE and access to these opportunities also helped to bolster teachers' confidence in teaching science. Revisions to the program have the potential to increase the BioSITE course's impact on teachers and to better support their science instruction, particularly in light of recent adoptions of the Next Generation Science Standards and the Common Core Standards in California.



Findings: CDM Staff

Interviews with CDM and BioSITE program staff generated insight into the program components that staff felt to be most impactful. The section below details the ways in which staff assertions and predictions aligned with and diverged from summative evaluation findings and from the CDM logic model.

Summative evaluation results generally supported staff members' predictions regarding the program's impact on high school students. Staff members called out the importance of the mentorship model and small group learning for students, asserting that teaching others makes you learn better. This idea was supported by the results of interviews with BioSITE students—unprompted, 33% of interviewed students asserted that the teaching component of the course helped them with comprehension of the material, and 17% said that it helped them to retain content. Staff also asserted that many students in the course want to be teachers or work with kids, an idea supported by the findings detailed in earlier sections of this report.

Staff also called out the course's power in affecting students' relationship with the environment—they asserted that students' environmental awareness is increased, they learn that they can take action to make a difference in the environment, and that everything is interconnected. As demonstrated earlier in this report, summative evaluation data supported these assertions.

Staff asserted the value of the inquiry experiences in BioSITE—where students are doing investigation in a field setting and generating questions. They also asserted that students learn that science is a process they can engage in, with connections to their lives and to the real world, and that the course helps to cultivate a positive orientation to scientific information. While the course certainly served to reinforce these ideas for students, many students entered the course already bought in to these concepts.

Interestingly staff members asserted in interviews that the highest priority outcomes for the BioSITE class are around students' development as individuals—their teamwork, critical thinking, and presentation skills, and their confidence and flexibility. They asserted that students do not necessarily get a deep understanding of the science of water quality in the class, and that increasing students' interests in science careers is not a substantial focus of the class. This idea was largely supported by the results of the summative evaluation, but does not correspond with the CDM logic model as it is currently constructed.

The summative evaluation found potential evidence to support staff members' predictions regarding the value of the BioSITE program for fourth grade students. Staff emphasized the program's potential impact on fourth grade students' awareness of environmental issues and what they can do about it, and their comfort in and connection to the environment. Staff also asserted the value of the mentor relationship for fourth grade students, and claimed that the program teaches fourth graders certain science skills such as asking questions and science thinking. As suggested earlier, further study about the fourth grade students' experience and learning from BioSITE would be helpful in better understanding how their participation could be supported to address these potential outcomes in a more consistent manner.

Staff members’ predictions regarding the BioSITE program’s impact on fourth grade educators both aligned with and diverged from evaluation findings. Staff expressed desires that the program broaden teachers’ understandings of science and of science teaching, ideas that are supported by data detailed in previous sections. Staff also reported that teachers are aware that BioSITE aligns in the Next Generation Science Standards and the Common Core standards, and expressed the hope that BioSITE content was integrated with fourth grade teachers’ other work. Educators expressed some success and some challenges related to this, which are detailed below in the Recommendations section.



Conclusions

Based on interviews with BioSITE and CDM staff and the findings summarized in this report, a range of student outcomes may result from participation in the BioSITE program. This intersects with CDM's current logic model, which is focused on developing positive science identity, academic development (e.g. concepts, skills and practices), and personal and social development (communication, group work, career exposure, etc.).

Overall, the BioSITE program structure creates a potential pathway to provide students in fourth and tenth grade opportunities to deepen and/or expand their understanding of science and the environment in San Jose. At the high school level in particular, the program draws high school students to the program for different reasons, and also allows them to gain from the learning experiences in different ways. For example, the program clearly attracts students already interested in science, but some students also reported being initially interested in BioSITE because of an interest in the environment or in teaching younger students.

Regardless of students' initial or primary interest in applying to participate in BioSITE, the program provided opportunities to reinforce an understanding of the nature of science that is active and participatory; that is focused on data collection, analysis, and communication of science; and that includes science content and skills not taught in typical science education classes but represent a more accurate understanding of the work of scientists. Fundamentally, BioSITE provides an important opportunity for students to continue on their pathway to become more scientifically literate citizens. A summary of findings by stakeholder group is included below:

BioSITE provided *high school student participants* with important opportunities to deepen and enhance their engagement with science and science education. As a supplementary elective course, BioSITE serves to move each student forward on his or her pathway toward becoming scientifically literate citizens. Especially pronounced were student outcomes related to communication of science and students' connection to the environment, two important components of students' development as citizens equipped to address the environmental issues facing our world. The BioSITE class aligned with many of the elements PHS sophomores claimed made science class meaningful and engaging; correspondingly, high school participants in BioSITE found the class to be meaningful and engaging.

Data from *BioSITE alumni* provided evidence to suggest that the BioSITE course's impact on high school students related to their communication skills, relationship to science and the environment, and understanding of science persist after they finish the course, and to suggest that BioSITE may have influenced some students' choices of college majors and careers. Additionally, of those who responded to the voluntary survey, BioSITE alumni reported very positive experiences and memories related to the course. Further investigation into outcomes for BioSITE alumni is recommended, to confirm how representative these findings are and to provide further context around them.

There is evidence to suggest that BioSITE positively influenced *fourth grade students'* connection to the environment, perception that science is “cool,” and comfort in some foundational science skills. According to fourth grade teachers, the hands-on science opportunities provided to students in an outdoor setting and the existence of the high school student leaders as role models were particularly impactful. Improvements regarding the use of journals has potential to deepen BioSITE’s influence on these students’ science identity. Fourth grade BioSITE participants are just beginning on their pathway toward becoming equipped to tackle environmental issues, and the BioSITE program has the potential for additional impact in this area.

The most valuable components of the BioSITE course for *fourth grade teachers* were the river site visits, hands-on activities, and access to BioSITE staff as science content experts. These experiences helped to bolster teachers’ confidence in teaching science. Revisions to the program have the potential to increase equitable access to BioSITE opportunities, increase BioSITE’s impact on teachers, and better support teachers’ integration of BioSITE in their classrooms and their science instruction in general.

Recommendations

Recommendations for Strengthening the Pathway for Science

As has been discussed throughout this report, the BioSITE program structure creates a potential pathway to provide students in fourth and tenth grade opportunities to deepen and expand their understanding of science and the environment in San Jose. If the CDM staff would like to further maximize this opportunity, several ideas could be explored further:

Deepen focus on fourth grade students. As noted earlier in the report, high school students enter BioSITE already interested in science. If program staff wish to influence students who are not already interested in science to become more engaged, then the focus of the BioSITE program could be on ensuring consistency across the experiences of the fourth grade teachers and students in the program. This would likely require more systematic attention to what the high school students do with their fourth grade students. It could also entail more intentionally constructing the science learning pathway between fourth and tenth grades—building on the significant number of high school BioSITE participants who also participated in fourth grade, and potentially identifying and focusing on the San Jose elementary schools that feed to PHS and other high schools involved in BioSITE.

Consider middle school components. If CDM staff members are interested in building out the science pathway provided by BioSITE, the missing link in the current version of BioSITE is middle school. The middle school years are a critical time in children’s development—interests developed during this period can carry students through high school and beyond. To address this, program staff could consider adding a BioSITE program component at the middle school level, to provide a bridge on students’ pathway between the fourth and tenth grade BioSITE experiences.

Sharpen messaging around science careers. Findings related to BioSITE alumni suggest that the program may have had an influence on some students' choice of careers related to science, the environment, and/or teaching, as 30% of the total number of alumni survey respondents indicated that BioSITE influenced their career goals. To strengthen this pathway, participating high school students could be intentionally reminded about how the BioSITE experiences may help them consider fields of study and/or careers in science, technology, engineering or math. These high school students are already activated and interested in science, but through this program, they also learn and develop other important skills including communication, group work and mentoring that would help them be successful in school, work and life.

Consider ways to engage BioSITE alumni. To further strengthen the science learning pathway, BioSITE alumni could be provided with more frequent or regular opportunities to engage with the program, through online events, informal gatherings, and/or large events like the 10-year anniversary celebration. Keeping alumni connected to the larger BioSITE community could potentially serve to reinforce BioSITE's impact on students and support them to continue on their science learning pathway.

Recommendations for Program Design

Consider restructuring BioSITE recruitment processes. Since BioSITE is currently reaching students already interested in science, BioSITE and CDM staff should consider embracing the fact that this is a secondary science class that does not have the pressures of being an "A-G" requirement course for college admission. BioSITE currently provides important opportunities for students to further expand and deepen their interest in science while also offering opportunities to grow as individuals, particularly in the area of environmental awareness and behaviors. If, however, there is the desire on the part of BioSITE and CDM staff to reach students not interested in science and try to actively engage high school students in science and the environment in order to shift their thinking about science, that would require restructuring how high school student recruitment occurs, as well as the criteria by which students are selected for the course.

Prioritize and communicate key BioSITE outcomes. The summative evaluation findings showed moderate misalignment between stated BioSITE program goals and the program elements staff members found to be most valuable and important. Given the rich experiences in which high school and fourth grade students engage in BioSITE and the wide variety of outcomes that students may glean, we recommend that the BioSITE and CDM staff reflect on what would be considered the key priority program outcomes, particularly in the area of science learning--what the specific goal outcomes might look like--and then align them with program activities and delivery. For example, is the focus on communicating particular science content or concepts? On scientific practices such as data collection, analysis and communication? On the use of scientific processes to support environmental stewardship and action? Reflecting and agreeing upon key program outcomes will help all stakeholders, including fourth grade teachers, understand what is expected of staff and participants. The CDM staff took action on this through a rubric-development process undertaken with the evaluation team to clarify goal outcomes for the fourth

grade student share projects.⁴ It is recommended that this outcome clarification and prioritization process be continued and expanded.

Recommendations for Supporting Teachers

Evaluation findings demonstrated that opportunities exist to better support fourth grade teachers in integrating BiosITE into fourth grade classrooms, and in teaching science in general. The fourth grade teachers had several suggestions to this end:

Improve consistency of journal use in BioSITE. Ensure that all fourth grade students are receiving the same instructions from their high school leaders regarding writing in their journals, such that journals are used consistently and all fourth grade students have the necessary information recorded in their journals to enable post-field day classroom follow up and integration.

Consider expanding access to BioSITE at elementary school sites: Data collected with fourth grade teachers indicated that both teacher and parents desire equitable access to the BioSITE program across fourth grade classes at individual elementary school sites. Involving all fourth grade classrooms at each elementary school would help principals and teachers in addressing concerns about equity by providing all fourth grade students at each school access to the similar science education experiences. Expanding access in this way could take several forms such as potentially (A) reducing the number of field days for each elementary school class such that more classes could participate without increasing the number of high school leaders; or (B) increasing the number of high school classes (and thus high school leaders) to correspond with increased elementary school participation. In this scenario, attention should be paid to the importance of BioSITE core staff—throughout the summative evaluation process, stakeholders remarked about the importance of Robert Zaccheo and Biret Adden in the success and high quality of the program.

Support fourth grade teachers in Common Core implementation through BioSITE. Given changes in elementary schooling related to Common Core (and also Next Generation Science Standards), BioSITE could help teachers address these new standards through BioSITE experiences. Several teachers recommended the inclusion of integrated non-fiction texts as a means of utilizing the BioSITE experience to support the implementation Common Core Standards:

We want our kids to read more nonfiction literature, and this would be a great opportunity to have the kids read about environmental issues, what is going on, in the city of San Jose, the environment, the world, everywhere. And get them into that text that is going to make them think and come up with the problem solving skills-what can I do, and how can I make it better. It would be great if we could get our hands on that kind of literature.

⁴ This rubric is included in Appendix F.

It would be great if we could actually have that type of [nonfiction] literature in the classroom [like] issues of an environmental magazine that we can read articles and have our kids read, because our kids are still responsible for reading and writing. But if they can read and write about these issues, they have something more meaningful to respond to in their writing. So as a teacher to grow, I feel the need to have a lot more of these resources—if there are articles or magazines—anything we can give our kids so they can read and we can have discussions, and they can write about it—it's one of the ways I would like to integrate the program more in the classroom.

Consider enhancing fourth grade teachers' roles in the BioSITE program. Providing teachers with meaningful ways to participate in the BioSITE program would better enable them to integrate BioSITE into their classroom instruction, and also deepen the degree to which the program served as valuable professional development around science content and science instruction for elementary school teachers. Specific recommendations for teachers regarding ways to support them in integrating BioSITE into their classroom teaching are included in Appendix B.

