Evaluation of the Science Squad Program for the Biological Sciences Initiative at the University of Colorado at Boulder:

I. Benefits, Costs, and Trade-Offs

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Executive Summary

Project Overview and Evaluation Goals

The Science Squad is a science outreach program of the Biological Sciences Initiative (BSI) at the University of Colorado at Boulder, funded by a grant from the Howard Hughes Medical Institute. The Science Squad is a group of graduate students from science and engineering departments who visit K-12 school classrooms to lead inquiry-based, hands-on science presentations for the K-12 students. Most of the presentations are aimed at secondary (middle and high school) levels, with a few available for elementary grades. The programs are available to schools in the Denver metropolitan area, with an emphasis on schools serving high minority populations and low-income neighborhoods. Teachers may schedule multiple presentations through a year, up to a maximum of four.

Science Squad members typically serve on the Squad instead of serving as a teaching assistant (TA) for a standard college course. Members of the Science Squad work together with BSI staff to create science presentations that include hands-on activities and that are related to their area of expertise. They prepare several different programs and typically offer these programs in the schools two days a week, presenting to several classes at one school each day. The program thus provides an intensive teaching experience to Squad members as well as a science enrichment experience for the K-12 students and teachers.

Our evaluation of the Science Squad program was designed to address the program's longer-term outcomes and factors that contribute to its effectiveness. Teacher demand for Science Squad programs is very high, and by all reports, the program is successful in many respects. The program is long-lived, with goals and a structure that have been generally stable since its inception in 1992. Internal evaluations by the BSI staff, including teacher feedback forms and Science Squad member reports, have provided much evidence already to document the program's effectiveness and refine its delivery. For this evaluation, therefore, the question was not so much whether the program was successful, but for whom and in what ways it was effective. The choice of qualitative interview methods for this study is particularly suitable for investigating the nature and range of program outcomes and the processes by which they arise. The evaluation questions that are addressed include:

1) What are the benefits to the key groups of program participants, including K-12 students, K-12 teachers, and the Science Squad members?
2) What are the costs to Science Squad members of participating?
3) By what processes do these benefits and costs arise?
4) In what ways does participation in the Science Squad influence the career path of former Science Squad members?
5) What are the benefits and trade-offs that arise from elements of the program design, in particular the choice to offer a one-time intervention to a large number of classrooms and the choice to target under-served schools?

We investigated these questions through the use of ethnographic interviews with two key groups of participants—teachers who used the Science Squad regularly, and former Science Squad members. These minimally structured interviews promote the discovery and in-depth analysis of

issues important to both the interviewees and the interviewers, as opposed to testing the hypotheses of researchers who have already narrowed the issues to a precise set. The interviews were transcribed, coded, and analyzed using methods detailed in the report. Interview data was not analyzed for differences by gender and ethnicity because of the small sample sizes for men and for non-white groups.

We interviewed sixteen teachers who were frequent users of the program, the group most likely to report substantial impact of the program. With teachers, we explored student response to the program and the presenters, if and how teachers incorporated the Science Squad presentation into their courses, its impact on their use of inquiry teaching methods, and barriers they encountered.

Because working as outreach educators may change the repertoire of skills and career goals of graduate student presenters, we also evaluated the longer-term impact of Science Squad participation on Squad members. Twenty-four former Science Squad members from the years 1992-93 through 2001-02 were interviewed in retrospect about their gains in skills, effects on their career paths, and their beliefs about the effectiveness of this type of outreach program.

In the present report, we describe our findings about the benefits, costs, and trade-offs from the Science Squad program, and the processes by which these arise (evaluation questions #1-3 and 5). Those findings are summarized here and detailed in the full report. The issue of career paths (#4) is a complex one that must take into account participants' incoming career goals, interests, and motivations for participating as well as their experiences during the program and their career opportunities and decisions afterwards. Following a separate analysis, findings about this evaluation question will be described in a separate report.

Many outreach programs nationwide use a model similar to that of the Science Squad, supporting classroom visits by scientists or other experts. While we interviewed participants in a particular science outreach program, we expect that many of our findings about the benefits and costs of this program to the students, teachers, and presenters will be applicable to other, similar programs.

Summary of Findings

Benefits to Students

Both the teachers and the former Science Squad members reported similar observations of the students during the presentations. They observed student behavior patterns that showed a high level of engagement in the presentations and believed that students from different levels and backgrounds enjoyed the topics and hands-on activities. Teachers described how students' interest often continued past the time of the presentation and resurfaced in independent projects and within other assignments.

Science Squad members similarly reported that the new science learning opportunities provided by the Squad engaged students in science, helped them to learn new concepts and skills and to make connections between science and the world, and adjusted their views of science and scientists. Students were also exposed to new opportunities for careers and education in science and gained confidence in their ability to do science and become a scientist.

Factors that Made the Science Squad Effective for Students

Both teachers and Science Squad members identified several elements of the Science Squad

programs that contributed to their effectiveness. These included:

- The use of materials and equipment not otherwise available in classrooms;
- Topics that were interesting, relevant, and engaging to students and helped them connect science to their lives;
- Pedagogy that included hands-on activities and a variety of learning strategies that reached diverse groups of learners;
- The novelty of a different classroom presenter, who brought a change of pace, shared deep content expertise, and was interesting to students because s/he was young and different from their teacher.

From the teachers' point of view, the presentation skills of the Science Squad member were crucial. The teachers expected the presenters to be well-prepared and energetic, and for the most part found them so. Many teachers described an intentional use of the Science Squad to provide career information and a role model for the students, as a student, scientist, or researcher. The opportunity to fill these roles and interest students in scientific careers also motivated many Squad members. Both teachers and Squad members found that discussing Squad members' personal background, education, and career path encouraged students to view presenters as role models and helped them to identify personally with the presenter. This was challenging, however, when students were too young or had too little time to form a personal connection with the presenter.

Science Squad members found the teacher to be an important mediator, making the students' experience an optimal one. Teachers could increase the impact of the presentation when they used the Science Squad repeatedly through a year, prepared students for the program and followed up on it, participated actively in the lesson, maintained classroom discipline, and linked it with their curriculum. Teachers could also make the Squad's impact more lasting by incorporating inquiry teaching strategies generally or specific experiments and learning activities into their future classroom offerings. These teacher behaviors seen as effective by Squad members were the same as those reported by the frequent-user teachers as ways they made the Science Squad programs successful, consistent with our expectation that our interview sample represented a "high-end" group of teacher users of the program.

The main problem teachers reported was scheduling the Squad presentations, due both to high demand for programs and to the logistics of making contact between a busy teacher and busy graduate student.

Benefits to Teachers

In addition to the benefits to their students, teachers reported that they continued to use the Science Squad because of the benefits related to their teaching. Teachers reported gains in their understanding of science topics and new approaches to teaching them, and Science Squad members saw the same gains in the teachers they had encountered. In addition, Squad members reported that teachers benefited from the chance to take a break from leading class to observe and reflect on their teaching, from feeling supported by the Science Squad and the BSI, and from being co-engaged with a fellow science educator in an activity important to both.

While the Science Squad does model exemplary inquiry-based teaching strategies, frequent-user teachers reported relatively little impact on their own teaching and learning approaches, since most of these teachers—a select group—were already utilizing hands-on activities and inquiry-

based science. They explained, however, how the program reinforced their belief in the importance of hands-on science, and a few did credit their teaching style to the modeling from the Science Squad. Squad members also reported reinforcement and validation of the methods of teachers who already used inquiry, but in addition reported that teachers just beginning to use inquiry methods were inspired and encouraged to pursue these strategies by the positive responses to the Science Squad that they observed in their students.

Motivations for Becoming a Science Squad Member

Science Squad members were recruited to the program by a combination of advertising and positive word of mouth from past members. The members had a high degree of prior teaching experience, particularly with experiential education. They were motivated to join the Squad by a combination of factors: their desire to teach—including enjoyment of and aptitude for teaching as well as a desire to improve their teaching skills, their interest in social justice, their need for funding during graduate school, and their dissatisfaction with the personal rewards and career possibilities that they saw being offered in their current graduate education.

Benefits of Being a Science Squad Member

Members reported a large number of benefits from their participation in the Science Squad. These benefits were profound and often carried forward to members' later professional work. Members gained skills in teaching, communication, and organization. Teaching skills were particularly important, and were developed through a combination of repetition and refinement as members presented repeatedly to slightly differing audiences, classroom observation, and collegial exchange with teachers, BSI staff, and fellow Squad members.

Members also developed new and useful understandings about education, including diversity issues, student learning, and the work of teachers and schools. They received personal benefits through gains in confidence in their ability to do and teach science, and emotional satisfaction from feeling they were doing something useful and important, and doing it well. All members also experienced career-related gains. In addition to practical gains such as résumé enhancement, professional networking, and improved job performance, they reported benefits to their career decision-making that included clarification, confirmation, or refinement of a career path.

Costs of Being a Science Squad Member

The costs reported by members were generally rather less substantial than the rewards. The primary cost was a logistical one—the impact on their research work and personal lives of the extra time required to be in the Science Squad versus a standard TAship. As a Science Squad member with a 50% appointment, Squad members really did work 20 hours a week instead of the lower actual time requirement of a nominally equivalent TA appointment. Extra stress from the logistical requirements of organizing school visits, communicating with teachers, planning and prep work, and traveling to schools was a second major logistical cost. There is some overlap in the difficulties reported by Squad members and those reported by teachers, particularly with respect to communication and the scheduling process. However, both groups valued communication in advance of the presentation, when they could achieve it, as a chance to clarify expectations and learning goals.

Some Squad members reported emotional costs, such as feeling frustrated with ill-prepared students or apathetic teachers, or feeling overwhelmed by the magnitude of the national task of improving science education. They also reported being marginalized by members of their

departments for their choice to pursue teaching over research and teaching at the K-12 level over college teaching.

Bang for the Buck

We asked Science Squad members to address a common critique of short-term interventions like that of the Science Squad and many other programs—that because the program offers a short-term intervention (one or two classroom sessions) to a large number of schools, its impact may be limited compared to an intervention of greater depth. Many saw validity in this criticism but also offered a number of counter-arguments, pointing out that the large number of classrooms served added up to a sizeable net impact. Repeat visits, particularly to under-served schools, further magnified the impact. The importance of the Science Squad presentation as a special event and the opportunities that teachers had to enhance and revisit the presentation were both factors that could make the Squad's impact more deep and lasting.

Members pointed out that, while it is difficult to measure the effects on student of a short-term program, this does not mean it does not have impact, and cited examples of profound impact on individual students. Squad members also offered advice to the BSI about ways to address this issue and more generally to improve and expand the program. On the whole, Squad members were articulate about the trade-offs of this program design, but viewed the benefits of the program as outweighing the negatives.

High Praise

Throughout the interviews, both teachers and Squad members had high praise for the program. Teachers appreciated having the Science Squad members come to their classroom, and many suggested ways to expand the program. Students became interested in science and curious about scientific careers as they learned about interesting and cutting-edge topics through participating in hands-on activities, and their teachers often learned alongside them.

Squad members reported lasting and meaningful impacts on their personal and professional lives. They spoke very highly about the quality of their interaction with the BSI staff and of the program as a whole. From our preliminary analysis of the effects of Science Squad participation on their careers, it is clear that these effects are profound. Our initial analysis suggests that it may be reasonable to view the Science Squad as *primarily* a program for supporting the professional development of science and engineering graduate students who are interested in teaching and who, perhaps because of this "deviant" interest, may be at risk for dropping out of their graduate programs, while also providing an effective and well-run science enrichment program for K-12 students and teachers. This aspect will be explored in detail in a second, forthcoming report.