Support high school BioSITE instructors in sharing BioSITE findings and experiences with their colleagues. At PHS, Robert Zaccheo's position as science department chair enabled productive sharing regarding BioSITE program experiences and summative evaluation findings with the other teachers in the department. Teachers expressed a desire to hear about (for example) the results of the pre and post survey conducted with 10th grade PHS students. CDM staff could implement more systematic ways of enabling the sharing of BioSITE experiences with other teachers at the high schools involved in BioSITE, as a way to advocate for the value of experiential, service-learning type science learning experiences at the high school level.

Recommendations for Further Research

Conduct a retrospective study with BioSITE alumni regarding program impact. Data collected from alumni suggests that BioSITE may have long-term influence on high school student participants. To further investigate this, it would be worthwhile to invest in a retrospective study of BioSITE that explored the program's long-term impact on students by engaging program alumni. Collecting contact information of BioSITE alumni and administering a short survey once a year would serve to create the systems to conduct such a study while also strengthening BioSITE alumni's connection to the program.

Conduct systematic research regarding program impact on fourth grade students. Summative evaluation findings suggest that the fourth grade BioSITE experience may be a powerful opportunity to activate students' positive relationships with science and the environment at the very beginning of their science learning pathway. If this is of interest to CDM staff, to further investigate this it is recommended to ensure consistency across fourth grade students' experiences and eventually conduct further examination of the program's impact on fourth grade students.

Investigate the efficacy of different iterations of the BioSITE program. If CDM staff are considering scaling the BioSITE program or extending fourth grade participation (as recommended above), it is recommended that research be conducted to explore the outcomes associated with other iterations of BioSITE. For example, a study could investigate the impact on fourth grade students and teachers of a version of BioSITE where each elementary school class attends fewer field days. This kind of research into different iterations of the BioSITE program with different levels of intensity will allow CDM staff to identify the best ways to scale BioSITE without compromising program impact.



BioSITE Summative Evaluation Report

Appendix A

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Appendix B

Specific Stakeholder Recommendations

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Specific Recommendations from Stakeholder Groups

Additional Suggestions from Teachers to Support Integration of BioSITE: As shown in the chart included in an earlier section, the teacher blog and teacher training could be improved for increased impact on teachers. As mentioned in the previous section, the level of explanation and comprehension regarding water quality tests could also be improved. One teacher gave a particular suggestion about this: “I liked the idea of having students be experts in a single water quality test and then teach other students.” Some teachers also expressed desires for improved behavior from high school students, expressing the idea that their dress code was at times inappropriate and suggesting that there be more consistent expectations for high school student teachers regarding their dress and comportment.

Teachers also indicated interest in integrating more science in their classroom, and gave some suggestions as to how this could be accomplished. In addition to the Common Core integration described above, they:

- Expressed a desire for advance notice of topics that will be covered in BioSITE on particular days.
- Suggested that integration could be improved if the 4th grade educators are more involved in teaching the content to 4th graders: “Teacher could be a better partner in teaching curriculum which would lead to better integration with classroom science teaching.”
- Requested that the BioSITE schedule should be adjusted to allow teachers to follow up on the BioSITE experience with their students the same afternoon
- Revise the order and timing of BioSITE units to better match the progression of 4th grad curriculum
- Provide additional BioSITE staff support in conducting follow-up activities and continued field observations in 4th grade classrooms: “Being able to continue the research and field observations with help from BIOSITE staff was most helpful for both the students learning and me too.”

Specific Suggestions for Improvement from High School Participants and Alumni: Students suggested that additional instruction prior in the beginning of the course would be helpful.

Specific suggestions included:

- Make the first lesson plan they create a “practice” lesson plan
- Practice the first teaching day
- Create opportunities for class or group bonding in the beginning of the year, to dispel cliques

Students had additional suggestions about preparation for teaching. Some requested additional room for creativity or the ability to design their own lessons, and others requested additional preparation time and opportunities to practice each game in class before the teaching day. Alumni suggested that discussion be encouraged between in addition to within groups, and students also made suggestions to improve in-class reflections—they requested fewer or shorter reflections, and also suggested that the reflection questions vary each time. They also had very

specific suggestions regarding the mechanics of the teaching days—several requested transportation to the river. They also suggested the following:

- Small boots for kids
- Paint back of boards with white board paint so each group has a white board, to save paper
- Give each team a Walkie Talkie
- Sock stash
- Better way to carry boots/other stuff

BioSITE students suggested that program alumni be brought in to give advice. This suggestion resonates with alumni feedback for improvement, which included the request to keep alumni updated, perhaps through a newsletter.

Individual alumni also requested deeper engagement with science topics through teaching 4th grade students “solutions, not just make pledges,” incorporating current events, and requiring outside reading to “go deeper on careers.” These recommendations are summed up by the following quote:

Make sure that current events are a integral part of the curriculum. Also, requiring an extra bit of outside reading (book reports and the like) might prove to further encourage exploration of career choices. And finally, encouraging more discussion between groups on ideas for presenting ideas to the students might be helpful to everyone involved.

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Appendix C

Survey Results

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Survey items were grouped into constructs for analysis and are included below.

Construct 1: Interest in Science

Question: How much do you agree or disagree with the following statements?

I would like to have a job where I use scientific thinking and/or knowledge.
I would like to do scientific work.
I would like to work with other scientists to solve problems.
I would like to be a scientist.
It's important to use science knowledge to make a difference in the world.
If I wanted to, I could be someone who works in a science field.

Construct 2: Communication in Science

Question: How much do you agree or disagree with the following statements?

I feel confident that I can speak in front of groups of people.
I feel comfortable asking questions in science class.
I feel that my classmates respect my comments in science class.
I feel comfortable answering a science question out loud in class.

Construct 3: Interest in the Environment and Making a Difference

Question: How interested are you in the following?

Learning about how to protect the environment.
Learning about plants, animals, and the places they live.
Visiting natural areas (e.g., national and state parks, local rivers, lakes).
Learning about my local environment.
How often do the following statements describe you?
I'm careful not to waste water.
I'm careful not to litter.
I talk to my friends or family about the environment.
I work as a volunteer in my community.
When I'm outside, I pay close attention to different plants and animals.

Question: How much do you agree or disagree with the following statements?

I'd rather be outside than inside.
I'd rather go to a shopping mall than to a lake or pond.
I feel it's important to take good care of the environment.
I'd rather play video games than explore outside.
I see science all around me in my daily life.
I might someday like to volunteer or work in a natural area or park.
Humans are a part of nature, not separate.

Construct 4: Thinking Scientifically

Question: How much do you agree or disagree with the following statements?

I like to ask questions.

I use information from different sources to help me make decisions.

I am curious about a lot of things.

I like to figure out different ways to answer a question.

I like it when someone challenges my thinking.

I like to figure out how things work.

I like giving reasons to explain what I think.

Paired-Samples T-Test Analyses: Entire 10th Grade Population at PHS

The test was conducted on average scores for each scale (scores were only generated for participants who scored 50% or more items). For the entire 10th grade population at PHS, only Construct 4 was found to be statistically significant increasing between Pre and Post. However, all four scales seem to be increasing as a trend.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Construct 1_Pre	2.3250	362	.75230	.03954
	Construct 1_Post	2.3787	362	.78122	.04106
Pair 2	Construct 2_Pre	2.5352	362	.74386	.03910
	Construct 2_Post	2.5483	362	.74891	.03936
Pair 3	Construct 3_Pre	2.5101	362	.43400	.02281
	Construct 3_Post	2.5297	362	.46264	.02432
Pair 4	Construct 4_Pre	2.7497	362	.65932	.03465
	Construct 4_Post	2.8169	362	.66070	.03473

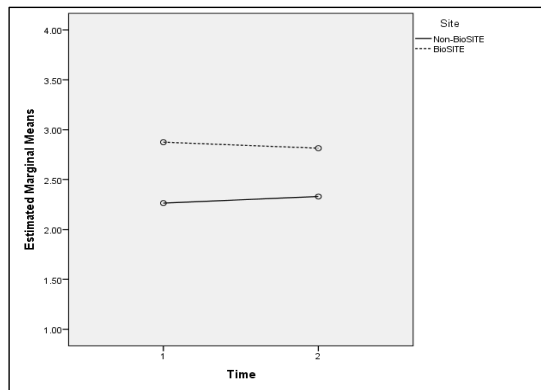
Paired Samples Test

		Mean	Std. Deviation	Paired Differences			t	df	Signif. (2-tailed)
				Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Construct 1_Pre - Construct 1_Post	-.05368	.56762	.02983	-.11235	.00499	-1.799	361	.073
Pair 2	Construct 2_Pre - Construct 2_Post	-.01312	.61331	.03224	-.07651	.05027	-.407	361	.684
Pair 3	Construct 3_Pre - Construct 3_Post	-.01956	.34972	.01838	-.05571	.01658	-1.064	361	.288
Pair 4	Construct 4_Pre - Construct 4_Post	-.06715	.51543	.02709	-.12043	-.01388	-2.479	361	.014

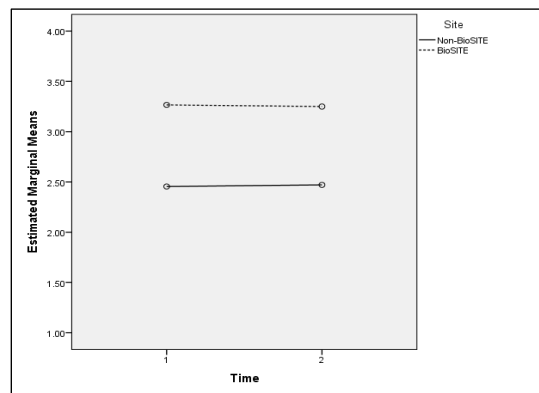
Paired-Samples T-Test Analyses: Comparing BioSITE and Non-BioSITE Student Responses

The graphs and tables below illustrate how BioSITE students consistently scored higher than their non-BioSITE peers on all of the constructs. Also, while non-BioSITE students improved on the "interest in science" and "thinking scientifically" constructs, changes for BioSITE students were not statistically significant.

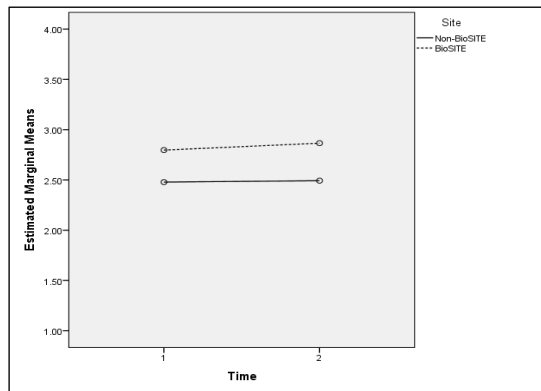
Construct 1



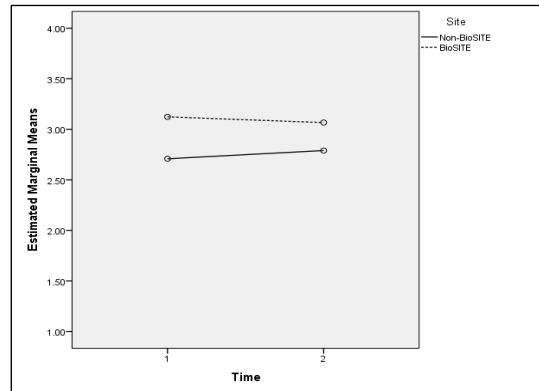
Construct 2



Construct 3



Construct 4



Paired Samples T-Test (Separating BioSITE and Non-BioSITE Student Responses)

Paired Samples Statistics

Site			Mean	N	Std. Dev	Std. Error Mean
Non-BioSITE	Pair 1	Construct 1	2.2643	326	.72919	.04039
		Construct 1	2.3306	326	.77307	.04282
	Pair 2	Construct 2	2.4545	326	.71687	.03970
		Construct 2	2.4709	326	.72413	.04011
	Pair 3	Construct 3	2.4784	326	.42912	.02377
		Construct 3	2.4925	326	.45949	.02545
	Pair 4	Construct 4	2.7085	326	.66763	.03698
		Construct 4	2.7893	326	.67127	.03718
BioSITE	Pair 1	Construct 1	2.8750	36	.74469	.12412
		Construct 1	2.8148	36	.72679	.12113
	Pair 2	Construct 2	3.2662	36	.57002	.09500
		Construct 2	3.2500	36	.59462	.09910
	Pair 3	Construct 3	2.7969	36	.37272	.06212
		Construct 3	2.8659	36	.34353	.05725
	Pair 4	Construct 4	3.1230	36	.43081	.07180
		Construct 4	3.0668	36	.49692	.08282

Paired Samples Test

Site			Paired Differences					t	df	Sig. (2-tailed)
			Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
						Lower	Upper			
Non-BioSITE	Pair 1	Construct 1	-.06626	.56872	.03150	-.12822	-.00429	-2.104	325	.036
	Pair 2	Construct 2	-.01636	.62175	.03444	-.08410	.05138	-.475	325	.635
	Pair 3	Construct 3	-.01410	.35241	.01952	-.05250	.02429	-.723	325	.470
	Pair 4	Construct 4	-.08078	.52995	.02935	-.13852	-.02304	-2.752	325	.006
BioSITE	Pair 1	Construct 1	.06019	.55227	.09205	-.12668	.24705	.654	35	.517
	Pair 2	Construct 2	.01620	.53779	.08963	-.16576	.19816	.181	35	.858
	Pair 3	Construct 3	-.06898	.32467	.05411	-.17883	.04087	-1.275	35	.211
	Pair 4	Construct 4	.05622	.33903	.05650	-.05849	.17093	.995	35	.327

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Appendix D

Additional Data Collected During Summative Evaluation

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Additional Data from Interviews with High School BioSITE Students

Students chose BioSITE for a variety of reasons, the most popular of which was the teaching aspect.

- 7/12 students said they decided to take BiosITE due to the teaching aspect
- 4/12 students mentioned community service hours
- 3/12 students each mentioned the outdoor location and the environment topic
- 2/12 students mentioned the science focus
- 1 student each mentioned the following topics:
 - Because it was in the newspaper
 - Due to conservation focus
 - Friends said BioSITE was fun

Prior to starting BioSITE, students were predominantly aware of the teaching aspect and the outdoor location

- 6/12 students mentioned each of these topics
- 1 student each mentioned awareness of the biology topic, the environment topic, and the conservation topic.

Students had a wide variety of expectations for their BioSITE experience.

- 3/12 students had expectations around the social nature of the class
- 2/12 students expected to teach
 - Additionally, one student mentioned that they expected behavior management to be difficult, another expected that working with kids would be challenging, and a third expected teaching to be easy. An additional student expected to learn teaching tips in the course
- 2/12 students expected to learn content.
 - Additionally, one student expected the content to be difficult, and another expected they would learn more than in other classes
- 2/12 students expected to learn communication skills
- 1 student each mentioned the following expectations
 - *Expectations about 4th grade students*
 - Students will be focused
 - Kids that do BioSITE might be more interested in science when they are older
 - 4th graders will be engaged
 - *Other expectations*
 - BioSITE gives a different perspective
 - Learn about group work
 - Will be hands-on
 - See real examples

Most interviewed BioSITE students were excited about the course's teaching component, and a significant portion had prior experience working with children.

- 8/12 students reported feeling excited to teach
- 5/12 students reported prior experience with kids
- 2/12 students reported prior experience teaching kids
- 4/12 students reported that they were nervous about teaching
- One student reported that they were uncomfortable around children before BioSITE

When reflecting on their experiences teaching, BioSITE students called out that they enjoyed the teaching experience, and that behavior management was difficult. Several students also said that seeing that their students learned was a highlight of the experience.

- 7/12 students reported that they enjoyed teaching
- 7/12 students reported that behavior management was difficult. 2/12 students specifically called out that one problem child was difficult
- 4/12 students said that seeing that their students learned was a highlight
- 2/12 students said it was a highlight when their students enjoyed the experience
- One student each expressed the following:
 - Hard when kids said they didn't like it
 - Hard to balance needing to discipline kids and not wanting to take their experience away
 - Enjoyed seeing kids grow
 - 4th graders learned how to help the environment
 - 4th graders learned impact of actions
 - Being a role model part of teaching
 - Creating lesson plans difficult
 - Kids got the most out of hands on
 - Hands on helps comprehension
 - Hard when didn't have enough time to plan
 - Feel like have ability to teach and organize

BioSITE students' favorite and least favorite parts of science aligned with the survey results, and were maintained across BioSITE and comparison group students.

- *Favorite:* Experiments/labs, science in everyday life, learning about how the world works, nature, good teachers, hands-on
- *Least Favorite:* Lectures, bad teachers, content that is irrelevant to life, memorization, tests, notes

Interviewed BioSITE students reported a wider range of ideas about what good teaching is than comparison students. Both sets of students' ideas were consistent with what was reported in the survey.

- *Good Teaching: BioSITE Students*
 - Clear
 - Depth
 - Examples, demonstrations
 - Good descriptions
 - Hands on

- Relevance to student life
- Level of enthusiasm
- Friendly
- Engaging voice
- Visuals
- *Good Teaching: Comparison Group Students*
 - Hands on
 - Relevant to life
 - Good explanations

All interviewed students thought they were doing real science in BioSITE

- Most common responses were because BioSITE involves working in and testing the local environment, and due to the water quality tests.
- 5/6 Comparison Group students also felt like they were doing real science, for variety of reasons

Students made a wide variety of comparisons between BioSITE and other classes, the vast majority positively favoring BioSITE.

- *BioSITE involves real science and opportunities for hands-on learning*
 - 8/12 students said that BioSITE was “going out and experiencing the real thing,” as compared to “sitting there and having the teacher tell you things” in other classes
 - 7/12 students said that BioSITE is more hands-on than other classes
 - 4/12 students said that BioSITE better because involves real data/experiments
 - 3/12 students said that in BioSITE you actually get to experience the process of science
- *BioSITE is relevant to everyday life and the real world*
 - 5/12 students said that BioSITE is more relevant/related to everyday life than other classes
 - 7/12 students said that in BioSITE is better than other classes because you apply concepts
 - 3/12 students said that they experienced improved comprehension of the material due to this
 - 2/12 students said that BioSITE is better than other classes because you are actually contributing something, you have a purpose
- *BioSITE facilitates deeper thinking, and the development of a well-rounded set of skills*
 - 3/12 students said that BioSITE goes into more depth than other classes, and one said that BioSITE involves deeper thinking
 - One student mentioned each of the following:
 - BioSITE more open-ended, other classes more closed-ended
 - BioSITE teaches a well-rounded set of skills, not just science concepts
 - BioSITE better because involves deeper thinking
 - In other classes thinking like a scientist means thinking about science
 - Students ask more questions in BioSITE
 - BioSITE follows different pedagogical ideas
- *BioSITE is oriented toward social interaction*

- One student mentioned each of the following:
 - More social interaction than in other classes
 - BioSITE more community/group oriented than other classes
 - More group work in BioSITE
- *BioSITE teaches a different approach to science than other classes, but students are mixed about the degree to which its content is distinct*
 - 4/12 students reported that BioSITE content is the same as other classes
 - One student each mentioned the following:
 - BioSITE is field research instead of lab work
 - BioSITE focuses on how to improve the environment, other classes focus on what has already been discovered
 - BioSITE involves multiple types of science
 - Environmental content in BioSITE is different
 - Content in BioSITE is more important
- *The student experience in BioSITE differed in some ways from that of other classes*
 - One student reported that they experienced less pressure in BioSITE than in other classes due to the teaching structure, and another said that BioSITE required less work than other classes.
 - Another student noted that they thought BioSITE was better than other classes because it takes place outside
 - A fourth student said that they thought the BioSITE classroom experience was the same as other classes
- *Students found BioSITE to be a productive and new experience*
 - 4/12 students said that they experienced better comprehension in BioSITE than they did in other classes
 - 2/12 students said that BioSITE was better than other classes because it was fun
 - 2/12 students said they had never done anything like BioSITE before.

Additional Data from High School BioSITE Student Journal Entries

After BioSITE, students' perceptions of barriers to pro-environmental behavior included:

- Time (11 mentions)
- Laziness (6 mentions)
- Motivation (2 mentions)
- Convenience (2 mentions)
- The fact that “all other people” are careless (2 mentions)
- The following items received one mention each:
 - Hard to convince others in household
 - Money
 - Easier not to worry
 - Modern lifestyle
 - Someone else's problem
 - Different than the norm
 - Need worldwide change
 - Traditions
 - Not top priority

Midway through BioSITE, some students reported that their ideas about science changed by doing water quality testing. The following shifts were mentioned:

- Ideas of what science is changed from science as indoor experiments to science as used to monitor environment or world (3 mentions)
- Learned that science requires trial and error (1 mention)
- Learned that science is about learning about how things work (1 mention)
- Learned that science doesn't have to include testing or long procedures (1 mention)
- Appreciate the benefits of science more (1 mention)
- Learned that experiments are tedious, help us know about world (1 mention)
- Learned that science involves creativity, logic, trials (1 mention)
- Learned that science isn't just about the body and chemicals (1 mention)
- Learned that science can tell you about water quality (1 mention)
- Learned that science is not just in class, it can be outside and have practical uses (1 mention)
- Feel more knowledgeable about science (1 mention)
- Made science mean more to the student (1 mention)
- Learned that science affects us and our environment (1 mention)
- Learned that science isn't just inside in lab coats, it is out in the field (1 mention)

Early on in the BioSITE class, students mentioned that sitting and observing the environment affects them in the following ways:

- Realize how peaceful and pretty it is (12 mentions)
- Makes student want to help environment/Wonder how to help environment (10 mentions)
- Relaxes the student, makes them feel peaceful (6 mentions)

- Sitting and observing the environment makes student more aware of world/real nature (4 mentions)
- Makes student appreciate nature (2 mentions)
- Wonder how it all happens (1 mention)
- Want to preserve environment (1 mention)
- Reminded not good to disturb environment (1 mention)
- Feel connected to nature (1 mention)
- Reminds of love for environment (1 mention)
- Causes worry about damage humans can do (1 mention)

At the end of the BioSITE year, students mentioned that spending time outdoors during the year affected the way they think about the environment in the following ways:

- Realized how much humans can impact the river (7 mentions)
- Motivated more to care for the environment and respect it (8 mentions)
- Notice more in the environment or my surroundings, realized the biodiversity around me (6 mentions)
- Realize beauty of environment, appreciate it (3 mentions)
- Want to change it because can see effects individual can have (2 mentions)
- Want to change it because can see effects individual can have (2 mentions)
- Show how much earth needs our help, that the river is not healthy (2 mentions)
- Still want to help environment (2 mentions)
- Realized the importance of the environment (2 mentions)
- More comfortable in the environment (2 mentions)
- Helped me relax (2 mentions)
- Caused me to look at the environment differently, or in a deeper way (2 mentions)
- No change in thinking (2 mentions)
- Realized I'm not a big outdoor person (1 mention)
- See how everything is connected (1 mention)
- Caused interest in birds (1 mention)
- Teaches me to think outside of myself (1 mention)

At the end of the first semester of BioSITE, students asserted that the most important parts of BioSITE for 4th graders are:

- Conservation message (14 mentions)
- Being at the river/helps understanding (6 mentions)
- High schoolers as teachers/role models: (6 mentions)
- Hands on learning (5 mentions)
- Environmental knowledge (4 mentions)
- Having fun: (2 mentions, including "such that they have good memories of the river")
- Changing ideas of/relationship to science (2 mentions)
- Learning the "why" (1 mention)
- Getting to participate in conservation (1 mention)
- Real moments of learning (1 mention)
- Learning social skills/organization (1 mention)