In sum, it is clear that, despite the short contact time between students and presenters, the Science Squad is an effective program and provides a valuable experience with many positive and long-lasting effects for students, teachers, and presenters alike.

Table of Contents

Introduction

I. Project Overview

This report is the first report from an evaluation of the Science Squad program sponsored by the Biological Sciences Initiative at the University of Colorado at Boulder. The study was conducted by an independent evaluation team from Ethnography and Evaluation Research, also at CU Boulder.

The Science Squad is a group of graduate students from science and engineering departments at the University of Colorado at Boulder who visit K-12 school classrooms to lead inquiry-based, hands-on science activities for the K-12 students. Members of the Science Squad work together with the BSI staff to create presentations and activities that are related to their area of research or expertise. Examples from past years include a presentation on DNA mapping using electrophoresis, one on forest fires and related ecology, and another on sunscreen. Most of the presentations are aimed at secondary (middle and high school) levels, although some are available for elementary grades. The programs are provided to schools in the Denver metropolitan area, with an emphasis on schools serving high minority populations and low-income neighborhoods. When each year's roster of programs is announced, teachers telephone to schedule a presentation. Teachers may schedule multiple presentations through a year, up to a maximum of four.

Typically, Science Squad members occupy the position as year-long, half-time graduate teaching assistantship, although a variety of adaptations of this design have emerged over time, including quarter-time positions, half-year positions, and shared positions. Most members are graduate students, but a few members have been postdoctoral fellows, undergraduates, or recent baccalaureate graduates. Each member typically offers several different programs and spends two days a week in the schools, presenting to a series of classes or class sections. The program thus provides an intensive teaching experience to Squad members as well as a science enrichment experience for the K-12 students and teachers.

According to its mission statement, the Biological Sciences Initiative supports programs that "increase the number of students interested in careers in the biological or medical sciences, to strengthen their biology education, and especially to encourage minority and women students entering the sciences." By doing outreach to secondary students, the Science Squad aims to give a new face to the typical image of a scientist and get younger students interested in science as a college major or career.

A. Goals of this Evaluation

Teacher demand for Science Squad programs is very high, and by all reports, the program is successful in many respects. The program is long-lived, with goals and a structure that appear to have been quite stable since its inception in 1992. Internal evaluations by the BSI staff, including teacher feedback forms and Science Squad member reports, have provided much evidence already to both document the program's effectiveness and refine its delivery. For this evaluation, therefore, the question was not so much whether the program was successful, but for whom and in what ways it was effective. The choice of qualitative interview methods for this study is particularly suitable for investigating the nature and range of program outcomes and the processes by which they arise. The evaluation questions that are addressed include:

1) What are the benefits to the key groups of program participants, including K-12 students, K-12 teachers, and the Science Squad members?
2) What are the costs to Science Squad members of participating?
3) By what processes do these benefits and costs arise?
4) In what ways does participation in the Science Squad influence the career path of former Science Squad members?
5) What are the benefits and trade-offs that arise from elements of the program design, in particular the choice to offer a one-time intervention to a large number of classrooms and the choice to target under-served schools?

We have investigated these questions through the use of ethnographic interviews with two key groups of participants—teachers who used the Science Squad, and former Science Squad members. These minimally structured interviews promote the discovery and in-depth analysis of issues important to both the interviewees and the interviewers, as opposed to testing the hypotheses of researchers who have already narrowed the issues to a precise set.

We interviewed fifteen teachers who were identified by the BSI staff as frequent users of the program. We also spoke with twenty-four former members of the Science Squad, who had participated in the program during academic years 1992-93 through 2001-02. The interviews with Science Squad members were retrospective, to enable us to inquire about career and other longer-term outcomes. Despite the long time since some Squad members had participated—up to ten years—interviewees were able to provide surprisingly detailed accounts of their experience as well as reflect thoughtfully about the longer-term ramifications of that experience.

We asked both groups to discuss their motivations for participating and their experiences with the program, and to give their advice to the program staff and to other Squad participants. We asked teachers to discuss the benefits to their students and themselves, and the difficulties or problems they had experienced with the program. We asked Science Squad alumni about the benefits to the students and teachers that they served, and the benefits and costs to themselves. We asked them to describe their interactions with BSI staff and reactions to the Science Squad in their department, and to trace their career path following their Science Squad participation, addressing any long-term effects of their Squad participation on their careers. We also asked them to address a common critique of programs such as the Science Squad, that they offer a one-time intervention that may not lead to any longer-term effects.

In this report, we describe our findings about the benefits, costs, and trade-offs from the Science Squad program, and the processes by which these arise (evaluation questions #1-3 and 5). The issue of career paths (#4) is a rich and complex one that must take into account participants' incoming career goals, interests, and motivations for participating as well as their experiences during the program and their career opportunities and decisions afterwards. Because of the idiosyncratic nature of any individual's career path, careful analysis is required to extract the broader patterns that arise across a group of diverse individuals. Thus these issues require a different type of analysis, which is still underway. Findings on this evaluation question will be described in a separate report.

B. Study Methods

These methods of data collection and analysis are ethnographic, rooted in theoretical work and methodological traditions from sociology, anthropology and social psychology. Classically, qualitative studies such as ethnographies precede survey or experimental work, particularly where existing knowledge is limited, because such studies can uncover and explore issues that shape informants' thinking and actions, and estimate the relative significance of these issues. The ethnographer generates hypotheses for the experimentalist to test and questions for the survey investigator to ask. However, with the aid of computer programs to assist analysis of text data, ethnographers have also been able to disentangle patterns in much larger text data sets than was previously possible, and to report their findings using descriptive statistics. Although conditions for statistical significance are rarely met, the results from analysis of text data gathered by careful sampling and consistency in data coding can be very powerful.

The interviews were minimally structured so as to encourage interviewees to reveal their own perspectives instead of tailoring their input in response to categories introduced by researchers. The protocols were developed and continually refined in response to emergent issues, so that insights gained from early interviews could be explored further in subsequent interviews.

To preserve confidentiality and anonymity, the names of interviewees were known only to the interviewers, kept in a locked drawer, and replaced with coded labels on all documents and tapes. In reports of findings, no interviewee is identified, and illustrative quotations are edited to ensure anonymity. In a few cases where the content of the quotation may reveal the identity of a speaker, we have asked speakers for permission to use the quotation. The study was approved by the Human Research Committee at the University of Colorado at Boulder.

Interview tapes were transcribed *verbatim*. The transcripts were submitted to *N'Vivo,* computer software that allows for the multiple, overlapping, and nested coding of a large volume of text with a high degree of complexity. Each interview transcript ("file") was searched for information bearing on the research questions. Information is typically embedded in speakers' accounts of their experience rather than in abstract statements. Transcripts can be checked for internal consistency among opinions or explanations offered by informants, their descriptions of events, and the reflections and feelings these evoke.

Segments referencing issues of different type or perceived importance are tagged with code names. Codes are not preconceived, but empirical—each new code references a discrete idea not previously raised. Because answers to the same question may differ in character or cover different issues, codes are developed to describe the nature of the response given, not the question asked. Interviewees also offer information in spontaneous comments, narratives, and illustrations. They often make several points in the same passage, each of which is separately coded.

Each coded file contributes to the data set of both coded observations and the defined codes that label them. Groups of codes that cluster around particular themes are assigned to domains (Spradley, 1980). This interconnected and branching set of codes and domains grows into a codebook that, at any moment, represents the state of analysis.

The clustered codes and domains and their relationships define themes of the qualitative analysis. In addition, the frequency of use of particular codes or domains can be counted for the sample or for important subsets (e.g. by gender). Together, these frequencies thus describe the relative

weighting of issues in participants' collective report. In this report, we have reported these frequencies in terms of the number of individuals raising a particular topic, which includes those who discussed it briefly, at some length, or in multiple instances during the interview. Because of the nature of loosely structured interviews (as opposed to the uniformity of survey questions), these numbers do not represent a true quantitative measure of respondents' feedback. Questions are not asked in the same order or with the same wording in every interview; and some topics arise spontaneously and thus are not represented in every interview. Comments made by a single individual may be particularly insightful in explaining and relating comments made by others. Thus, the numbers should not be used to make statistical inferences, but are nonetheless useful in that they indicate the general magnitude of trends.

Reference cited

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Findings from Interviews with the Teachers

I. Teacher Response

A. Teacher Interview Sample

We interviewed teachers who were identified by the BSI staff as "frequent users" of the Science Squad program. These teachers arranged for presenters to come to their classes from two to four times a year, and many have used the Science Squad since it was first initiated twelve years ago. Based on their extensive experience using the program, we considered them to be knowledgeable sources of information who would be able to provide insight into its influence on themselves and their students. In addition, as frequent users of the program, they would provide the best possible case for observing any benefits that might be occurring, since clearly these were teachers who continued to use the program because they found some value in it. Students were not interviewed because of the difficulties of receiving consent from minors and because they may not be as articulate in expressing their ideas compared to the teachers. Moreover, it would be difficult to separate the effects of the Science Squad from other effects (such as having an effective teacher of the sort who might be likely to make good use of the Science Squad) in any attempt to measure the lasting effects of a short-term intervention.

The teachers were asked open-ended questions about their experiences over the years, such as why they choose to have the presenters to come to their classroom, the influence Science Squad has had on their teaching, and the observable benefits of the program to the students. The interviews were conducted over the telephone and typically lasted for about twenty minutes.

In our sample of sixteen teachers, all identified themselves as Caucasian, and only one was male. Eight brought the Science Squad presenters to a high school level class (grades 9-12), six taught in middle school classes, and two were from the elementary school level. The teachers mostly identified their schools as 'suburban' (11), but five were from 'urban' or 'inner-city' schools, including three schools with a high minority population. Two had a student population comprised of over 75% Hispanic students, and another was evenly divided between Hispanic and black students. Almost all of the 16 teachers were already involved in other BSI programs before they starting using the Science Squad, either attending teacher workshops, and/or applying for grant money to buy science equipment.

B. Purpose of this Report

The goal of the study is to investigate the longer-term impact of the Science Squad according to teachers who have used it extensively. In our sample, teachers gave an overwhelmingly positive evaluation of the Science Squad. There were a few minor suggestions for changes that could be made to improve the program, but overall these teachers would be more than satisfied to continue using the program as it is currently run. Therefore, we will use these interviews mainly to explore in depth *why* the Science Squad has been so successful. While the suggestions for change will be discussed in context, they are not the focus of this report. The information here can be used to understand the aspects that attract teachers to the Science Squad and keep them returning year after year. It is obvious that the program has had a positive impact on teachers and students; this report aims to find out how that is accomplished.

This report will first look at the ways in which teachers think that Science Squad affected the students it has served, including students' behaviors that demonstrated their interest and

engagement and how the presenters have or have not served as role models. Next, we will investigate the impact the program has had on the teachers themselves, looking at the reasons why they continued to use the Science Squad and the ways in which it has influenced their teaching. Some logistical issues such as scheduling and the populations served will be addressed in the final section.

C. Praise for the Science Squad

The main point that most interviewees wanted to convey was how much they appreciated the Science Squad, and that the program should continue. Their comments indicated that they were aware of the goals of the Science Squad and believed it to be an effective program. Teachers appreciated the link between secondary education and the local university.

> I think it's just been a wonderful program, and I'm just thrilled that it's being offered and that I teach in Boulder and can avail myself. I think it's good to have a partnership between the university and the school district, and I think it's real important to have women scientists come into the classroom. I think it sends a real positive message.
>
> I think that it's a great, great program, and I think it's a wonderful outreach program to high school students and other students. I think it enhances our experiences and again give kids a future of what higher education is all about.