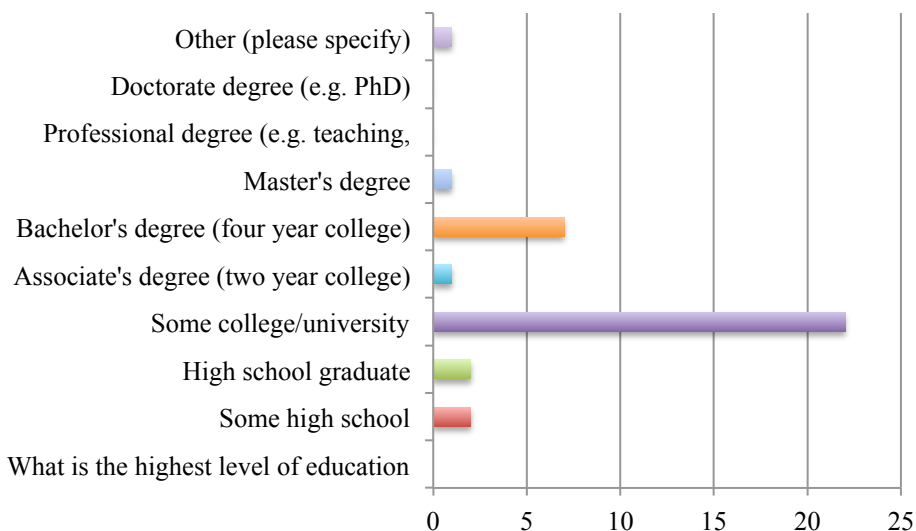
- Making a connection between the content and the real world (1 mention)

At the end of the BioSITE year, high school participants asserted that the teaching experience has the following effects on them:

- Learn to interact with kids (10 mentions)
- Helps understanding and learning (10 mentions)
- Improves public speaking skills (3 mentions)
- Get to be a leader/leadership skills (3 mentions)
- Teaches teamwork (3 mentions)
- Causes an ability to see from the teacher's perspective, increases respect for teachers (3 mentions)
- Improves organizational skills and preparation (2 mentions)
- Imparts more patience (2 mentions)
- Allows us to learn [the content] (2 mentions)
- Learn how to be a good teacher (2 mentions)
- Able to apply knowledge in other classes (2 mentions)
- Improves independence (1 mention)
- Learn to be more interactive (1 mention)
- Learn how to listen (1 mention)
- Good experience for future teaching career (1 mention)
- Learn to interact with the environment/how to protect it (1 mention)
- Learn how to deal with hard situations (1 mention)
- Increases awareness of environment (1 mention)
- Able to learn something I love (1 mention)
- Learn to deal with people (1 mention)
- Improve communication skills (1 mention)
- Cause pride and a feeling of accomplishment (1 mention)
- Learn how to improve community (1 mention)

Additional Data from BioSITE Alumni Survey

At the time of taking the BioSITE alumni survey, the vast majority of alumni respondents had enrolled in college.



At the time of taking the BioSITE alumni survey, alumni were attending a wide variety of institutions and concentrating on a variety of topics.

2-Year Colleges

- Institutions:
 - De Anza (2 Students)
 - Mission (1 Student)
 - West Valley (1 Student)
- Topics:
 - Science related (1 Student)
 - Not Science, Environment, or Teaching Related (3 Students)

4-Year College

- Institutions:
 - UC Davis (4 Students)
 - San Jose State University (3 Students)
 - UC Berkeley (2 Students)
 - Chico State University (2 Students)
 - San Francisco State University (2 Students)
 - Cal Poly San Luis Obispo (2 Students)
 - UC San Diego (1 Student)
 - UCLA (1 Student)
 - Cal Poly Pomona (1 Student)
 - Linfield College (1 Student)
 - Northwestern (1 Student)
 - UC Santa Cruz (1 Student)
 - Colgate University (1 Student)
 - Duke University (1 Student)

- UC Irvine (1 Student)
- UC Santa Barbara (1 Student)
- St John's College (1 Student)
- Northeastern University (1 Student)
- Topics:
 - Science-Related (13 Students)
 - Teaching-related (3 Students)
 - Environment-Related (2 Students)
 - Not Science, Environment, or Teaching-Related (7 Students)

Graduate school

- Education Credential (3 Students)

BioSITE Alumni Career Goals Spanned a Variety of Topics

Alumni Career Goals

- Teaching or Youth-related (11 Students)
- Science-related (10 Students)
- Environment-related (6 Students)
- Not Science, Environment, or Teaching-Related (11 Students)

BioSITE Summative Evaluation Report

Appendix E

Slides from Presentation to PHS Science Department Regarding 10th Grade Survey Findings

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Children's Discovery Museum BioSITE 10th Grade Survey Preliminary Results

**For Pioneer High School
San Jose Unified School District
September 13, 2013**

Presented by Bernadette Chi, PhD and Leah Reisman

Project Funding Provided by:
The Gordon and Betty Moore Foundation



Introduction

- During the 2012-2013 school year, the Children's Discovery Museum in San Jose contracted with the Research Group at the Lawrence Hall of Science at UC Berkeley to conduct a summative evaluation of the BioSITE program focusing on Pioneer High School (PHS).
- PHS staff were incredibly helpful in allowing and supporting our data collection; they also expressed interest in the results of our study.
- The purpose of this brief presentation for the Science Department at PHS is to provide data and results from the BioSITE 10th Grade Survey.



Sample and Methods

- Pre/post survey of 2012-13 10th graders
 - N=362 (pre/post-survey matched responses)
 - Excluded special education classes, students not taking a science class, those absent on survey days AND make-up days, and those who left or joined PHS mid-year
 - Survey included mostly closed-ended items.
 - One open-ended question: “What, if anything, makes science class engaging and meaningful to you?” (suggested by Mr. Zaccheo)
 - 88% of students responded to the open-ended question in a meaningful way, which is a very high percentage!



Closed-Ended Survey Items-1

- 10th grade students' responses regarding their relationship to science thinking showed statistically significant improvement over the course of the year.
 - Responses improved on the following items:
 - I like to ask questions.
 - I use information from different sources to help me make decisions.
 - I am curious about a lot of things.
 - I like to figure out different ways to answer a question.
 - I like it when someone challenges my thinking.
 - I like to explain how I know something.
 - I like to figure out how things work.
 - I like giving reasons to explain what I think.
 - 5-item scale with the following response options:
Strongly Disagree, Disagree, Neither Disagree nor Agree, Agree, Strongly Agree
- Pre-survey mean score for this scale was between “Neither Disagree nor Agree” and “Agree.” Post-survey mean score was also between these two response choices, but increased closer to Agree.



Closed-Ended Survey Items-2

- 10th grade students' responses about the other tested constructs did not show statistically significant change over the course of the year, including:
 - Interest in science careers
 - Communication skills
 - Connection to the environment
 - Understanding/Definition of science/science thinking
 - Action around making a difference/contributing to the community
- However, students consistently gave fairly positive responses around all of these constructs
 - Mean scores for all constructs on the pre-survey were between “Neither Disagree nor Agree” and “Agree.”

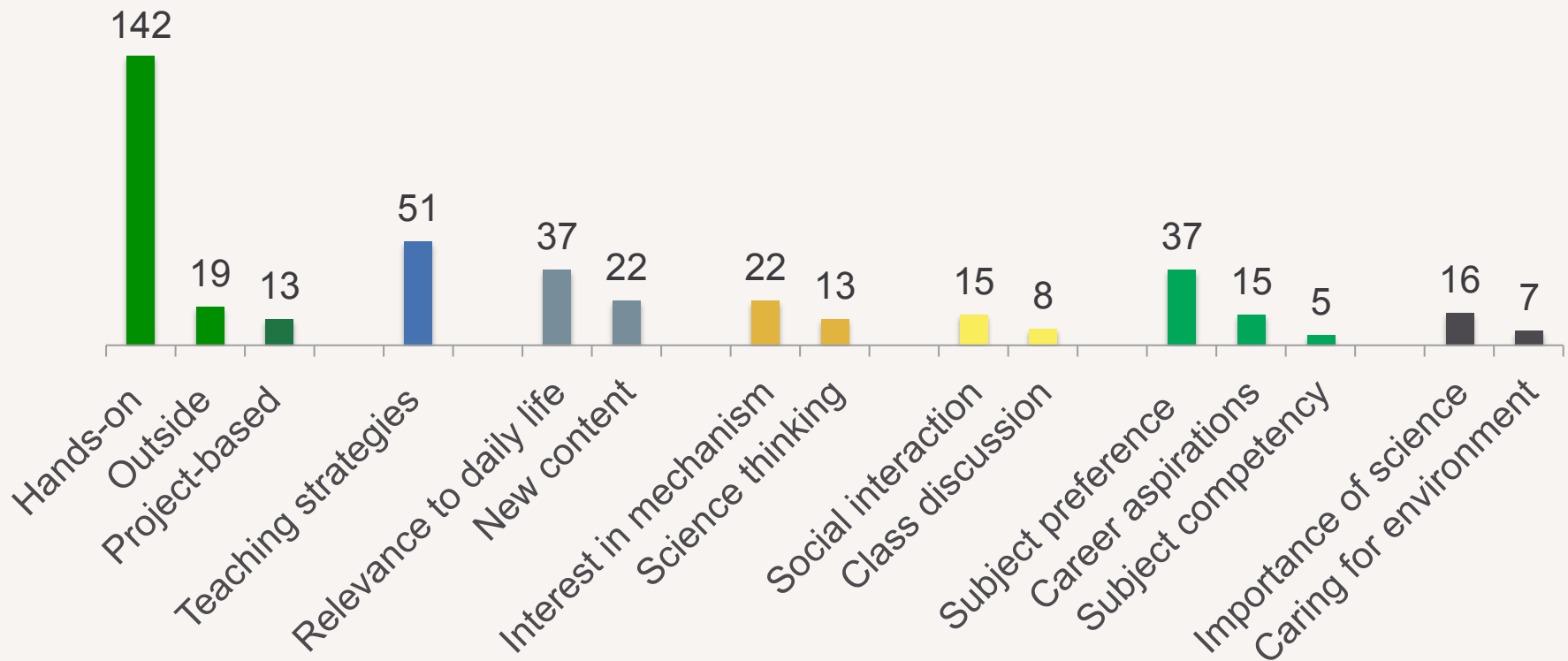


Closed-Ended Survey Items-3

- BioSITE students' responses did not show statistically significant change over the course of the year for any of the constructs tested.
- However, BioSITE students consistently scored higher (more positively, closer to “Agree”) than their peers in other science classes
- This suggests a ceiling effect—students in the BioSITE class enter the class already feeling positively towards the constructs tested, therefore it is difficult for their responses to increase.



Open-ended Survey Item: *What, if anything, makes science class engaging and meaningful to you?*



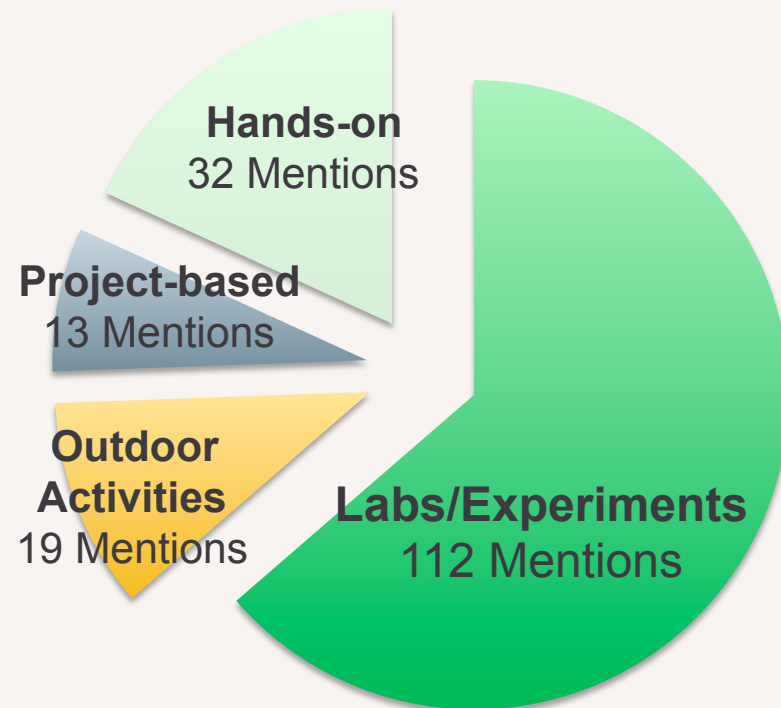
*Frequencies represent # of mentions; some students provided more than one idea.



Many students find hands-on activities, that are project-based or that take place outdoors engaging.

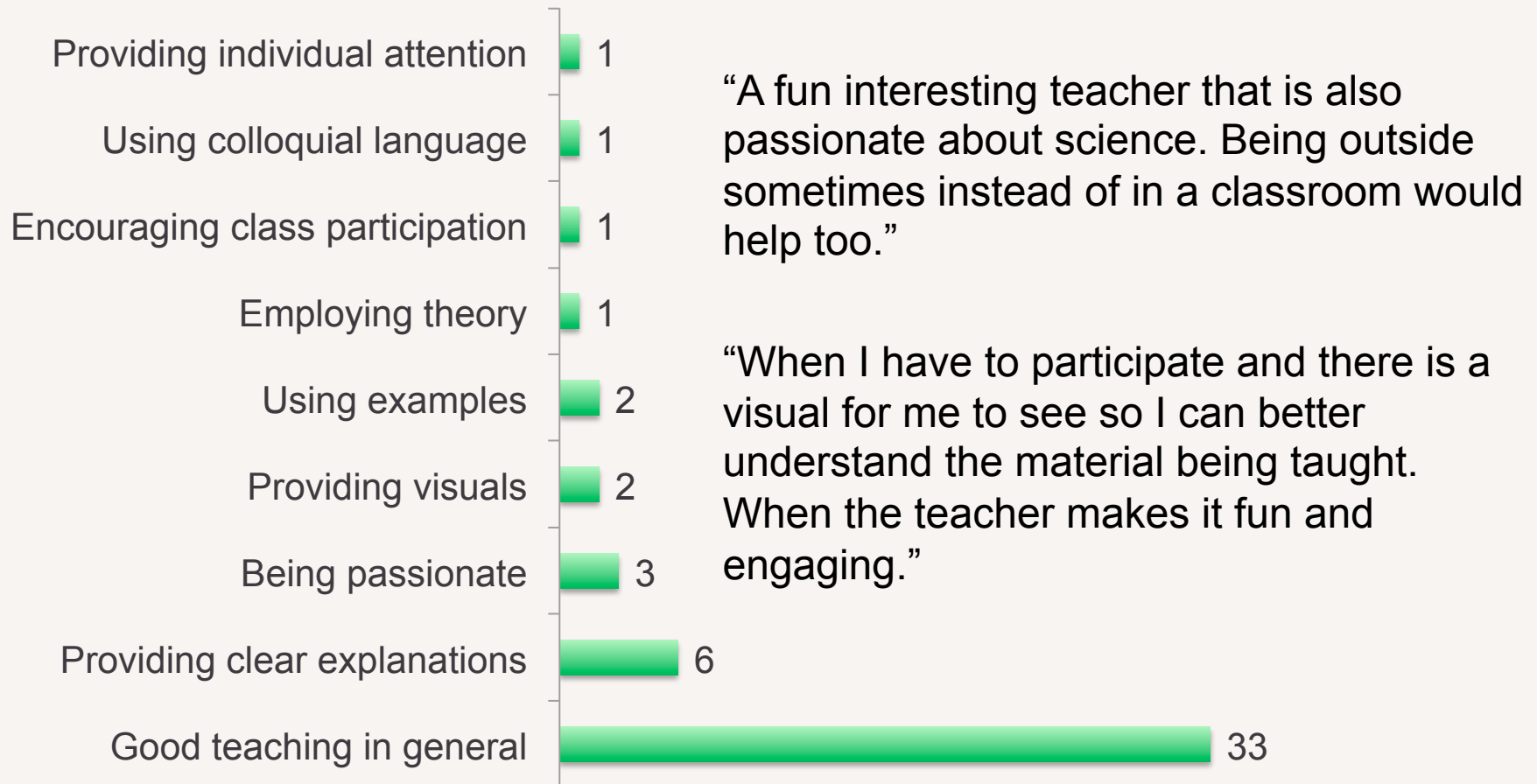
“When we do labs and group work so I can ask questions with my peers and see if they're struggling with the same topics as me.”

“Doing interactive activities that help me to fully understand what I am learning and give me the capability to ask deeper questions and challenge thoughts. Basically anything that does not involve sitting in a classroom listening to a lecture and taking notes.”





Of those students who cited teachers or teaching as engaging, they reported appreciation of various teaching strategies and characteristics.





Students appreciate material that is new to them and relevant to their lives.

- “The parts of science class that I find most engaging are the hands on activities/ labs” we do that show us how science is a part of our daily lives.”
- “Learning about anything that I find relevant to me makes learning science meaningful. if I know that I'm never going to use the skills or knowledge that is being taught, why should I care about learning it at all?”
- “I find it engaging when topics in class relate to knowledge outside of class. Learning about something that was in a book, movie, or other type of not school related media makes the topic far more engaging.”
- “Learning about different aspects about science and discovering new things I never knew about”



Several students expressed specific interests in the mechanism and modes of thinking involved in science.

- “I like actually being able to figure things out rather than just being presented with facts to memorize”
- “As a high school student what makes science class engaging and meaningful to me is being able to explore different possibilities and looking at things in more than one way.”
- “What makes science class engaging is the idea of knowing how the world works even if we can't see some of the processes due to small size.”
- “It's interesting when we can relate to the lessons being taught in class. Another important aspect is the 'why'. It's difficult to understand and appreciate when one does not understand why the phenomenon occurs.”

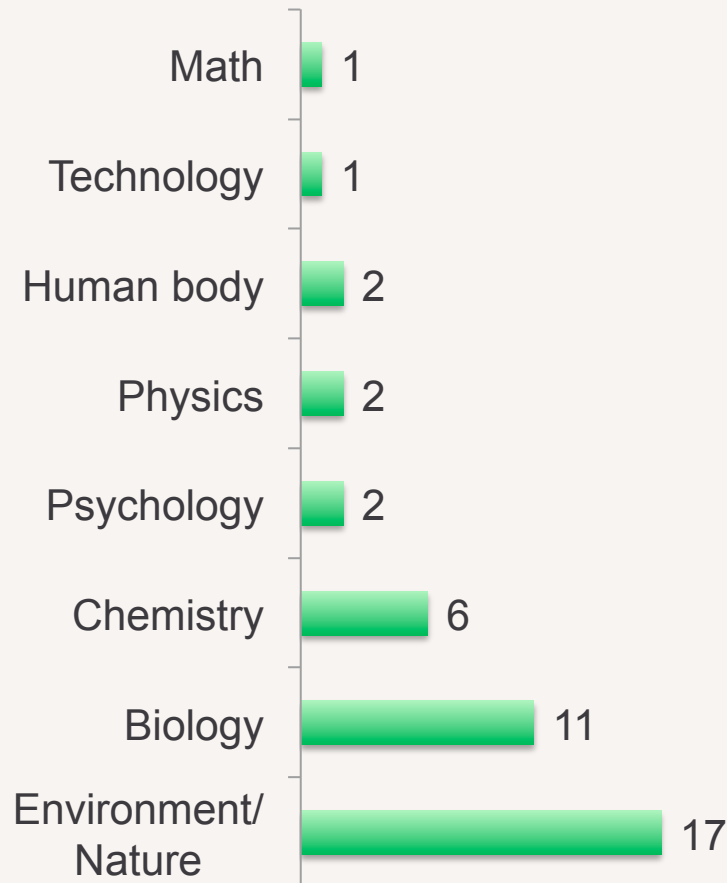


Students valued opportunities to interact with their peers.

- “When the teacher makes the lesson interesting by involving the whole class in the discussion”
- “When we do labs and group work so I can ask questions with my peers and see if they’re struggling with the same topics as me.”
- “The labs and the cooperation with other students makes it more engaging.”



When students reported preferences for specific science topics, nature and the environment were at the top of the list.



- “I really do not like science but what I find interesting is different animal species”
- “As a high school student, observing the world we live in and exploring the life of living creatures makes science class engaging and meaningful to me. Also, the way science is in our everyday lives and in jobs I want to have in the future makes it meaningful as well.”



Several students mentioned the importance of science, particularly related to environmental conservation.

- “The fact that you learn facts crucial for survival and the possibility of making a change in the future.”
- “As a high school student what makes science class engaging and meaningful to me is by doing all of the projects Because science is important to me.”
- “Science is meaningful because it helps discover new things like medicine and different species. It's pretty interesting and it can make a difference in the world.”

BioSITE Summative Evaluation Report

Appendix F

Instruments and Protocols

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10th grade survey (CDM) May 2013

Greetings,

Researchers and school staff are trying to understand more about high school students' interest in science. We have a series of questions for you because you are in a 10th grade science class.

There are no right or wrong answers. We want to know your thoughts and opinions. Please answer honestly as your name will not be linked with your responses. Thank you in advance for letting us know what you think!

Please enter the number on the card we gave you.

How interested are you in the following?

	Not interested	Hardly interested	A little interested	Pretty interested	Very interested
Learning about how to protect the environment.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Working to make my community a better place.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Learning about plants, animals, and the places they live.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Visiting natural areas (e.g., national and state parks, local rivers, lakes).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Exploring the outdoors near my home.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Learning about my local environment.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Learning about different cultures or other ways of life.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

How much do you agree or disagree with the following statements about science?

	Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree
Science is a body of knowledge such as principles, laws and theories, which explain the world around us (matter, energy, life, etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Science is the study of fields such as biology, chemistry, or physics.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Science is exploring the unknown and discovering new things about our world and how they work.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Science is carrying out experiments to solve problems of interest about the world around us.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Science is finding and using knowledge to make the world a better place to live in (e.g., curing diseases, solving pollution, and improving agriculture).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Science is inventing or designing things (e.g., artificial hearts, medicines, computers, spacecraft, etc.).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

How often do the following statements describe you?

	Never	Hardly Ever	Sometimes	Often	Always
When I'm outside, I pay close attention to different plants and animals.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I work as a volunteer in my community.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I turn the lights out when I leave the room to conserve energy.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I'm careful not to waste water.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I'm careful not to litter.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I talk to my friends or family about the environment.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

10th grade survey (CDM) May 2013

How much do you agree or disagree with the following statements?

	Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree
I like to ask questions.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I use information from different sources to help me make decisions.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am curious about a lot of things.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I like to figure out different ways to answer a question.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I like it when someone challenges my thinking.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I like to explain how I know something.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I like to figure out how things work.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I like giving reasons to explain what I think.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

In doing their work, scientists do a lot of thinking. They get curious, ask questions, think about how things work, figure out different ways to investigate their questions, observe and document what they see, and explain how their investigations and observations help to answer their questions.

Based on this definition of what it means to think as a scientist, how much do you agree or disagree with the following statements?

	Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree
I am comfortable thinking like a scientist.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I like to think like a scientist.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Anyone can think like a scientist.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

How much do you agree or disagree with the following statements?

	Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree
I would like to have a job where I use scientific thinking and/or knowledge.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like to do scientific work.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like to work with other scientists to solve problems.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would like to be a scientist.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Being a scientist or working in a job requiring scientific thinking and knowledge would be a very interesting and rewarding life's work.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

10th grade survey (CDM) May 2013

How much do you agree or disagree with the following statements?

	Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree
It's important to use science knowledge to make a difference in the world.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Learning about science helps me make a difference in the world.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel comfortable answering a science question out loud in class.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I know what doing scientific research is like.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
If I wanted to, I could be someone who works in a science field.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Scientists can really make a positive difference in the world.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel confident that I can teach science to younger children.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel confident that I can speak in front of groups of people.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel comfortable asking questions in science class.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel that my classmates respect my comments in science class.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

How much do you agree or disagree with the following statements?

	Strongly Disagree	Disagree	Neither Disagree Nor Agree	Agree	Strongly Agree
I feel comfortable in the outdoors.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Humans are a part of nature, not separate.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I'd rather be outside than inside.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I'd rather visit a park than see a movie.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I'd rather go to a shopping mall than to a lake or pond.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I see science all around me in my daily life.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel it's important to take good care of the environment.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It's important to protect as wide a variety of animals and plants as we possibly can.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I'd rather play video games than explore outside.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I might someday like to volunteer or work in a natural area or park.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please respond to the following question in 1-2 sentences:

As a high school student, what, if anything, makes science class engaging and meaningful to you?

The End! Thank you for your time and effort.

BioSITE Research Study
High School Student Interview Protocol
Fall 2012

Introduction

Thank you for taking the time to talk with me today. I am part of a team from the Lawrence Hall of Science researching how participating in science activities affects students. I will be asking you questions about what you think about the BioSite program and about science in general. I won't tell anyone what you say. Specifically, when we share our findings, we will summarize the general topics that students mention and we won't use any names. Feel free to take time to think about your responses—we hope you are honest. Do you have any questions for me? (Can I tape the interview so that I can remember what you say?) Let's get started.