Also mentioned was how the BSI provided the much-needed professional and moral support for teachers.

> I'm one of their most ardent supporters. Really, because I think it's a wonderful program and I've utilized it to the max. It's just that I think that more and more things are becoming difficult for teachers, and I feel sorry for what teaching is becoming, in some respects. So I feel that anything that makes it easier for the teacher. And it's not people who are trying to get out of work, to have somebody else come in and do their work for them. Because you're there, you're making sure everything runs smoothly, and all of that. But this is like something added that catches their attention, and I think it's a good thing.

Teachers kept returning year after year because of the positive experiences they had with the program in the past. They were continually impressed with the level and preparation of presenters.

> I think it's very well thought-out. I think it's run very efficiently and it's always changing, and so you're never gonna run out of topics that you can have in your classroom. And the grad students are *very* well prepared. They know exactly what's gonna happen in the classroom.

II. Student Benefits

The main reason why teachers continued to use the Science Squad in their classroom was the variety of learning experiences and opportunities it provided for their students. Fourteen teachers reported that their students were engaged in the activities and eleven gave examples of how students expressed a continued interest in the presentation topic. Additionally, the hands-on focus of the presentation was considered to be successful at reaching students from all different levels. One of the most important influences of the Science Squad on students was the presenter serving as a role model. The Science Squad member embodied a scientist and researcher, as well

as being a student in higher education. Many teachers brought the Science Squad in to expose their class to a young person in these areas who may not fit the typical image of someone in that role. A common belief expressed was that the students were more likely to view the presenter as a possible future self if they found some sort of similarity between themselves and the presenter, such as gender, race, or common interests.

A. Student Response

The teachers were asked about how their students responded to the presentation by the Science Squad. Again, the majority of the reports were positive. Teachers said the students were engaged, sometimes indicated by their enjoyment of the hands-on activities (5 teachers), asking questions (3), and an expressed interest in the topic content (3). Students were easily engrossed in the planned activities.

> It was hard to stop them from what they were doing. I think they were looking at bones, or they were looking at photos and they were trying to figure out a mystery, so it was hard to bring 'em back because they wanted to talk more about it in their groups or look at things again. So I think that's a really good sign.
>
> I'm always relieved and surprised, how respectful they really are. I think some of that's because they know they like labs and they see the lab and the set-up and so they're ready to at least try to listen and be respectful.

Some students explicitly told their teachers how they enjoyed the presentation.

> Kids out and out just said that was fun (laughs). So they say and that means they like it. And they were all on task; they weren't messing around so that's pretty much my cue that they're interested in what they have to do. And yeah, they were excited about it.
>
> One kid came up to me and goes, "Oh, will she come back? I really want to talk to her more about this; I'm so interested in evolution." So she did get them very excited. And she had lots of things for them—there were so many different skulls to look at and for them to interact with that the kids really did enjoy that.

Overall, students' behaviors were interpreted by teachers to indicate a high level of engagement and involvement in the presentation. Not a single teacher reported any type of disengagement or non-interest on the part of their students

1. Differences in Response

There were slight individual and group differences in how the students reacted to the presentation, depending on their level of affiliation and interest with the topic or presenter. However, a common theme emerged that the Science Squad was successful at reaching students from a variety of different backgrounds and levels. Eleven teachers indicated that all of their students were equally engaged in the presentation. This is important, because in any given day, presenters could be in a regular Earth science class with English language learners, immediately followed by an AP (Advanced Placement) biology class that is accustomed to advanced lessons. Science Squad members must have a presentation that is able to reach a lot of different students and should be adept at adjusting their language and content depending on the level of the students they are with. Teachers expressed surprise at how even students who were not interested in science still became engrossed in the activities.

> That if the presentation was good, and it usually is, that it engages the students. And whether their primary interest is science or not, they still are engaged.
>
> I have seen kids that are low achievers that have low motivation, don't do very much. Some of the few times that I've actually seen them engaged and excited, and doing something, is when science squad presenters were there.

In addition, teachers reported that it was not only the high-performing students or advanced classes who were captivated by the Science Squad.

> It's been a funny thing, as I have done this, I've always expected my Honors Bio classes to be a little bit more sophisticated in the questions they ask, and maybe in their ability to manipulate the experiment—and what has always been funny to me is, they're not. At a sophomore level, the kids, once they're put into that kind of environment, they pretty well function at the same level. They ask the same basic questions and they have the same confusions during the presentation. It's been very interesting.

One teacher spoke about how her students who were English language learners were able to participate in the presentation because of the hands-on activities.

> The ESL kids tend to do OK with it because, typically, there are lots of hands-on materials. They don't, obviously, cognitively get every piece, because of the language barriers. But most of them will get a sense of what it's about.

Most teachers agreed that presenters were skilled at making their presentations appealing to all different student groups, from language learners to those who had not expressed much curiosity in science.

2. Students' Continued Interest

The interest it generated in the students often persisted longer than the time of the presentation. One of the criticisms of the program is that the period of exposure for students in a class to a Science Squad presenter is so brief that it may limit any long-term effects. This section will investigate some of the longer-lasting influences on students and further in the report, we will look at influences on teachers. Continued interest was expressed by students in multiple ways. Teachers talked about how students revisited the presentation topic on their own, sometimes by doing follow-up research, discussing with peers, or by integrating the content into a related area.

> I would say going down the hallway, quite often I've heard them talk about whoever the Science Squad member was there and the topic. So yeah, I think it's easy for them to keep being engaged in it and talk about the topic well after the Science Squad member has left.

Eight different teachers shared ways that their students brought up information from the presentation.

> I had kids ask me if they could find books—at least on the forensics one, on the pheromone they wanted. A lot of them went on the [inter]net to find out more about pheromones, period.
>
> And what was funny is some kids did choose the bioluminescence, but some students went to the enzymes in the human body, and it was very interesting. A lot of kids, what they did is, they wondered, "Well, if we took stomach acid and we changed the

> temperature, what would happen?" And I thought, "Well, that was interesting." At least they used their experience that they had from the Hughes Initiative.

An elementary teacher who is with her students all day described how she is able to see them make cross-disciplinary connections.

> What's interesting with kids—and it happens only in a classroom of kids that stays with the same teacher all day, and why I'm kind of against in elementary them moving—is I notice children will incorporate something they learned from science, into some other area. They're always saying, "Oh, it's like this!" or "Oh, it was like that this morning!" or, "Remember, we did this!" So you get the opportunity to see all that happen, whereas the children who have to move around a lot, it gets real disconnected. So they'll relate it to literacy things, or… I'm just amazed at how they'll bring up, and they'll say, "Oh, that thing was just like what we saw in the bird beak thing!" So they make some really nice transitions to other areas.

These examples show how students often remember and apply information from the presentation. If they do not recall the lesson content, at the least there is a sense of enthusiasm that is generated by the Science Squad visit.

> I had one girl who—we do current events in my class every month and who purposely found a currents events article that was similar to something one of the Science Squad classes had been on. And I remember she wrote about it and part of their current events is they do a summary, but then another piece is, "Why did you choose this article? Why was it interesting to you?" And it was "Well, we had this class in science about this…" and that sort of thing. So there definitely is some retention of that. They don't get every detail, but the sense of the topic and the excitement about it.

Teachers found that students expressed a continuing interest in topics and ideas from the Science Squad presentation in a number of ways—from integrating concepts into another field, to doing research on their own.

B. Career Education

Another long-term impact is how the Science Squad can lead to a career interest in a science field. Teachers were asked if students expressed any interest in science as a career as a result of the Science Squad visit. Teachers believed that students benefited from the exposure to a real-life scientist and learning of the opportunities that their work offers.

> I think with them coming in too, that kids realize that science is a real neat field to go in and there're so many careers in science. And I think that's what kids need to know about, what can a scientist do, and what areas can they go off into as careers go. So usually that's something that comes up regularly in my classroom.

> One of the things that's nice about Science Squad, and that I also try to do in just about everything we do, is make them aware that people get paid for doing these things. You know, that people get paid to go study lemurs in Madagascar, and people get paid to figure out how people died. And that those are career options—they get paid for hiking in. 'Cause sometimes kids just don't get that.

> Because that's one thing that a lot of us in the high school think is really missing and that we're not doing a very good job with is the link—the jump from high school to college and that whole career piece. I've been telling them, because I heard it through BSI, that biology and computers together are going to be really needed for the decoding, finishing up the genomes, making sense of it. But, that's all I really know. I'm sure biochem is really important too, but nuts and bolts. And the counselors don't really know, they don't think that abreast of it.

The career education aspect is further elaborated in terms of the presenter serving as a role model, but it is evident here that students learned about opportunities in science. Many teachers articulated ways that all types of students demonstrated their engagement and interest, becoming immersed in the activities and asking many questions. The interest in the topic and ideas from the Science Squad emerged during the presentation and persisted afterwards. The teachers' discussion of the student reaction correspond directly to the goals of the BSI program—specifically, to spark an interest in science in those who were not aware of the opportunities in the field that may lead to a career or major. The teachers' views that career exposure is a benefit to students, and their explicit use of the Science Squad to introduce career ideas to students, are themes echoed by the Science Squad members, as shall be discussed later. This is also an area that they suggest be even more emphasized in the future. The modeling of science as a career or major will be further discussed below in terms of the presenters as role models.

III. Impressions of Science Squad Presenters

On the whole, the presenters received high praise from the teachers. They were thought to be well prepared with teaching experience and well-planned presentations, and excited about what they are doing. Their enthusiasm about the topic and the activities was often passed along to the students.

> All of the Science Squad members love what they're doing. It really comes across in the presentation that they're enjoying what they're doing. They like working with the kids and it's where they are at that time in their life.

The teachers often gave credit to the BSI program for the selection of Science Squad members and the high-quality training they receive that make them successful in the classroom.

> It seems obvious that somewhere along the line the people presenting are getting some coaching on how to work with kids and they are willing to interact with children. They are not a presenter that comes up and does overheads for 45 minutes and lectures about their topic. They want the kids to be doing something. The typical class is this beginning foundational information for five minutes, do an activity, and then, "Let's pull it all together" and "What did we learn?" kind of thing. And that's very kid-centric and very student-involved.

> I think that they pick their Science Squad members really, really well. And so they get people that are really enthusiastic, and really, really want to teach kids. And that's why the programs year after year are so high quality. I think they spend a lot of time with the members even before they get into the classroom, making sure everything is gonna work right, and they're gonna be able to get it done in the class program time. 'Cause I've never had a Science Squad member that didn't have things really organized, and knew

> exactly what to do, and how long everything was gonna take. I mean, it runs so well it's always impressive because you have fifty minutes to get it done. And there's a lot that usually needs to get done, and they always do it. So I think that there's a lot of good support in the background to really make things run smoothly..

Teachers considered the presenter to be one of the main factors in determining whether or not the Science Squad presentation as a whole is effective. Five teachers stated that the quality of the presentation was dependent on the individual presenter who came.

> A lot of it's related to the graduate student that comes… so if he or she is good, it's a phenomenal experience. If they're average, it's an average experience. It's never been a poor experience, though.

It is, therefore, important for the BSI to hire members who are able to fulfill the expectations of teachers. One teacher discussed a poor experience with a presenter who did not seem dedicated to teaching and who had difficulty forming bonds with the students.

> I don't know what it is, but some of them just can't seem to relate real well with that level of student. And I don't think that is a training thing, that's something they probably haven't run into. After all, they're doing other things—they're furthering their career and most of them are not planning to be high school teachers. And so some of them have that kind of gift and some don't. And they usually know because they're uncomfortable, they don't feel satisfied, they're not happy, they don't feel like they've done well, and so they probably don't do it again.

Interviews with former Science Squad members reveal that they often began their position with prior teaching experience and were motivated to join the Squad because they enjoyed teaching and working with students. This interest in teaching and reaching out to students is appreciated by teachers. The presenters' scientific expertise alone was not sufficient for creating an effective presentation; it must be combined with pedagogical skills and interest in passing along their knowledge. The teachers have come to depend on the presenters to be well-prepared and energetic. They considered the presenters to be one of the most important factors in determining the success of a presentation. Strong presenters also opened the opportunity for students to look up to them as occupying a role that they may want to fill in the future.

A. Presenters as Role Models

Many teachers signed up for the Science Squad with the idea of bringing in a role model for the students. The members represent being a college student, a scientist or researcher, and are often minority figures in the field. Teachers cannot represent the role of professional scientists to their students. Because they may not be trained in all fields of science, and because they concentrate on their role as educators, they are often behind on the current state of any particular science field. Seven teachers mentioned that their students benefit from exposure to a real-life scientist.

> My students don't have any idea what some of the opportunities are out there for them in science. And so when they have someone who's not that much older than they are, talking excitedly about some esoteric area of research, it is really neat.

An elementary school teacher made an effort to help her 4th and 5th grade students become knowledgeable about what type of careers in science are available.

> I incorporate that in purposely to say, "This is something you could do!" I introduce the person as a scientist, not as another teacher, but a scientist whose job is to go and study a particular area that they would like to know about.

The Science Squad presenters are not just researchers, but as students from the local university, they also represent higher education to the K-12 students. Explaining what they do on a daily basis as a graduate student and the specifics of what they study and how can open the younger students' eyes to future possibilities.

> I think when they see someone again from outside of school, knowing that this person is in the real world going to school, going for their degree, either a graduate degree or work—just being outside of school and actually being interested in science, enjoying science, enjoying kids, I think that means a lot to them.

One teacher stated that it is a central ambition for many of her students to get into college, and anybody who can guide them or share their experiences easily captures their attention.

> I think the contact has been extremely positive for them, because these are usually people who are in the process of educating themselves, and coming from the University of Colorado is very impressive to them. For some of them, that's a real important goal and somebody who is really energetic and really not part of the normal, the norm—seeing me everyday. I think it's an excellent experience. I think they respond very positively.

This, of course, is more relevant to the older secondary students, but teachers told us they tried to plant the idea of college in the minds even of elementary students.

Three teachers discussed their belief that someone who is young is better able to connect with students. It provides them with a more immediate possibility of what they can do in the future.

> I want them to see real people that are closer to their age really doing something in science and how they got into it. And I really think that's a neat part, and that isn't something I'm doing.

> So that the students can see that it's not just old people such as myself that are doing this, that there are young people just beginning out their career in a science-related or biology-related field.

This section relates to the idea of teachers using the Science Squad to bring "somebody different" into the classroom that will be discussed later in the report. Obviously, there are certain characteristics that they are looking for to make the visit more meanwhile for the students. They want to provide diverse images of scientists and researchers through the younger, minority Science Squad members. Many teachers described an intentional use of the Science Squad to provide a role model for the students—whether as a student, scientist, or researcher.

1. Sharing Personal Information

One way to encourage students to view presenters as role models is to have the presenters talk about their individual background, education and research interests. Typically, the presentation includes some time for the Science Squad members to introduce themselves and share personal information.

> I usually quiz the presenters on their background, kind of informally as we're setting up, and if there's something in their background that the kids could relate to.… I remember

> one fellow was doing some research on iguanas in Puerto Rico. You try and find some uniqueness of this person, and that is helpful. Then also, depending on how pressured we are to get the class in, it's nice to have them relate just what they do in a typical day as a post-grad student.

Sometimes this is purposefully generated by the teacher who asks members to share their experiences with the students.

> And then I usually ask the kids, or I ask the presenter to take it to, "Hey, what's grad school like?" "What are up-and-coming careers in biology?", "What's CU like?" That kind of thing, even just for a few minutes. Or just to take questions from the kids, "Tell us about your research project." And most of them do.

Interested students also might question the presenter, or other times it is a planned part of the presentation.

> And the kids, ya know, they'll come in, and they'll ask them (Science Squad members) all these questions. And they might ask about their research, they might ask them about going to CU, what they do there, those kinds of things. But I think they see them as positive adult role models in general that want to interact with kids.
>
> I don't know if they outwardly show that, but they always are impressed when someone comes in and they'll ask, like when they give their introductions, they'll ask about what they're studying and they'll ask questions, and so to me that shows some interest.

Teachers view the sharing of personal background as an important aspect of the Science Squad, because otherwise the opportunity to have the presenter pose as a role model is lost. This is where the students get detailed information about being a scientist, doing research and going to college. They might learn about their typical daily routines, or they might learn of exciting possibilities that they did not know existed for someone in these roles—such as traveling to do research.

2. Presenters Being Similar to Students

Students were also more likely to be able to make a connection or feel affiliated to someone who they know personally and can identify with. Some teachers reported that students may feel more of a bond or are more likely to look upon someone as a role model if they are similar to the presenter in some way. This can be a physical similarity, but it is often through the sharing of personal details as described above that allows students to realize these connections. Students who are already very interested in science might feel an immediate bond to the members of the Science Squad and vice-versa.

> The kids who really are involved in science, they really like talking to the people, the grad students that are in there. They get a special spark about 'em and their eyes light up a little bit more than what I see day to day. I think they really identify with those students. They can see that in four or five or six years they could be doing the very same thing, and I really see a light in their eyes. I suppose they are seeing them as a role model. I just think they have a special connection with those people—they speak the same language.

Another way to be similar is as a woman. A large percentage of the Science Squad participants are female, which was noted by several teachers. This was seen as not only a benefit for the girls

in the class who were provided with a role model in an area that perhaps was not accessible for them before, but also as valuable for the boys to see a woman achieving in the field. Five teachers expressed the idea that women scientists served as role models.

> I really think that's important to have women scientists come into the classroom, because it's good for the girls, and it's also good for the boys to see it.
>
> I think that when we have female presenters, the girls get a little more engaged, because of that female role-modeling and having a female scientist.
>
> I think that the girls in particular really enjoy science squad, because most of the presenters are women. And I think that a lot of the ones that are maybe thinking about science for later on just think it's really neat to see somebody, a female, doin' something that they might want to do later on. But I also think a lot of the boys think it's really interesting, that all these girl scientists come in. It might kind of change their image of who a scientist is a little bit.

Students are also more likely to view the presenter as being like them if it is apparent that they share the same racial or ethnic background. This may be especially important for minority groups who are not as exposed to higher education or do not have experience with scientific research. As this teacher explained, being introduced to Science Squad presenters who occupy these roles, and with whom students can affiliate, opens up new possibilities.

> There were a couple minority presenters they've had over the years, which was pretty exciting to see, 'cause a lot of the ESL students I work with, and minority students I work with, don't envision themselves in the scientific community. It's not a role that they see as in the realm of reality for them. And so, I know that's one thing that Hughes is trying to foster. And so anytime we can latch on to somebody who's interested in doing Science Squad who has that background, is wonderful.

Several Science Squad members articulated their desire to provide an alternative representation of a scientist and to break down the stereotype of scientists as white and male, but in fact few of the presenters themselves came from ethnic minority groups. A teacher from an inner-city school emphasized the importance of having more diversity in the Science Squad.

> There's not many presenters, though, that are minority, and I really think that they need to recruit some. Because when you ask about role models, it's pretty hard for them to see the Science Squad members as role models because they really aren't for our students. So, I would say increase the number of minorities involved in the program.

Increasing the representation of minorities in the sciences is a stated goal of the BSI. However, this teacher's suggestion may be difficult to attain given the population from which Science Squad is hired. This section highlights one of the important factors behind the presenter appealing to the students as a role model. Many teachers articulated the idea that students are more interested in somebody who is similar to them in some way. It is easier, then, for the student to imagine their future-self occupying the same position. Otherwise, the Science Squad presenter can be perceived as just a visitor who occupies a high-status position that is completely out of their realm.

B. Not a Role Model

In some instances, teachers found that the students did not consider the presenter to be a role model. Four interviewees articulated their belief that their students did not view the Science Squad members as role models. Their reasons were evenly broken down across two explanations—there was not enough time or because the students were too young. Presenters and students did not get to know each other very well when the Science Squad was only in an hour-long class for one day. Consequently, there were not sufficient opportunities for many to form that personal connection that is so vital in creating a role model.

> I don't know, since it's such a short period of time. I mean, if she were to come back again, maybe.
>
> Well, I don't know. It's kind of difficult when they come in once or twice and then they never see them again. It's difficult to say that it went that far, but at least they saw people *doing* something. You know, that was beyond high school work. So I would hope so.

A suggestion was made to have the presentation encompass more than one day so the same person could return to the same classroom and builder stronger bonds with students.

Understandably, the younger students from the elementary and middle school classes were less likely to look at the Science Squad presenter as a role model. They were years from applying to college and not many have began considering their future career. Even though this teacher did not see any explicit behavioral signs indicating that her middle school students looked up to the presenter, she believed that the image of a woman in science and the idea of extended higher education still made an impression.

> *Interviewer:* Did you see any signs that students saw the presenter as a role model?
>
> *Teacher*: Um, no. I don't mean that in a bad way. I think that she—especially because I happened to have all females this year—I think she really *serves* as a role model, I just don't see the kids interacting with her that way. They just don't—middle school students just struggle with that. It's not like I saw them asking a lot of questions about college or graduate school. Eighth grade is still pretty far away for these kids. Graduate school is, like, unbelievable. Some of the kids I can always remember always going, "You already have a college degree, and you're in college again!" But I think some of that is very vicarious. I think that, same with having a female science teacher, I think it's just there, it's just out there and they don't know that it's that. I mean, I think it is working as a role model, I just don't think it's an "in your face" one.

Several teachers raised the issues of a lack of a time to form a connection with the presenter and the students being too young to view the presenter as a role model. However, teachers still believed that the members left an impression.

C. Adjusting to the Student Population

In this section, we discuss ways that the Science Squad member can modify their presentations to appeal to specific student groups. Three teachers critiqued the rare presenter who treated the students as if they were younger than they really were. Students get turned off quickly when they believe that the presenter is 'hokey' and trying too hard to push their agenda.

> Sometimes if a presenter comes in and sort of down-talks to them or just treats them like they're very young, it makes the presentation very sour to them. But I'd say that was the really rare case that that's happened. Like maybe once in the whole time that I've ever had it.

On the other hand, there is also the converse challenge of avoiding speech that is at too high a level for the students to understand. A middle school teacher described how he informs the presenters about the students' level.

> Although I've seen it get better over the years, their vocabulary is very high level. And it took awhile, at least the ones that I was dealing with, although I didn't necessarily deal with the same people all the time. But I would kind of brief 'em at the beginning that the vocabulary level had to be real low level. And not that they shouldn't use scientific terms, but maybe don't get too much into that 'cause these kids aren't gonna remember it anyway. They'd rather have vocabulary that meant something to them, and later in their life they'll probably realize that it has a real name.

Two teachers mentioned the importance of tailoring the presentation to the specific classroom population. That way, the presenters can make it more suited to students' age and level, and more culturally relevant.