1. Will you tell me a little bit about yourself? What things do you like to do, what are your interests, etc.
 - a. Do you have ideas about what you want to do when you get older?
2. Why did you want to sign up for the BioSITE science class?
 - a. What did you know about it before you started?
 - b. What do you think this class is going to be like?
 - c. How do you feel about the fact that you'll be teaching 4th graders in this class?
 - d. Did you participate in BioSITE as a 4th grader?
 - i. What did you remember about that experience? What did you like?
3. Could you describe the ways that you have learned science in school before BioSITE?
 - a. What have been your favorite parts of science classes so far (if any)? What makes them your favorite?
 - b. What have been your least favorite parts? Can you tell me why they are your least favorite?
4. Close your eyes. Get a picture in your head of “doing science.” What does it mean to “do science?”
 - a. Who do you think can be good at doing science? Where did you get this idea?
5. Have you heard the phrase “think like a scientist?” What does that mean to you?
 - a. When do you think like a scientist, if at all?
 - b. Do you feel confident that you can “think like a scientist?”
6. Do you see science as an important part of who you are?
 - a. If yes, probe in what ways.
 - b. If no, probe why not?
 - c. Probe if necessary to make sure they address how they see science as part of their internal/personal self

(continued on next page)

7. What type of role does science play in your life?
 - a. In what ways do you do or use science in your life outside of school?
 - b. In what ways do you use science or science thinking in your life?
 - c. Probe if necessary to make sure they address how they see science as part of their external/day to day life
8. Are you interested in or concerned about the environment?
 - a. In what ways?
 - b. Do you feel like you can make a difference in helping the environment?
 - c. Have you done things that might help make a positive change for the environment?
 - d. In your opinion, how are science and the environment connected?
9. How do you think students' past experiences, backgrounds, or cultures might affect what they do, feel, and think in science classes? Do you think science teachers should pay attention to this when they think about how best to teach science? Why or why not?
 - a. Have you had teachers that have done this? In what ways?
10. Is there anything else you'd like to tell me about what you think about science or your science class?

BioSITE Research Study
High School Student Interview Protocol
Spring 2013

Introduction

Thank you for taking the time to talk with me today. I am part of a team from the Lawrence Hall of Science researching how participating in science activities affects students. I will be asking you questions about what you think about the BioSite program and about science in general. I won't tell anyone what you say. Specifically, when we share our findings, we will summarize the general topics that students mention and we won't use any names. Feel free to take time to think about your responses—we hope you are honest. Do you have any questions for me? (Can I tape the interview so that I can remember what you say?) Let's get started.

Introduction

1. Can you tell me a bit about your experience in BioSITE this year?
 - a. What was it like? What were some highlights and low points?
2. How is the BioSITE science class similar to and different from your prior science classes?
 - a. Probe for way class was taught, information covered, class setting, role as a student, etc.
 - b. Which way of learning science do you prefer, and why?
 - c. How would you compare what you learned in BioSITE this year with what you have learned in other science classes?
 - i. Probe for examples of what they learned in BioSITE and other science classes.

Science

3. Do you think that the way you “do” science in previous science classes is different than how you “do” science in BioSITE? ***Note* Omit this question if already covered in question 2.**
4. Did you feel that were doing “real” science in BioSITE? How so? Why not?
5. Close your eyes. Get a picture in your head of “doing science.” What does it mean to “do science?”
 - a. Who do you think can be good at doing science? Where did you get this idea?
6. Have you heard the phrase “think like a scientist?” What does that mean to you?
 - b. When do you think like a scientist, if at all?
 - c. Do you feel confident that you can “think like a scientist?”
7. Do you see science as an important part of who you are?
 - d. If yes, probe in what ways.

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- e. If no, probe why not?
 - f. Probe if necessary to make sure they address how they see science as part of their internal/personal self
8. What type of role does science play in your life?
- g. In what ways do you do or use science in your life outside of school?
 - h. In what ways do you use science or science thinking in your life?
 - i. Probe if necessary to make sure they address how they see science as part of their external/day to day life
9. Do you think your ideas or feelings about science have changed through your participation in BioSITE?
- a. How so? Please explain.
10. Have your ideas about yourself as a scientist, a science learner, or a 'science person' changed at all?

The Environment

11. Are you interested in or concerned about the environment?
- j. In what ways?
 - k. Do you feel like you can make a difference in helping the environment?
 - l. Have you done things that might help make a positive change for the environment?
 - m. In your opinion, how are science and the environment connected?
12. Do you think your ideas or feelings about the environment have changed through your participation in BioSITE?
- a. How so? Please explain.
13. Have you learned anything about your ability to make a difference in your community or in helping the environment?
- a. How so? Please explain.
14. Finally, has the BioSITE class made you think differently about what you might want to do when you get older? OR Do you have ideas about what you want to do when you get older?
15. Have you learned anything about yourself by participating in the BioSITE program?
- a. Can you give some examples?

Experience Teaching 4th Graders

16. What was it like for you to teach science to the 4th graders?
- a. How has that experience changed you, if at all?

- b. Do you think teaching younger children helped you feel more comfortable learning science? Why? How so?
17. ***If time permits, ask this question*** How do you think students' past experiences, backgrounds, or cultures might affect what they do, feel, and think in science classes? Do you think science teachers should pay attention to this when they think about how best to teach science? Why or why not?
- n. Have you had teachers that have done this? In what ways?
 - o. Have you had any experiences related to this during BioSITE this year?
 - i. Probe whether they feel like this influenced their own teaching this year?
18. Is there anything else you'd like to tell me about what you think about science or your science class?

BioSITE Research Study
Non-BioSITE High School Student Interview Protocol
Spring 2013

Introduction

Thank you for taking the time to talk with me today. I am part of a team from the Lawrence Hall of Science researching how participating in science activities affects students. I will be asking you questions about what you think about the BioSite program and about science in general. I won't tell anyone what you say. Specifically, when we share our findings, we will summarize the general topics that students mention and we won't use any names. Feel free to take time to think about your responses—we hope you are honest. Do you have any questions for me? (Can I tape the interview so that I can remember what you say?) Let's get started.

Introduction

1. Will you tell me a little bit about yourself? What things do you like to do, what are your interests, etc.
2. Can you tell me a bit about your experience in science class this year?
 - a. What was it like? What were some highlights and low points?

Science

3. Did you feel that were doing “real” science in your science class this year? How so? Why not?
4. Close your eyes. Get a picture in your head of “doing science.” What does it mean to “do science?”
 - a. Who do you think can be good at doing science? Where did you get this idea?
 - b. Has your opinion about this changed since the beginning of the school year?
5. Have you heard the phrase “think like a scientist?” What does that mean to you?
 - c. When do you think like a scientist, if at all?
 - d. Do you feel confident that you can “think like a scientist?”
 - e. Has your opinion about this changed since the beginning of the school year?
6. Do you see science as an important part of who you are?
 - f. If yes, probe in what ways.
 - g. If no, probe why not?
 - h. Probe if necessary to make sure they address how they see science as part of their internal/personal self
 - i. Has your opinion about this changed since the beginning of the school year?
7. What type of role does science play in your life?
 - j. In what ways do you do or use science in your life outside of school?
 - k. In what ways do you use science or science thinking in your life?

THE RESEARCH GROUP
UC Berkeley, Lawrence Hall of Science

- l. Probe if necessary to make sure they address how they see science as part of their external/day to day life
- m. Has your opinion about this changed since the beginning of the school year?

The Environment

- 8. Are you interested in or concerned about the environment?
 - n. In what ways?
 - o. Do you feel like you can make a difference in helping the environment?
 - p. Have you done things that might help make a positive change for the environment?
 - q. In your opinion, how are science and the environment connected?
 - r. Has your opinion about this changed since the beginning of the school year?
- 9. Do you have ideas about what you want to do when you get older?
 - a. Has your opinion about this changed since the beginning of the school year?
- 10. Is there anything else you'd like to tell me about what you think about science or your science class?

Revised Journal Prompts
BioSITE Summative Evaluation
2012-2013

1. August 20th, first river visit
 - How does sitting and observing nature affect the way you think about the environment?
2. August 21st, in class before scientist activity
 - What do you think of when you think of a scientist? (3-5 words/phrases or ideas)
 - Do you see yourself as a scientist? Why or why not?
3. In September before Unit 1 (Repeated as #6 in May)
 - Why is it important to make a difference to the environment?
 - In what ways can you personally make a difference to the environment?
4. In January, after teaching water quality unit
 - Describe how your ideas about science have changed by doing water quality testing
 - What do you think it means to be a scientific thinker?
 - How can learning to think like a scientist benefit other parts of your life?
5. In March after teaching Salmon Unit
 - What do you see as the benefits to you of teaching the science concepts of BioSITE to elementary students?
6. In May before teaching Unit 7 (Same as #3)
 - Why is it important to make a difference to the environment?
 - In what ways can you personally make a difference to the environment?
7. In May midway through Unit 7
 - In what ways, if any, has spending time outdoors this year affected the way you think about the environment?
 - What are the challenges to helping the environment in your everyday life?
8. Late May (Mostly same as #4)
 - What do you think of when you think of a scientist? (3-5 words/phrases or ideas)
 - Do you see yourself as a scientist? Why or why not?
 - What do you see as the benefits to your elementary students of participating in the BioSITE program?
9. Final reflection in June. Short answer survey page, not in journals

- In what ways, if any, has learning about science in BioSITE this year influenced the way you think about the environment?
- What do you see as the connection between science and the environment, if any? Has your opinion about this changed since participating in BioSITE?
- We have seen many changes in each of you as the year progressed through BioSITE. What changes, if any, have you seen in yourself?
- If you were in a job interview with someone who didn't know anything about BioSITE, how would you describe the program and why it is important to you?
- If you were in charge of running BioSITE next year, including training the high school students, what would you do differently?
- What pieces of advice would you give to the BioSITE Facilitators of next year?

You may not realize it, but BioSITE has been around for 10 years! We would love to hear about what's been happening with you!

We'd like to stay in contact with you! Please provide your up-to-date contact information below.

First Name:	<input type="text"/>
Last Name:	<input type="text"/>
Permanent (Home) Address:	<input type="text"/>
City/Town:	<input type="text"/>
State:	<input type="text"/>
ZIP:	<input type="text"/>
Country (If not U.S.):	<input type="text"/>
Preferred Email Address:	<input type="text"/>
Preferred Phone Number:	<input type="text"/>

Please read each item below and mark "yes," "no," or "I am still in high school." If you mark "yes," please provide additional detail in the textbox.

Education

Since high school, I...

	Yes	No	I am still in high school
Went to a 2-year college	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
If yes, where? Did you graduate? What did you study?			
<input type="text"/>			
Went to a 4-year college	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
If yes, where? Did you graduate? What did you study?			
<input type="text"/>			
Went to another type of school	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
If yes, where? Did you graduate? What did you study?			
<input type="text"/>			

Work

Since high school, I...

	Yes	No	I am still in high school
Got a job	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
If yes, what kind?			
<input type="text"/>			
Joined the military	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
If yes, what kind?			
<input type="text"/>			

Other

Since high school, I...

Yes

No

I am still in high school

Took a break

☐☐☐

If yes, please give us the details!

Other

☐☐☐

If yes, please give us the details!

How old are you?

If you can remember, please tell us the school year you took BioSITE.

We have been working with an evaluation team from UC Berkeley over the last two years to learn about BioSITE's influence on participants.

We will follow up with you after the event to give you an opportunity to share your feedback about your experience with the BioSITE program! We look forward to hearing your thoughts.

CDM BioSITE Alumni Survey

Hey BioSITE Alumni! It's hard to believe, but BioSITE has been around for almost 20 years! We are trying to learn about what's been happening with past BioSITE participants, and about their experiences with the BioSITE program. We are getting help from researchers at the Lawrence Hall of Science at the University of California, Berkeley on this survey. Thanks so much for your willingness to share your opinions with us!

This survey asks questions about how participating in BioSITE may have influenced your educational, career, and life decisions, including your attitudes about science. It should take you about 15 minutes to complete the survey. Participation is voluntary so skip any question you don't want to answer. Please be honest; your answers will be kept as confidential as possible, though we should let you know that confidentiality cannot be guaranteed in online research. Your email address will be kept secure until it is removed prior to analyzing the information, and your name will not be attached to any reports of our findings.