> I know particularly in this one she needed some help just in coming down to our kids' level a little bit better. And so it's just *really* knowing middle school content—that there's nothing wrong with using large words, but it's just being sure to give some definition, especially for kids that English is their second language.

A teacher mentioned that when the Science Squad member is aware that there is a large Hispanic population, s/he could come prepared to define necessary vocabulary words or maybe use some words in Spanish.

> *Interviewer:* Right, so making it culturally relevant then would really help in some instances.
>
> *Teacher*: If you show them a little bit of individual attention, that keeps 'em hooked a lot. You realize that there's a lot of ESL students in the class, then maybe certain things—[that you] will write the word on the board rather than just saying it, and that you will print rather than doing cursive.

The poor experiences where presenters failed to account for differences in students were the exception rather than the rule. Most teachers were impressed with the ability of the Science Squad members, including two who spoke about the presenter's ability to meet the level of the students in the class.

> The presentations have always been very well adjusted to the age level. They don't use a lot of the real fancy words; they keep it pretty simple for the kids.
>
> It hit the child who's at the top end, that doesn't necessarily get stimulated, down to the one at the bottom end that's like, "Oh, something else over my head." I'd say it was creative to the point where it involved lots of different abilities, and interests.

This points to the importance of developing Science Squad members' teaching skills, so that they can realize when students do not understand the content or know when they can make the activity more advanced. In summary, the presenters play a large role in determining the

perceived success of the Science Squad visit. The teachers believed that it is important to provide a role model for the students—someone who is a college student, scientist and researcher. Although the students only have contact with the presenters for one day, the limited time can be offset if the presentation is directly tailored for the specific student population and the presenters take a moment to share background information about themselves so students can more easily form personal bonds.

IV. Why Teachers Use the Science Squad

Aside from the student benefits and general praise, four main reasons emerged from the interviews to indicate why the teachers were eager to sign up for the Science Squad to come to their classroom. The sections above focused on the benefits of the program for students, and as we have seen, benefits for their students are a main motivator for teachers to continue to use the program. Teachers were intentional in using the Science Squad to provide role models, expose students to careers, and enhance their interest in science. In the following section, we will discuss the reasons behind these benefits—the ways that the Science Squad programs helped teachers do their work and met teachers' needs and goals for their students. These reasons thus help to explain *why*, in teachers' views, the Science Squad programs were effective and why they continued to use them. Personal and professional influences on the teachers themselves are discussed in a later section.

Teachers explained the factors that contributed to their decision to continue to use the Science Squad year after year. These categories, in decreasing order of frequency of mention, are:

- Equipment (11 teachers),
- Presentation topic (10),
- Having somebody different teaching in their classroom (8),
- Presentation style (8).

Often, the explanation of any one teacher included multiple reasons that fell under different categories. The numbers reported are the number of different teachers who mentioned the category as a factor in why they use the Science Squad.

A. Equipment

A main attraction to the program was the type of equipment or materials used in the presentations. This was equipment that teachers otherwise would not have had access to, because it was too expensive, too difficult to maintain and set up, or teachers did not know how to use it.

> They tend to be classes that I don't have materials to instruct kids with myself. And they also tend to be classes that, like the forensic botany, require a lot of prep time—and I don't have time to do that. I know the Science Squad has undergrads who are TAs, who are prepping their samples and stuff like that. It allows the kids to have something special that I wouldn't be able to do otherwise.
>
> Another reason I like it so much, particularly when they were still doing the sequencing of the kids' DNA and doing the ALU insertion type of thing, that it's not equipment that we have, and we can't do the PCR and the DNA fingerprinting here.

Some examples of materials from recent presentations that would not otherwise be available to teachers include samples of different skulls, access to electrophoresis to analyze DNA, and objects to set up a crime scene.

B. Presentation Topic

Ten teachers mentioned that the content of the presentations motivates them to use the Science Squad. In a later section we will look at how the topic they choose fits in with their curriculum, which is often a primary consideration. Teachers frequently chose topics that they did not know well or did not feel comfortable teaching. They often considered the presenter to be somewhat of an expert.

> *They're* doing the research all the time, so they're specialists. And when you're teaching in the classroom, you've got to have a little bit knowledge about everything.
>
> …because it provides opportunities for experts in different fields. In biology, you cannot be knowledgeable about everything, so that there are people who know a lot about diabetes, or know a lot about phosphorescence, or something of that nature, and they come as experts to your class. They would know more on that particular subject than I would, so it's a good thing to have them come.

As the teachers mentioned, science teachers are often responsible for knowing a wide breadth of the field, sometimes to teach multiple courses. In contrast, the Science Squad members were able to have deeper knowledge into specific areas. When it was a topic that they did not know well, teachers got the opportunity to learn alongside their students. Some teachers signed up for the Science Squad so they could become familiar with new topics and get ideas on how to teach them. Science Squad members were not just teaching the students, they were teaching the teachers as well.

> Experts coming in and talking about topics that I really wouldn't be able to do for my class. So I think that's the best benefit. We all learn and the kids get a lot out of it, because I don't know those topics.
>
> It gives me new information and it makes me realize you know how much they respond to having things out and about. But what I really appreciate is the new knowledge that I get, too.

Teachers were often excited about how current and "cutting-edge" the topics were. It was difficult to find information for teaching new science discoveries that are not yet in their textbooks.

> They definitely always have been high-quality, cutting-edge stuff. At least cutting-edge relative to what's in our textbooks. And it's stuff that is exciting to expose my students to.
>
> I think the topics are usually pretty current, or if they're not, they're things that are tried and true that the kids are interested in—a lot of things that affect their bodies, like the EKG and the bicycle, or the UV light one. So there's a lot of things that they're sort of interested in, and then they get to take part in the whole process.

The topics were ones that teachers believed would meet the interests of their students. One teacher chose the forensics presentation because she knew that her students were fascinated with a show on television that used related methodology, *Crime Scene Investigation*.

C. Somebody Different

Another benefit was simply bringing a different person into the classroom to lead for the day. This had various benefits, according to the teachers—it exposed students to somebody other than themselves who may have a different teaching style, offered a change of pace, or provided a role model and showed students what scientists really look like.

> I think it's really good for my kids to really be exposed to a lot of different people and not just hear one point of view, not just hear one teacher. I think they love having someone different talk to them.
>
> Because, again, I think that it enhances my curriculum having someone different from me teach and also having the students see someone who is educated, who's interested in science, who's interested in kids, who's out in the real world. It's not just, "Oh, teachers," you know, who care. There are people out there in the real world actually doing research and practicing science they're in. They come from an institution an educational institution that I believe my students admire and most of them look forward to attending—from the University of Colorado.
>
> It brings somebody in, so it's fresh for them and they have a role model—somebody else that's interested in science that's presenting something to them, and they also have some cool ideas.

Teachers felt that students often paid more attention and became more interested in the topic when they had a 'guest' and especially when it was somebody young. Having somebody different also relates back to the section on presenters serving as role models, which showed that the characteristics of the visiting instructor were also very important.

D. Presentation Style

Finally, many teachers valued the teaching approach used in the Science Squad presentations. Half of the teachers pointed to the hands-on or inquiry-based activities that got their students involved in actually doing science.

> The biggest impact is being able to provide the students with exposure to a variety of labs that we otherwise couldn't do. Because again, the labs are what makes science live, and if you can't tweak their interest in a variety—I mean, not everybody's gonna be interested in the same thing. The greater the variety of lab topics is, the greater the possibility of reaching kids for science.

As will be addressed further elsewhere in the report, an interesting correlation is that most of these teachers reported that they already used similar types of teaching methods in their science classes. Hands-on and inquiry-based science was not something novel or different that they needed the Science Squad to bring in, like the expensive equipment, but something that they believed was important in teaching. However, the positive effects that they saw on the students, such as an increased level of engagement or understanding, reinforced their belief in the value of hands-on learning.

In conclusion, the four most frequently mentioned reasons on why teachers chose to continue to use the Science Squad were the equipment, the topic, having somebody different teach, and the presentation style utilized. The Science Squad brought in equipment and materials that were difficult for the teacher to acquire or use. The topics appealed to the students—they were

relevant, matched their interests, and enabled them to participate in hands-on activities. Presenters offered a change of pace for teachers and students. They were able to get into more depth of content and were appreciated by students for being young and different from the norm.

V. Curriculum Issues

A. Presentations Fitting into the Curriculum

In signing up for the Science Squad, teachers also had to consider how the presentation would fit into their curriculum. With so many standards to cover in a school year, teachers often felt a lot of pressure to get through the material and did not feel they had much time for topics outside the curriculum or for exploring topics in a lot of depth. Thus, one factor that led teachers to choose the Science Squad, or at least to choose among the different presentations that are offered, was how well it fit into their curriculum.

> I look at, sort of, my overall calendar and see what presentations I think would fit in really well, would really be a good add-on to my curricula. And then kinda look at about when I'm gonna do those particular topics, and then I give them a call…
>
> *Interviewer*: Why did you choose the one on insects?
>
> *Teacher*: Because I don't do enough on arthropods. It's just one of those things that with once you start doing molecular biology you lose a lot of the things that you used to cover routinely. So that's sort of an enhancement, though we'd talked about arthropods, it was just one more—well, that tied in to so many different areas.

Not all teachers limited the presentations they chose to those that fit in with their curriculum. Some of them felt that the presentations are valuable enough to stand alone or actually seek something different because it is cutting-edge, relevant or matches students' interests.

> I read the description of it, and since there're so few for elementary school, it narrows the number that I could look at to begin with. I try and look at our curriculum and see what might tie in at all with science. But I use them anyway, whether it has anything to do with fifth grade or not.

One teacher describes how she originally scheduled a presentation that fit into her curriculum, but the presenter replaced it with a different topic. However, the program still included an emphasis on inquiry learning, which she considered as a way for the new topic to 'fit' into her class.

> Actually, she was originally supposed to do something on, I want to say the circulatory system, where the kids built model hearts, because that fit in perfectly with my curriculum. And then as it turned out, when she called… that program, for whatever reason, wasn't going well that year. The logistics of it weren't working. And so she had actually just suggested this one. It was scientific method, but other than being scientific method, and having the kids formulate hypotheses, and coming up with their own mini-experiments, it didn't fit into the curriculum. But the scientific method part did. And it was inquiry-based, which I always like to do as well.

Not fitting in the curriculum, however, may be a reason some do not use the Science Squad. Because we spoke with frequent users of the program, we were speaking with teachers who found value in and re-used the program independent of its fit to their curriculum, and we were unlikely to sample teachers who had elected not to use the Science Squad because it did not fit

their curriculum. In our interview sample, fitting into the curriculum added an additional appeal to teachers who wanted the presentation to have more context, but often they believed that having a guest in the classroom and doing hands-on activities was still worthwhile. There were also other teachers who had difficulty scheduling the presentations during the time when they were studying the same topic. As a result, students might see a presentation on a topic that they studied a couple of months before. This problem will be further discussed in the section on scheduling.

B. Preparation and Follow-Up

Even if the presentation was not conveniently embedded in the current unit, giving students relevant background knowledge could help them understand it better. Follow-up activities could provide the opportunity to expand and reflect on what they learned. This is one way of producing longer-lasting effects from the Science Squad so that it is not just a one-shot event that students might not remember.

Once the specific presentation and date had been decided, teachers typically did something to prepare their students for the presentation. Five teachers indicated that they had just done a similar unit so there was not a need to include more background.