If you have any questions about the survey, please ask Bernadette Chi via email at bchi@berkeley.edu or by phone at 510-643-1294. If you have any questions or concerns about your rights and treatment as a study subject, you may contact the office of UC Berkeley's Committee for the Protection of Human Subjects, at 510-642-7461 or subjects@berkeley.edu.

Thank you again for taking the time to check out the survey. Your feedback will be very useful to BioSITE program staff and funders to understand how BioSITE may influence students and to improve the program in future years!

Please respond to the following before starting the survey:

- ☐ No, I wish to stop participation in this survey
- ☐ Yes, I understand the information above and agree to participate in the survey

Are you 18 years of age or older?

- ☐ Yes
- ☐ No

CDM BioSITE Alumni Survey

Please indicate how much you agree or disagree with each of the following statements.

Participating in the BioSITE program...

	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
Improved my presentation skills	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Improved my organizational skills	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Helped me feel that I have more control over what happens in my life	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Helped me get along better with people my age	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Helped me connect with other young people interested in science	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Made me realize that I can do things I never thought I could do	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Improved my communication skills	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Made me feel like I was part of a community	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Gave me a new perspective on the options in my life	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Increased my self-confidence	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Improved my problem-solving skills	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Introduced me to educational options I had not considered	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Introduced me to career options I had not considered	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Improved my ability to work as part of a team	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Helped me develop leadership skills	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

If you have any comments you'd like to share about your answers to these questions, please share them below.

CDM BioSITE Alumni Survey

Please indicate how much you agree or disagree with each of the following statements.

Participating in the BioSITE program...

	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
Motivated me to seek leadership opportunities elsewhere in my life	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Broadened my understanding of what counts as science	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Deepened my interest in the environment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Motivated me to find other teaching-related opportunities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Motivated me to make my community a better place	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Increased my interest in science outside of school	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Increased the degree to which I see science as an important part of who I am	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Increased my interest in science in school	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Increased my interest in a career related to the environment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Increased my interest in teaching as a career	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Motivated me to find other science-related opportunities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Increased my belief that I can make a positive difference in the environment as an individual	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Sparked my sense of curiosity about science	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Increased my interests in school overall	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Increased my interests in science as a career	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Broadened my understanding of what it means to think scientifically	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

If you have any comments you'd like to share about your answers to these questions, please share them below.

What is your favorite memory from BioSITE?

In what ways, if any, has participating in the BioSITE program influenced you?

CDM BioSITE Alumni Survey

What is the highest level of education you have completed up to this point?

- ☐ Some high school
- ☐ High school graduate
- ☐ Some college/university
- ☐ Associate's degree (two year college)
- ☐ Bachelor's degree (four year college)
- ☐ Master's degree
- ☐ Professional degree (e.g. teaching, accounting, law, medicine, etc.)
- ☐ Doctorate degree (e.g. PhD)
- ☐ Other (please specify)

If you...

Attended a two year college, where did you go? What did you study?

Have you completed your degree?

Attended a four year college, where did you go? What did you study?

Have you completed your degree?

Attended a graduate degree program (e.g. master's degree, professional degree, or doctorate), where did you go? What was your concentration?

Have you completed your degree?

What is the highest level of education you intend to complete?

- ☐ Some high school
- ☐ High school graduate
- ☐ Some college/university
- ☐ Associate's degree (two year college)
- ☐ Bachelor's degree (four year college)
- ☐ Master's degree
- ☐ Professional degree (e.g. teaching, accounting, law, medicine, etc.)
- ☐ Doctorate degree (e.g. PhD)
- ☐ Other (please specify):

If you...

Plan to attend a two year college, what do you plan to study?

Plan to attend a four year college, what do you plan to study?

Plan to pursue a graduate degree, what is your planned concentration?

CDM BioSITE Alumni Survey

In what ways, if any, has participating in the BioSITE program influenced your educational choices or goals?

Since participating in BioSITE, I have...

	Yes	No
Participated in a teaching or mentoring-related volunteer opportunity?	<input type="radio"/>	<input type="radio"/>
If so, what was it?	<div></div>	
Participated in a science or environment-related volunteer opportunity?	<input type="radio"/>	<input type="radio"/>
If so, what was it?	<div></div>	
Held a teaching or mentoring-related internship?	<input type="radio"/>	<input type="radio"/>
If so, what was it?	<div></div>	
Held a science or environment-related internship?	<input type="radio"/>	<input type="radio"/>
If so, what was it?	<div></div>	
Held a teaching or mentoring-related job?	<input type="radio"/>	<input type="radio"/>
If so, what was it?	<div></div>	
Held a science or environment-related job?	<input type="radio"/>	<input type="radio"/>
If so, what was it?	<div></div>	

If you are currently employed, what do you do?

What are your ultimate career goals and aspirations?

CDM BioSITE Alumni Survey

In what ways, if any, has participating in the BioSITE program influenced your career choices or goals?

What advice, if any, do you have for the BioSITE and Pioneer High School staff about how to improve the BioSITE program in future years?

How old are you?

If you can remember, please tell us the school year you took BioSITE.

What are the initials of your first and last name? (e.g. LR)

What is the DAY of your birthday? (e.g. for October 19th, you would select "19")

If there is anything else you'd like to share, please share it below.

Children's Discovery Museum of San Jose
BioSITE Program Summative Evaluation
Instructions for Observations

Take running fieldnotes during the session you are observing. For **both elementary and high school students**, pay particular attention to the following areas. Mark notes that are pertinent to each category using the codes below.

1. Understanding of science and scientific thinking:

Students understand nature of science, the idea that science is a process and a way of understanding the world. Students can engage in science exploration and use science thinking skills. They believe they have power to make a difference in the world, using science as a tool to do this.

- a. Use code: **1+** for observations that illustrate positive exhibition of this outcome (whole or part).
- b. Use code: **1-** for observations that illustrate negative exhibition of this outcome (e.g. students saying that science is only a school thing)
- c. Use code: **1-part** for observations that illustrate something in between

2. Connection to environment, making a difference, contributing to the community:

Students demonstrate sense of connection to the environment, awareness of environmental issues, and conservation behaviors (including talk of engagement in science activities outside of school)

- a. Use code: **2+** for observations that illustrate positive exhibition of this outcome (whole or part).
- b. Use code: **2-** for observations that illustrate negative exhibition of this outcome (e.g. students saying that they don't see themselves as part of the environment)
- c. Use code: **2-part** for observations that illustrate something in between

3. Communication:

Students show an increased ability to communicate about science to others and increased confidence in their skills in acting as a leader, speaking in public or presenting their work.

- a. Use code: **3+** for observations that illustrate positive exhibition of this outcome (whole or part).
- b. Use code: **3-** for observations that illustrate negative exhibition of this outcome (e.g. students struggling to present their work to 4th graders)
- c. Use code: **3-part** for observations that illustrate something in between

4. Interest in science careers:

Awareness of science careers and interest in pursuing them.

- a. Use code: **4+** for observations that illustrate positive exhibition of this outcome (whole or part).
- b. Use code: **4-** for observations that illustrate negative exhibition of this outcome (e.g. student wants to be a singer)
- c. Use code: **4-part** for observations that illustrate something in between

5. Understanding the role and challenge of teaching:

- a. Use code: **5+** for observations that illustrate positive exhibition of this outcome (whole or part).
- b. Use code: **5-** for observations that illustrate negative exhibition of this outcome (e.g. students struggling to present their work to 4th graders)
- c. Use code: **5-part** for observations that illustrate something in between

Outcome	Description	Positive Code	Negative Code	Mixed Code
Understanding of science and scientific thinking	Students understand nature of science, the idea that science is a process and a way of understanding the world. Students can engage in science exploration and use science thinking skills. They believe they have power to make a difference in the world, using science as a tool to do this	1+	1-	1-part
Connection to environment, making a difference, contributing to the community	Students demonstrate sense of connection to the environment, awareness of environmental issues, and conservation behaviors (including talk of engagement in science activities outside of school)	2+	2-	2-part
Communication	Students show an increased ability to communicate about science to others and increased confidence in their skills in acting as a leader, speaking in public or presenting their work.	3+	3-	3-part
Interest in science careers	Awareness of science careers and interest in pursuing them	4+	4-	4-part
Understanding the role and challenge of teaching	Students understand the teacher's role, and the challenges teachers face (high school students only)	5+	5-	5-part

BioSITE 4th Grade Educator Survey_For CDM

University of California at Berkeley Consent to Participate in Research

Investigating Science Identity Through Youth Participation in Environmental Science Programs 4th Grade Educators

Introduction and Purpose

My name is Rena Dorph. I am the Director of the Research Group at the Lawrence Hall of Science at the University of California, Berkeley. My research team and I would like to invite you to take part in my research study. The purpose of this research is to understand how participation in environmental science programs influences youth's interest in and identification with science ('science identity').

Procedures

If you agree to participate in my research, I will ask you to complete the following online survey. The survey will involve questions about your and your students' experience participating in the BioSITE program, any impacts you think the program had on your students, and your experience with the share project you conducted with your students. and should take about 30 minutes to complete.

There is no direct benefit to you from taking part in this study, and you will not be paid for taking part. We hope that this research will help us understand more about how to improve science learning opportunities and experiences for children and youth.

Participation in the survey is completely voluntary, and you can decline to participate or stop participating at any time. You are also free to decline to answer any question you don't wish to. Whether or not you choose to participate in the survey and whether or not you choose to answer a question or continue participating in the survey, there will be no penalty to you.

As with all research, there is a chance that confidentiality could be compromised; however, we are taking precautions to minimize this risk. Your study data will be handled as confidentially as possible. If results of this study are published or presented, individual names and other personally identifiable information will not be used. All of the information that you provide in your responses to the survey will be kept confidential.

When the research is completed, we may save the survey data for use in future research done by the research team indefinitely. The same measures described above will be taken

BioSITE 4th Grade Educator Survey_For CDM

to protect confidentiality of this study data. We will hold on to all data up to 10 years after the study, after which time we will destroy all records from the study.

If you have any questions about this research, please feel free to contact me. I can be reached at rdorph@berkeley.edu or (510) 642-6477. If you have any questions about your rights or treatment as a research participant in this study, please contact the University of California at Berkeley's Committee for Protection of Human Subjects at 510-642-7461, or e-mail subjects@berkeley.edu.

If you agree to take part in the research, please select "Accept" from the drop-down menu below. If you do not agree to take part in the research, please select "Decline."

Thank you for participating in this survey! Your feedback is very valuable and will help improve the BioSITE program for future participants.

First, we'd like to hear about your thoughts about the value of the BioSITE program for your students.

Overall, how valuable do you think participating in the BioSITE program was for your students?

- ☐ Not at all valuable
- ☐ Slightly valuable
- ☐ Somewhat valuable
- ☐ Valuable
- ☐ Very valuable

We would appreciate it if you would elaborate on your ratings with examples.

How valuable do you think the following components of BioSITE were for your students ?

	Not applicable	Not at all valuable	Slightly valuable	Somewhat valuable	Valuable	Very valuable
Water quality data collection	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Spending time outdoors	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hands-on activities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Journal use	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mentoring by high school students	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Share project	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

BioSITE 4th Grade Educator Survey_For CDM

What do you think was the most valuable component of BioSITE for your students? We would appreciate it if you would elaborate on your response using examples.

What do you think was the least valuable component of BioSITE for your students? We would appreciate it if you would elaborate on your response using examples.

What impact, if any, do you think participating in the BioSITE program had on your students'...

	Large negative impact	Negative impact	Small negative impact	No impact	Small positive impact	Positive impact	Large positive impact
Sense of connection to the environment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Understanding of the nature of science	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Belief that science is "cool"	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Comfort in the outdoors	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Awareness of environmental issues	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to talk/communicate about science	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Confidence in their ability to do science	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Engagement in environmental conservation behaviors	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Belief in the power to make a difference in their natural environment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please elaborate on your ratings.

Did participation in the BioSITE program influence any student outcomes other than those mentioned above?

- ☐ Yes
- ☐ No

If yes, please elaborate

BioSITE 4th Grade Educator Survey_For CDM

What impact, if any, do you think participating in the BioSITE program had on your students' comfort level with the following concepts and practices?

After participating in BioSITE, students are...