> I think it depends a little bit on what it is, but for most of the presentations that I've had, they don't need to do a pre-lab, or anything like that. Usually their background knowledge that they have from whatever we're covering at the time is enough. And so most of the time I just explain that they're coming, kind of give them a general idea of what the program's gonna be about. And then, beyond that, I don't usually do much, because it usually ties in so well with whatever we're doing, or we've done.

Another five teachers stated that they took the time in the day before to give background information to students on what they would be learning. Almost all teachers used a follow-up activity such as class discussion, a related project or lab, a test or notebook write-up.

> Quite often we do a little journal writing or something, and they do a response to the activity and it's usually in our assignment notebooks for that day. [Students] would write down, you know, talk to your parents about the science activity…

Because the teachers were not always aware of the exact content of the presentations, some found it difficult to prepare their students. A suggestion was made that Science Squad members recommend some activities or content that teachers could address in the days prior to or following the presentation to further cement the material for the students.

> *Interviewer*: You're suggesting that before they come they send a little sheet about the concepts they're going to be covering, and some of the vocabulary.
>
> *Teacher*: If some of that had been taken care of, or even given as homework or what have you, so that as a teacher you say, "Okay, this week this is what's going on and then we'll have this guest speaker on this topic," and so on. But if it was a little more nailed down, like, "You need to know what these words mean, that will help you understand it." It could even be, "What do you already know about?" so that the teacher could have investigated prior to the workshop what the level of understanding was prior to the workshop.

Along the same lines, a teacher thought it would be helpful to have a handout of the general ideas of the presentation so that students would have something to trigger their memory.

Preparation activities helped to add context to the Science Squad visit by prepping students with the appropriate foreground knowledge so they are cognitively ready to comprehend the presentation content. Follow-up activities allowed students a chance to synthesize what they had learned and also served to extend the effects of the presentation. Most teachers did try to use such activities, but many also indicated that input from the Science Squad about what is important for students to know beforehand, and suggestions for what to do afterwards, would be greatly appreciated.

VI. Influence of the Science Squad on Teachers

This section discusses the types of influence the Science Squad has on the teachers who frequently use it. Of particular interest is the question of whether the teaching approach of the Science Squad has any influence on the teaching methods of the teachers who use it, by encouraging them to adopt similar methods. The frequent-user teachers seem to be a select group. Seven of the teachers interviewed originally found out about the program by attending another BSI function. These are teachers who already seek and take advantage of professional development opportunities in science. Therefore, the amount of influence the Science Squad can have on the teaching style of these teachers may be limited, because they already are convinced of the value of hands-on and inquiry-based learning activities. This is not necessarily the case, however, for all teachers; in the discussion by Science Squad alumni of teacher benefits, the Science Squad members do observe some effects on teaching style.

A. Most Common Teaching Style

In the interviews, teachers were asked to describe their typical teaching style. Nine of the fifteen said they incorporated labs or hands-on activities on a regular basis, and another four said they utilized discovery or inquiry-based learning.

> My teaching style is definitely hands-on. And everything is lab-related, so that I might do labs several times a week, but I would also have follow-ups to that lab so that we're constantly with a hands-on focus to everything. It fits right in with my style of teaching, but it's not that I've learned it from the Science Squad, no.

> I think it's more hands-on the more experienced I am as a teacher. 'Cause lecture doesn't cut it with kids, and they really need to be engaged more. Usually I do some kind of introductory stuff and tell 'em what we're gonna do, and write key words on board and just procedures. I go over what we're gonna be doing and then they usually work in cooperative teams. That way they can rely on each other and no one feels like they're incapable of completing the task, so cooperative groups work the best. Hands-on is the way to go, I would say.

Although these teachers were reluctant to credit the Science Squad with their use of hands-on activities, many did mention that it served to reinforce their belief in the value of interactive science.

> It has continued my belief that when the kids are doing activities they're learning and retaining more than when I'm up on the stage. And so, I guess it's reinforced my belief

> regarding that. I—since about the third year of teaching—kind of realized that's not the most effective plan of attack for kids.

One teacher used the presentation as an opportunity to reflect on her teaching.

> I guess just it reinforces for me why hands-on labs are good. I do a lot anyway, but it just continues to reinforce it, especially when I sort of observe. When I observe more intently how kids are listening or not listening to the content part, it makes it easier to realize why it's so important to do the lab part. It's kind of interesting too, to me, 'cause sometimes I'll sit and really listen to how they give instruction and think about how I do it to myself. So it kind of provides some reflective time for me.

As will be noted in the discussion by Science Squad members of the benefits to teachers, the opportunity to observe one's students and reflect on the instruction was a benefit often observed by Squad members.

B. Science Squad Influence on Teaching Style

Since many of the frequent-user teachers in our sample were already utilizing hands-on activities and inquiry-based science, the amount of influence that the Science Squad presentations could have on their teaching approach was limited. A smaller group of teachers did credit their teaching style in part to the modeling from the Science Squad. Several teachers also mentioned other ways they were affected by having the presentations in their class year after year.

Some teachers were more directly affected by seeing the Science Squad presentations. A few teachers have reproduced essentially the same presentations or activities in their classes in the years following the presentation. Sometimes the presenter shared ways to organize and set up the activities so that teachers could do it on their own.

> So, for example, the first program I had last year was a forensic botany presentation where the kids had to look at, sort of, fake stomach contents. …And they had to look at the things under the microscope and figure out if the crimes might have been related based on what was in their stomachs. And so they had to look at all these different foods underneath the microscope, and it was a great use of the microscope, and the kids thought it was really cool that they were looking at these puréed stomach contents. And I'm gonna use it this year as an introduction to cells. So, viewing cells and using the microscope. And I'm basically gonna use it as they did it. So I definitely get lots of ideas from them.

As will be discussed, past Squad members recognized that their visit was also a learning opportunity for the teachers, and sometimes made special effort to share more topic information and pedagogical tools. An elementary teacher mentioned how the Science Squad made her realize the importance of including science in the curriculum. Since she had that insight, she has made special efforts to have her students do science.

> I have written several science grants, and I think some of that has been spurred on because I realize that science is a really good hook for kids. It's very important for them to know more besides reading and writing, which is so easy, I think, for teachers to teach.

One teacher saw how a Science Squad member came in with a box containing all the materials for one lab and reorganized her supplies in a similar manner. Another teacher learned through observation how to lead her students in inquiry.

> When I first started, I didn't know how to take ordinary questions and turn 'em into an inquiry-type activity, and I have learned how to do that through watching the Science Squad members. They take very simple questions—I thought the kids would know that if you cooled the temperature the light would get dim—and they took a very simple question that I assumed the student would know the answer to, and instead turned it into an inquiry activity, finding out that kids had guesses all over the place as to what would happen to the brightness of the light with the temperature decreasing. So, it's been very interesting. And like I said, they've kind of trained me how to do it. And now their presentations fit in with my class, but that was not true when I first started.

This quotation shows the type of modeling by presenters, not only for the students about what it means to do inquiry science, but for the teachers as well. It also points to one of the longer-lasting effects that a day-long presentation can have in the classroom. Teachers explained above how the Science Squad has reinforced their belief in the importance of hands-on science, and many of the actual presentations have been adopted by the teachers and used in different classes. These benefits to teachers, and opportunities for lasting impact, are strongly echoed by the Science Squad members, as will be discussed in a later section.

VII. Teacher Role during the Presentation

In order for teachers to reap the benefits of the Science Squad visits and help the students get the most out of them, it helps for them to be actively involved and observant. The day of the presentation is not a day off for teachers. From the interviews with the former Science Squad members, it is clear that they experienced a wide range of teacher preparation and involvement, and that teachers such as these "frequent users" were on the high end of that scale. When asked about their role while the Science Squad is in the classroom, ten teachers said that they monitored the students' behavior and handled any discipline issues that might arise.

> It's not an issue with our students here very often, but I would also be in there to monitor behavior and just general classroom climate.

> I definitely take care of any behavior problems, although there are usually very few, because they're just so engaged by what's going on.

Teachers also offered assistance to the Science Squad in the set-up and performance of the activities. They did everything from passing out papers, putting the students into groups, and gathering materials, to answering student questions.

> Basically, the classroom teacher is responsible for discipline and for making sure that the lab flows well, and for getting anything that's needed from our end, and participating, helping—go around the room and make sure that the children are getting it.

Teachers felt responsible to be there to not only support students who needed help in the activities, but to support the Science Squad members in any ways necessary. They offer advice on how to tailor the presentation for their specific student population and answer any questions presenters might have. If the presenter appears to be faltering, a few teachers state that they interjected to maintain the flow of the lesson. One teacher described how she participated in the activities of the presentation along with her students, taking full advantage of the learning opportunity.

Teachers actively assisted the Science Squad member during the presentation by monitoring student behavior, helping to organize activities, and offering advice. Again, as we shall see, the Science Squad members agreed with the teachers that this type of teacher support helped to optimize the benefits of the presentation for both students and teachers. While Science Squad members reported a range of teacher behavior, the group of teachers interviewed here are clearly among the most active and effective in supporting the presentations

VIII. Logistics and Scheduling

In this section, we explore how teachers arranged for the Science Squad to come to their classroom. Although for most of these teachers it had been some years since they initially discovered the Science Squad, they still had to find out what the presentations are each year. Originally, about half of the teachers interviewed heard about the program during a professional development workshop offered by the BSI. Another six read a flier at school describing the Science Squad. Only one teacher heard about the program through a fellow teacher. However, some of these teachers have been using it since its inception, so there would have been nobody to recommend it. Now, these teachers take the responsibility to pass along the word about the program.

Teachers received a flier in the mail each year and knew that they have to call immediately to schedule a presentation, before the schedule gets full. Eight teachers mentioned the importance of scheduling early.

> I can tell you that if you do not call early, if you don't just jump on it, you're gonna miss the opportunity.
>
> And when that mailer comes, then hopefully I can get everything done immediately, because if you don't, you *don't* get in. Now. I mean, it didn't used to be that way. But the last several years have definitely been that way.
>
> We're sent a flier in the mail, usually around August, and then as soon as I can, when those phone lines open up, we call, because I know they fill up quickly.

Teachers who are not experienced Science Squad users may not be aware of the high demand for presentations and may miss out because they did not hurry to the phone. This may result in the same teachers using the Science Squad again and again because they know the system, while others are excluded. With demand for the program already high, clearly further advertising is not needed. However, because we talked to frequent users, rather than those who may have wished to schedule the Squad and not succeeded, we cannot address teachers' perceptions of the fairness of the scheduling system, an issue that may warrant some examination.

A. Problems with Scheduling

Although four teachers stated that they found the scheduling process to be easy and convenient, ten teachers mentioned problems or issues they had experienced in trying to schedule a presentation. Common complaints included that presentations get booked too early, that teachers had difficulty scheduling so far in advance, and that they had trouble reaching anybody on the phone.

Even teachers who knew to call immediately upon receiving the flier sometimes had difficulty reserving a presentation.

> You get your notification late summer, early fall, and for the past few years, I would get mine in right away, and I know one of my colleagues would do the same. Then we'd get a call back, maybe late September-early October, only to find out a lot of the times were taken and we were at the end of the list.

This may have occurred because the teacher was not in one of the types of schools in which the Science Squad wanted most to have a presence. However, when teachers had been using the program for years and are not informed, this caused frustration.

The fact that they have to arrange a date so early in the school year poses problems when the teacher have not planned what unit they will be studying when, or when they don't know the school schedule.

> Making the arrangements in the beginning of the year is hard for me, and I don't know if there's any way anyone can improve that. I think, for any teacher, making plans three months, six months in advance… Unfortunately, I think it was one time, it turned out that that was when we were giving ACT tests and there was a change in schedule or there's an assembly schedule or something that I'm totally unaware of. I don't think there's anything the Science Squad can do to change that, and it's hard.
>
> I always try to get them scheduled close to when we're covering that material. And the problem was I couldn't get it close enough to when I presented the materials, so it had probably been over a month since we had talked about that, and of course that material is difficult and that's not gonna stick with them. If we had just talked about it, it would have been better, but that's scheduling and you really can't do much better. They can't come except on certain days, and our calendar doesn't allow them to come on certain days and you know, that's, kind of the way it's gonna be. I don't think there's a fix for that.

Teachers would have preferred to schedule presentations in the same period of time that they are studying the related unit, but it was difficult when they had to schedule so early in the school year.

Teachers called a number and left a message saying that they would like to schedule a particular presentation. Typically, Science Squad members called back to discuss when they should come. One teacher expressed her frustration that she had not heard back after leaving a message.

> I still haven't heard back from [a presenter] and that's new. My biggest problem is, I call and the only thing I do is leave a recording, which is what you're supposed to do. And then, I never know—Did you get it? Did you not get it? Are you working on it? It would be really nice to just have an immediate call back—"I got it, I'm working on scheduling." And leave a message, because who needs to talk about it when that's basically all you need to say? Right now, I don't even know if they got my FAX from my classes.

B. Scheduling Suggestions

Quite a few teachers made suggestions for how to improve the scheduling process. For example, if presenters made their e-mail address available, then phone tag would not be an issue. A couple of teachers proposed an on-line web site for scheduling, where they could easily view which presentations were available for what days, and maybe sign up through the web site.

Most teachers understood that the Science Squad is low in supply and high in demand. They felt fortunate to be able to arrange a presentation at all, and accepted that it is impossible to meet all teachers' needs. The most common piece of advice that they wanted to pass on to the BSI was the suggestion to expand the program. Expansion could allow for more presentations at more schools, reaching a larger number of students. Expansion could also allow for multiple presentations with the same students, creating the opportunity to reinforce ideas and to form stronger bonds with presenters.

> Well, in the beginning years, we could have them more than two times. And that's real important, I think. And I realize they're probably serving more school districts now, but it's kind of nice if you could have something like that at least once a month so that there's some continuity in the program—that they don't just think these people are fly-by-nighters, but they are part of the educational package. And I think it's wonderful to expose lots of kids to this, but on the other hand, it's really good to give some in-depth stuff instead of a one-shot-in-the-pants type thing.
>
> I really think the strength of the program is work in fewer schools, but be more present in those schools.

Suggestions also were made to do more outreach to specific populations. Each teacher spoke from a personal point of view and made the case for increased benefits from having the Science Squad involved with their student population. The two elementary school teachers who were interviewed both urged the program to design more presentations for their younger students.

> I guess my complaint would always be—I guess the scientists aren't really interested in lower elementary kids (laughs). I guess their real limit is about fourth and fifth grade, and now there's a few more thrown in for third grade. And I think I found one this time who's, that said "K"—went down as low as kindergarten. My whole point has always been, if you want science to really be built in children, you gotta start at the bottom, and get that enthusiasm and that hands-on, and seeing people that come from outside the school who are doing things. And I think the only answer I got was that most of the people on the Science Squad were a little intimidated by, once again, a vocabulary issue. Not being able to come in and talk the subject like you're supposed to talk it. I think there was somebody that did communicating with chemicals—they did for the older kids, four or five, 'cause hardly anything happens to supplement their chemistry part. And here's a K-12 one, learning to live in space. But I do notice that there were quite a few this time that had gone down to third grade. So maybe I'm making a dent.

They expressed their observation that science is often left out of the elementary curriculum—many teachers at that level do not have experience creating labs or are not confident in their science knowledge. The younger students, they argued, stand to benefit much more from an introduction to real science and inquiry thinking.

A different teacher at a high-minority school believed that the Science Squad was much more vital for the students there, who have limited materials and limited contact with scientists and higher education.

> I just think the program is invaluable to inner-city and our schools, and I really hope that they will remain focused on them. I mean we're really—by comparison to some of the other schools—we really don't have the facilities that other schools have. Plus, we have

> students that are much more in need of having things of special focus, and things that catch their attention, and I think it's a good thing.

These teachers spoke from their unique perspective based on where they teach and the need that they see at their school for the Science Squad. That many and different types of schools vie for the services of the Science Squad shows the ability of the program to reach a diversity of populations.

IX. Summary of Findings from Teacher Interviews

Despite scheduling problems, the teachers we interviewed appreciated the Science Squad and the benefits it gave both them and their students. Teachers observed student behavior patterns that showed a high level of engagement in the presentation. Students from all different levels and backgrounds enjoyed the topics and hands-on activities. Their interest often continued past the time of the presentation and resurfaced in independent projects and within other assignments.

The teachers have come to depend on the presenters to be well prepared and energetic and consider them to be one of the most important factors in determining how successful a presentation is. Many teachers described an intention in using the Science Squad to provide a role model for the students—whether as a student, scientist, or researcher. One way to encourage students to view presenters as role models was to have them talk about their individual background, education and research interests. Students were more likely to be able to make a connection or feel affiliated to someone who they know personally and can identify with. Several teachers noted that lack of a time to form a connection with the presenter and the young age of students as barriers that prevented students from seeing the presenter as a role model.

The teachers continued to use the Science Squad also because of the benefits related to their teaching. They were motivated by the equipment, the topic, having somebody different teach, and the presentation style. The Science Squad members brought in equipment and materials that were difficult for the teacher to acquire or use. The topics appealed to the students—they were relevant, matched their interests, and engaged them in hands-on activities. Presenters offered a change of pace for teachers and students—they were able to get into more depth of content and were appreciated by students for being young and outside of the everyday norm.

Since these frequent-user teachers were already utilizing hands-on activities and inquiry-based science, the amount of influence that the Science Squad presentations could have on their teaching approach is limited. They did explain, however, how the program has reinforced their belief in the importance of hands-on science. A smaller number of teachers credited their teaching style to the modeling from the Science Squad or mentioned other ways they were affected by having the presentations in their class year after year.

The praise for the program in the interviews was extensive; teachers appreciated having the Science Squad members come to their classroom and many suggested ways to expand the program. The students learned about interesting and cutting-edge topics in hands-on activities, and the teachers often learned alongside them. Science Squad programs are viewed as a valuable experience that, despite the short contact time, has many longer-lasting positive effects for students and teachers alike.

Findings from Interviews with the Science Squad Alumni

I. The Interview Sample

We interviewed 24 past members of the Science Squad during the spring, summer and fall of 2003. The interviews were typically 45-60 minutes long and conducted by telephone. The interviewees' experience with the program ranged from one to six semesters, during the ten academic years 1992-93 through 2001-02. This sample was drawn from the complete roster of 34 participating individuals (including multi-year participants) during these years, so the sample of 24 represents a large and representative sample of all participants.

At the time of the interview, the Science Squad experience was quite recent for some; for others, it took place up to ten years ago. This spread in the time span of participants was useful because the resulting interview data set included both reflections on longer-term outcomes of the program from those who were well established in their careers after their Science Squad experience, as well as more recent recollections that represent the program as it is currently constituted. Because the focus of this study was on longer-term effects of the program, however, we gave slight preference to this group over the most recent participants in our sampling.

Based on our interviewees' comments, a few features of the program had changed somewhat over time. For example, the training of new Squad members and the nature and degree of the assistance they received in planning their presentations were more formalized after the early years, apparently in response to Squad members' feedback. In general, however the program was remarkably stable in its goals and organization and in the activities and outcomes reported by Squad participants. We were struck with the ability of participants from several years ago to recall details of their experience and to trace aspects of their current career back to that experience. Indeed, several participants commented in the interview that they hadn't realized they "had so much to say" about an experience several years in the past. Thus the inclusion of participants over a wide time span in the data set gives us more, not less, confidence in the robustness of our findings.

The interviewees included twenty women and four men, which is representative of the gender distribution of Squad participants from this time period. They represented the disciplines of biology, anthropology, engineering, geography, and physiology/kinesiology, the majority (16) coming from the two biology departments on the campus. Because disciplinary information was not available for the entire roster from which the sample was drawn, we cannot establish whether this distribution is representative of the Squad participants overall, but it does include the range of departments from the original roster.

Where possible from the interview data, we ascertained the Science Squad members' education or career status at the time of their participation in the program. For the 19 participants for whom this determination was unambiguous, 14 were graduate students in masters or doctoral programs at the time of participation. The remainder included advanced undergraduates, recent baccalaureate graduates, and post doctorates. Most members held the position as a graduate assistantship, but a few were hired as employees because they were not university students at the time (these were not, however, generally advertised positions, so the undergraduates or recent graduates were generally people who had some prior contact with the BSI). Despite these

variations, we refer to the Science Squad members collectively as "graduate students" for simplicity, because this perspective is strong in many of their comments.

At the time of the interview, all 24 interviewees were still working in science, engineering, or science education or seeking work in these fields. Eight held faculty or other teaching positions in higher education and six worked with K-12 education as either K-12 teachers or outreach professionals. Six were completing their scientific training, either as graduate students or postdoctoral researchers. The remainder worked in private firms, held academic research positions, or were seeking jobs.

In the following sections, some quotations are used that might identify the speaker to persons knowledgeable about the program. This occurs most often when a speaker is discussing his or her presentation topic. Where this was thought possible, we have sought and received permission from the speaker to use specific quotations in the report, and we have noted these instances in each case.

II. Becoming a Science Squad Member

In this section, we address the process of becoming a Science Squad member: who joined the Squad, how they were recruited to the program, and their motivations for joining.

A. Recruitment to the Science Squad

Science Squad members were recruited by a variety of methods. Traditional advertising strategies using fliers, e-mail, or announcements at allied programs such as the Graduate Teacher Program were effective: twelve of the 24 members interviewed mentioned these sources as calling their attention to the program or spurring their interest in applying to it. Several also mentioned the informational meeting announced on the flier as important in providing the details needed to make a decision about whether the program would be a good fit to their own interests.

The other important method of recruitment was through word of mouth. Eleven members reported that their interest in the program was initiated or increased by hearing about it from another participant in their department.

> I had had a friend who was on the Science Squad previously, and she had really enjoyed being on the Science Squad. And we had a lunch conversation about how much she got out of it and the rewards of being on the Science Squad, and so I was really eager to apply.

The two methods—advertising and word-of-mouth—often worked particularly effectively in combination. Fliers and e-mail messages called potential participants' attention to the program, who then sought out more information from friends or acquaintances had participated in the program. In a few cases, members were even approached by a peer and encouraged to participate.

> I think they had advertised to our department, but mainly because one of my fellow grad students had done it the year prior to when I worked for them. And so I'd spoken with her about her experiences, which she loved—and [she] did it for two or three years, I think. So mostly from talking to her.
>
> I suppose I'd seen the fliers that were sent out in our campus mailboxes, and was intrigued with that. Thought it sounded really interesting—and then I also knew two of my friends in the same department who were currently Science Squad members. And so

> when I found that out, I spoke with them, more about it, just trying to get some more information. And they had nothing but positive remarks to say—just that they had had a super experience with it and would definitely recommend it.
>
> It was actually another grad student who found out about the Science Squad. I think that she was at an educational fair or something that they were represented at. And so she found out about it, and we both had worked as TAs together, and so she kind of roped me into it.

One member, an early participant from his department, described being asked about the program by fellow graduate students.

> What was kind of strange is that person after person—and what I should say is graduate student after graduate student—in that program kept coming up to me, and they'd say, "Tell me about that experience you had. Tell me what that was all about."