	Much more uncomfortable	More uncomfortable	No impact	More comfortable	Much more comfortable
Asking questions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Speaking in front of others	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Conducting scientific tests and experiments	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Discussing science	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Spending time outdoors	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Observing the natural environment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Thinking like a scientist	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Participating in science class	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please share one or two stories from your experience this year that demonstrate the value and/or impact of the BioSITE program for your students.

Next, we'd like to know about your experience participating in the BioSITE program, and how it influenced you as an educator.

How valuable were the following components of BioSITE for you and your teaching practice?

	Not applicable	Not at all valuable	Slightly valuable	Somewhat valuable	Valuable	Very valuable
BioSITE staff availability	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Teacher blog	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Water quality data collection	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Journal use	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Visits to the river site	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Share project	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
BioSITE curriculum	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hands-on activities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
High school student mentors	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Teacher training	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

We would appreciate it if you would elaborate on your ratings with examples.

BioSITE 4th Grade Educator Survey_For CDM

What do you think was the most valuable component of BioSITE for you as an educator?
We would appreciate it if you would elaborate on your response using examples.

What do you think was the least valuable component of BioSITE for you as an educator?
We would appreciate it if you would elaborate on your response using examples.

What aspects of the BioSITE program could be improved?

In what ways, if any, has participating in the BioSITE program influenced your instruction?
We would appreciate it if you would include specific examples in your response.

Did you complete a 4th grade share project with your students this year?

☐ Yes

☐ No

What made it difficult for you to do a 4th grade share project this year? (Please select all that apply)

☐ Not asked to do the project

☐ Not enough time

☐ Too complicated/overwhelming

☐ Unclear about project expectations/guidelines

☐ Not enough BioSITE staff support

Other (please specify)

BioSITE 4th Grade Educator Survey_For CDM

What was the title of the share project you did with your students?

Please provide a 1-2 sentence description of the project's goals and activities.

What challenges did you face, if any, in implementing the share project?

What value, if any, do you think the share project had for your students' learning?

How could the information and support provided by CDM staff for the share project be improved?

Is there anything else you'd like to tell us about your experience participating in the BioSITE program?

Please select the high school you worked with during the BioSITE program and the number of field days your class participated in.

For how many years have you been participating in the BioSITE program? (including this year)

How many years of teaching experience do you have?

BioSITE 4th Grade Educator Survey_For CDM

Please indicate your ethnicity (you may choose all that apply):

- ☐ White
- ☐ African American
- ☐ Asian
- ☐ Native American
- ☐ Hispanic/Latino

Other (please specify)

Please indicate your gender.

- ☐ Male
- ☐ Female

BioSite Elementary Teacher Focus Group Guide

Thank you for participating in this focus group to help evaluate the BioSITE program you participated in this year.

1. Consent Forms

Hand out consent forms

- Before we get started, please read through this consent letter and sign it if you are willing to participate in the focus group. Does anyone have any questions about what is in the letter?
- To review, all of your contributions during this focus group will be kept private, and your name will not be associated with the feedback you provide. You are free to decline to answer any question, and to stop participating at any time. This conversation should last approximately one hour.
- Ok, thank you! Now, let's get started.

2. Background Information

- Let's go around the table and say our names and how many years you have been teaching.
- How would you describe your relationship with science?
[Are you passionate about it? An advocate? Phobic? Indifferent?]
- In general, how much science do you teach each week? Each month?

3. Program Components

- Overall, how valuable do you think participating in the BioSITE program was for your students? How so? Can you share stories about the program's impact on particular students/groups of students?

Pass out sheet that lists components of BioSITE: Mentoring by high school students, water quality data collection, hands-on activities, share project, journal use, spending time outdoors.

- In your opinion, what were the most valuable components of the BioSITE program for your students/what they liked most? How were they valuable? The least valuable components/what they liked least? Do you have any idea why?

4. Program Impact

- Please describe the influence, if any, participating in the BioSITE program had on your students. Can you share stories about the program's impact on particular students/groups of students?
- Ok, please turn your sheet over look at the list of areas that the BioSITE program could have influenced (*Understanding of nature of science, awareness of environmental issues,*

engagement in environmental conservation behaviors, ability to talk/communicate about science, belief in the power to make a difference in their natural environment, belief that science is cool, confidence in their ability to do science, sense of connection to the environment, ability to conduct scientific tests and experiments, other).

- When thinking about the influence the program had on your students, which two things do you think were most positively influenced, if any?
 - Did anyone select “other”? If so, what?
- Which two things were least influenced?
- Were any of these negatively influenced?
 - Did anyone select “other”? If so, what?

4. Other Program Questions

- What impact, if any, did participating in this program have on your teaching practice?
 - What aspects of the BioSITE program were valuable to you as an educator? What could be improved?
 - How valuable to you were the teacher blog, teacher training, BioSITE curriculum, and support from BioSITE staff?
- How easy or difficult was participating in the program for you? (Probe around tradeoffs, challenges, etc.)

5. Share Project

- Do you feel that a share project like the one you did is the right way to demonstrate student learning from the BioSITE program? Please elaborate.
- How could the information and support provided by CDM staff for the share project be improved?

6. Conclusion

- We’ve talked through all the questions we have for you. Is there anything else you’d like to add about your and your students’ experiences participating in the BioSITE program?
- Thank you so much for your time!

Components of the BioSITE Program

- A.** Mentoring by high school students
- B.** Water quality data collection
- C.** Hands-on activities
- D.** Share project
- E.** Journal use
- F.** Spending time outdoors

Potential Student Outcomes

- A.** Understanding of nature of science
- B.** Ability to talk/communicate about science
- C.** Belief that science is “cool”
- D.** Confidence in their ability to do science
- E.** Ability to conduct scientific tests and experiments
- F.** Awareness of environmental issues
- G.** Engagement in environmental conservation behaviors
- H.** Belief in their power to make a difference in their natural environment
- I.** Sense of connection to the environment
- J.** Other

BioSite Elementary Student Pre-Survey

Today's Date:

Your First Name:

Teacher Last Name:

Your Last Name:

Your teacher will read to you some sentences about science and how you may feel about it. Please listen carefully and fill in the answer that shows how you feel right now about each sentence. There are no right or wrong answers, so we hope you will be honest. All of your responses will be kept private and you will not be graded on your responses. Thank you!

Please fill in your answer:

	YES!!	yes	no	NO!!
a. I like science.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. Science is boring.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c. I would like to learn more about science.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d. Science is interesting to me and I enjoy it.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e. Learning about science is fun.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f. I think I will do well on science activities.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g. I am a science-type person.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
h. I listen to others when I am working in a group.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
i. I feel comfortable talking in a group or with my partner.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
j. I ask other students for help if I need it.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
k. It would be fun to teach science to other kids when I am older.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
l. I think that helping the natural environment is important.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Thank you for finishing this survey!

Post-Only Questions:

What was the best thing about the BioSITE program?

What did you learn from being in the BioSITE program?

Administration Script to be Read to the Students

This survey is part of the BioSITE program that our class is participating in this year, doing science activities with the high school students. I am going to read you some sentences about science and how you may feel about it. There are no right or wrong answers, so I hope you will be honest. All of your responses will be kept private, and the information will only be shared with the BioSite people who want to know how to make their program work better for students in the future. Also, you will not be graded on your responses to the survey in any way.

First, please write today's date, my name as the Teacher, and your first and last name in the boxes at the top of the sheet.

Now, please listen carefully as I read each sentence and fill in the answer on your sheet that shows how you feel right now. For each sentence, you can answer:

YES!! meaning you really agree with the sentence.

yes meaning you agree with the sentence.

no meaning you don't agree with the sentence.

NO!! meaning you really don't agree with the sentence.

Review these responses with your students so that they understand the difference between them. Next, read each question, a-l, out loud to your students. Once all students have finished, ask the following questions and make notes of students' responses. We would appreciate your feedback on these questions as well.

1. Were there any words in this survey that you/your students didn't know or were confusing to you?
2. Were there any questions in this survey that you/your students didn't understand?
3. Are there any ways this survey could be made better?

4th Grade Share Project Evaluation Rubric

Directions: Instructors separately fill out one rubric for each 4th grade share project. Score projects based on the degree to which the projects themselves reflect each category. After completing the rubrics, discuss ratings and reconcile any differences (especially when ratings differ by two or more numbers). Collaboratively decide on final ratings.

Note: This rubric measures how much projects succeeded in communicate program goals, not whether individual students or whole classes were impacted as a result of participating in the BioSITE program.

Circle project type: *ROW Pointilism Journaling Cube Journaling Buddy Watershed Mapping Schoolyard Habitat Other*

	3-Strong Demonstration	3-Some Demonstration	1-No Demonstration
Awareness of environmental issues	Project demonstrates a strong understanding of human impacts on the environment/environmental concerns and possible solutions to problems.	Project demonstrates some understanding of human impacts on the environment/environmental concerns and possible solutions to problems.	Project does not demonstrate understanding of human impacts on the environment/environmental concerns and possible solutions to problems.
Connection to environment	Project demonstrates a strong sense of connection to the environment, the importance of making a difference in the community and the interdependence between humans and the environment.	Project demonstrates some sense of connection to the environment, the importance of making a difference in the community and the interdependence between humans and the environment.	Project does not demonstrate a sense of connection to the environment, the importance of making a difference in the community and the interdependence between humans and the environment.
Belief in the power to make a difference	Project demonstrates strong sense of confidence in students' power to make a difference in the world around them, and shows understanding of how science can be used as tool to make a difference	Project demonstrates some sense of confidence in students' power to make a difference in the world around them, and somewhat shows understanding of how science can be used as tool to make a difference	Project does not demonstrate a sense of confidence in students' power to make a difference in the world around them, or show understanding of how science can be used as tool to make a difference
Understanding of science content	Project strongly demonstrates students' science content knowledge	Project somewhat demonstrates students' science content knowledge	Project does not demonstrate students' science content knowledge
Scientific thinking	Project strongly demonstrates understanding of science as a process, not a fixed body of knowledge. Strongly shows students' questioning, critical thinking, and observation skills.	Project somewhat demonstrates understanding of science as a process, not a fixed body of knowledge (could partially suggest understanding of science as learning facts). Somewhat shows students' questioning, critical thinking, and observation skills.	Project does not demonstrate an understanding of science as a process, not a fixed body of knowledge, or show students' questioning, critical thinking, and observation skills.
Communication skills	Project conveys science concepts to others in a clear and confident way.	Project conveys science concepts to others in an understandable but somewhat convoluted way.	Project conveys science concepts to others in a confusing and hard to understand way.
Relationship to science	Project strongly demonstrates the idea that students think science is cool, feel positively related to it, and can do it	Project somewhat demonstrates the idea that students think science is cool, feel positively related to it, and can do it	Project does not demonstrate the idea that students think science is cool, feel positively related to it, and can do it

BioSITE & DY-SCI Staff Interview Protocol

Thank you for taking the time to talk with me about your experience with the BioSITE/DY Program this year. Would it be alright for me to record?

1. Tell me about your experience with the BioSITE/DYSCI program this year.
2. What was different about the program this year, compared to previous years?
3. What were your goals for the program this year?
 - a. Personal goals?
 - b. Program goals?
 - c. Which of these goals were met? Not met?
4. What are you personally interested in finding out about the program through the evaluation?
5. What do you think went well with the program this year?
6. What could have been better about the program?
7. How do you think the program has influenced the program participants?
 - a. BioSITE: high schoolers, , 4th graders, 4th grade and high school teachers
 - b. DY-SCI: middle schoolers, parents
 - c. Please explain/provide examples. What have you seen/noticed? What have they learned (academic and social/personal)?
8. What would you recommend as changes to improve the program next year?
9. What do you see as the future of the program?
 - a. Continue as is, any major changes, growth goals, etc.?

Depending on timing, choose between asking both 10 and 11, or just 11.

10. As we're analyzing all of the great data from this year, we're coming to understand that students take the program for a variety of reasons, and get a variety of different things out of their experience. However, we're curious what pops into your mind when you think of:
 - a. Students when the first start the program—who are they? What are they interested in?
 - b. Students after they finished the program—what are they interested in? How have they changed? What have they learned?
11. *Ok, I heard you mention the following outcomes of the program _____.* If you had to prioritize, what do you see as the most important outcome of the program?

If time:

12. What have you personally gained or learned from your experience with the program?
13. Is there anything else you'd like to share about your experience with the program this year?