It is clear that the positive experiences of past Science Squad members, and the resulting strong reputation of the program in the participating departments, are excellent resources for recruiting new members.

B. Prior Experience of Science Squad Members

As a group, the most striking characteristic of the interviewees was their high degree of prior teaching experience. Four of the 24 interviewees had earned teaching certificates and had taught in the public schools. Thirteen had experience working with children in a variety of other educational settings: they had taught skiing, swimming, horseback riding, art, first aid classes, outdoor skills, and bird-watching. Some had judged science fairs, led activities for girls' science programs, worked as an environmental educator in a park, or volunteered at a science museum. They had served as camp counselors, taken young people on backpacking trips, and volunteered in inner city schools or with disabled children. Twelve also mentioned influential teaching experiences in higher education, primarily as TAs (teaching assistants) in their graduate programs. These experiences reveal a strong interest and prior experience with experiential education, an interest that may be a strong predisposing factor in participants' interest in the Science Squad, an important factor in their selection as Squad members, or both.

C. Motivations for Participating in the Science Squad

Members' motivations for participating in Science Squad, as they recalled them in retrospect, are telling. Motivations were mentioned both in terms of individuals' personal experiences—what drove individuals to pursue this opportunity—and in their observations of their fellow Squad members and generalizations made about their motives. Many of the motivations they describe can be clustered into broad categories. These categories, in descending order of frequency of mention, are:

- A desire to teach and to share science with others (21 members),
- Interest in social justice (14),
- Need for financial support during graduate school (8), and
- A desire to get out of their department for a change of scene or to broaden horizons (6).

Participants' motivations were complex; most interviewees mentioned motivations from two or more of these clusters. A strong thread, however, is that many participants were strongly driven

by altruistic motives and an interest in serving others. While they were aware of potential benefits to themselves, and motivated by these potential benefits, they very frequently mentioned the intrinsic rewards—a sense of giving back to the community, a desire to share their science with others—rather than specific benefits that they anticipated (e.g. pay, gain in skills, résumé enhancement). No member described being motivated strictly by extrinsic motives, particularly financial ones. As will become apparent later in the report, their motivations do in fact strongly resemble the benefits that they received from participation, but they are discussed here strictly in terms of what prompted members to apply to join the Squad and the expectations they had when they began this work. We shall next examine each of these clusters of motivations in turn.

1. Desire to Teach

Most (21) of the participants discussed their interest in Science Squad in terms of a desire to teach. Factors that shaped their desire to teach included enjoyment of and aptitude for teaching and a desire to gain more teaching experience.

The most-often mentioned reason behind this desire was simply that the participant enjoyed teaching.

> …Part of it was that I really missed teaching, really wanted to get into some teaching, and I enjoy high school age and middle school-age students, and so it seemed like a good, good way to spend my time.
>
> For three years, I had just been in a lab or out in the field doing research, and I really missed teaching. I definitely wanted to teach again, and I wanted to do Science Squad instead of a teaching assistantship because I think just hearing about [my friend's] experiences really made me interested in doing it myself.

Often this enjoyment was coupled to a recognition that they also had an aptitude for teaching. As noted above, many members had prior teaching experience, in some cases quite extensive, and many held a common interest in experiential education.

> So I had taught, and I really liked the kind of hands-on experience of learning, and, you know, enjoyed teaching. And this just sounded like a really different, neat opportunity.

Others had not discovered their interest in teaching until working as a teaching assistant during graduate school. However, they enjoyed this work, discovered an aptitude for teaching, and wanted to build on this experience.

> What I found, as I ended up being a teaching assistant, was [that] I really had a proclivity and some expertise in translating science topics for college students in a way that made me a really effective teacher.

Others were excited by the potential of sharing their excitement about their research.

> [My research at the time] was very exciting and provided me with a lot of material and ideas that I later integrated into the presentations that I would bring into the classroom. So I had a lot of *personal* research that I got to share.

As the teachers had noted in their interviews, this excitement was often contagious and passed along to the students. Many emphasized their desire and ability to teach to non-scientists or novice learners. Some distinguished this type of teaching from more specialized courses they

taught as graduate TAs. They were drawn to the Science Squad opportunity because it emphasized non-specialist audiences.

> I made a request asking if I could substitute my TA servitude, if you want to call it that, and instead join the Science Squad, because I knew that I would be probably better—I'd have more talent and I'd have a better time, and I'd teach myself some things—if I were to teach high schoolers rather than undergraduates.
>
> Every day that you are a teaching assistant, you are applying science in a very concrete way, so that other learners can understand the basics of science, so that they can then apply science in other ways within their own lives.

For many, this interest in bringing science to a more general audience persisted into their later careers. We will expand on this topic in later sections, but the following quotations highlight that this interest in sharing science broadly was a long-lasting one for many.

> And that's also been a recurring theme, both when I was a graduate student—I taught a fair amount for non-science majors as a TA—and then now, I'm working in that setting too. So I enjoy that mixture of working kind of outside the discipline with that population. And that goes back, I think, partly to the Science Squad as well, trying to get other non-science-oriented people excited about science and understanding science.
>
> I guess I could call it a personal mission, helping people understand difficult concepts that I've taken the time to come to understand and then relaying that information to them—but also relaying it to them with a level of excitement and enthusiasm that gets them excited to continue to learn about it on their own. Or at least develop an appreciation for how that information has come to be acquired.

A motivation closely related to enjoyment of teaching was enjoyment from being with young people, and an ability to relate well to them.

> I'm one of those people who loved high school. …I thought school was fun, and everything that went with it—the sports, things like activities, whether they'd be theater, or anything from chess to just foolin' around, with things that happen that high school students do. I always had a good time and I think that my… I'm trying to say this without saying that I'm immature, (laughs) but my maturity level was more of a high-schooler than when it came to a university-level setting. I can make those people laugh. I can make them learn. We have a lot of fun together and we seem to relate better with each other.
>
> I have just many, many, many young cousins of all ages, so I've always really liked working with kids. Then projects and crafts and activities have been my forte with the kids, so I think when I came into the interview, I had just thought a lot about what I would like to bring into classrooms to share with the kids.

In addition to their enjoyment of teaching, participants were motivated to participate in Science Squad to gain teaching experience. Many were considering teaching as a career and saw the Squad as a chance to investigate this career option.

> I was interested in seeing what it would be like to teach in schools, and Science Squad enabled me to do that without going to do a teaching degree.

> I did sort of think teaching was an option. [From my prior experience,] I knew I liked the teaching much better than the research. That was very clear. But where I was gonna teach, how I was gonna teach, whether teaching was really it, wasn't clear.
>
> I was teaching just the most general freshman biology lab, and that was the first time I had ever taught, was those labs, and I really enjoyed it. And so I wanted to further pursue that. And at that point I was starting to kind of contemplate getting into education. And I hadn't quite decided yet, but I had started possibly thinking about going down that path, and so I thought Science Squad would be a really good opportunity to let me figure out if that's something that I wanted to do or not—be in the public school classrooms.
>
> I *knew* that I wanted to teach eventually, and I thought, "Hey, this will educate me. This will be an opportunity for me to learn what a real classroom is like. And also test some things out. Because if I'm gonna be teaching someday, I have to figure out if it's really something I want to do, if I like it."

For a few participants, this included exploring teaching as a lifestyle as well as a career choice.

> So I was trying to pursue other options. In particular, teaching I had wondered about, in school, thinking that might fit in better with having a family.

Science Squad was seen as a good way to explore career possibilities in teaching because it provided a more immersive teaching experience than a traditional TAship. It required more time and commitment, but also enabled one to develop a more profound level of teaching skill and provided a more realistic view of the teaching profession and the realities of public K-12 education. Several members identified this as a need unmet elsewhere in their graduate education.

> One of the things I see in people who are interested in the Science Squad is people who are really interested in teaching and who are not getting the kind of teaching experiences they enjoy having as graduate students.
>
> The people that are attracted to Science Squad tend to be—I mean, a majority, clearly, are graduate students at CU Boulder. They are doing a professional program up there, they're doing their research, they're writing their dissertation, whatever, but they've always had an interest in education and they may be *thinking* about education or teaching, at some level. And this gives them some experience—it makes them have to be able to put together lesson plans and think about the logistics of presenting things. And sometimes researchers aren't always good at that. (laughs)
>
> I've always been kind of disappointed at the level of teaching instruction, or the amount of teaching instruction that's provided to advanced degree students. I mean, it's ridiculous that you're just expected to somehow magically learn how to teach just because you've been doing research for four to six years in graduate school. And so I thought, "Well, yeah, Science Squad sounds like a neat way to turn—to get a bigger, a broader diversity of teaching experience. Interact with people with all kinds of different backgrounds, different ethnic and racial backgrounds, different educational experiences, small schools, big schools, inner-city, suburban."

Participants were well aware, however, that their keen interest in teaching was not necessarily shared by their fellow graduate students.

> I know that the folks that I talked to about it were generally more focused on the teaching aspect of their future career than average.
>
> I was interested, and still am very much interested in teaching long-term. I'm seeking a Ph.D. but, you know, people have their various emphases that are normally foremost in their mind. And then some people just want to do the research and get the degree and go on and do more research—"If I have to teach, okay, but, you know, I'm a researcher."
>
> The majority of the students who, from my experience, have applied to the Science Squad, all wanted to teach. It was not just, "Let me do this to get some money," because the time requirements were so extensive. You can get money doing something like intro bio—it was the same, and it's a lot less work. So this is more challenging—therefore if you applied, and you took it, you got it, it meant that you were looking for something. So I think the majority of those students were oriented towards teaching somewhere in the future.

Nor, as we shall discuss, was their interest in teaching necessarily supported by their department and faculty advisors. The ramifications of this "deviant interest" in teaching for these participants' graduate school experiences and career paths will be explored further in a later report, but it is worth noting here that the level of interest in teaching among this group is probably not typical of all science graduate students. The students attracted to this program are unusual in this and, as we shall see, other ways.

2. Working for social justice

As some of the quotations in the previous section highlighted, many participants were interested in working in classrooms with diverse populations and at under-served schools. This included a desire not just to experience and understand such schools, but, often, to serve them. Fourteen members cited a desire to serve the broader community, or described a long-standing interest in social justice and equal access to education. One often-repeated theme was the desire to "give back" to the community.

> …I felt it was kind of nice to give a little bit back to the community.
>
> I had begun to think that graduate school was a very selfish endeavor in a lot of ways, that you just sit for hours and hours and read and read and read and discuss things. And I was ready to put some of the energy into the community also.
>
> I'd spent two years here in Boulder but didn't really know the community at all, and so I was looking for a way to just become more involved with what was going on in Boulder and Denver.
>
> I guess I've felt this all along through my graduate career, that my time spent doing what[ever] it is I'm gonna be doing is great for me, but I also need to do more than just satisfy my own interests, my own desires, but try to give something back to other people and try to expand. Because I was definitely a beneficiary of that when I was younger—other people sharing things with me.

For many, engagement in their community was a habit already, and they felt a need to continue their community service.

> …When I was an undergraduate, I was involved in so many different things. I was not just involved in academics, but I was involved in a lot of different student groups and

> community volunteer organizations and things like that, and so I really missed having some connection to something larger than the academic world. So I think that that's what was really appealing to me about Science Squad, was some way to interact with the community again, in a way that I could bring my professional expertise that I had gained through being a graduate student and do something with that that was meaningful for the community.

Providing access to high-quality science education for students who might not otherwise have it was important to many Science Squad members.

> I found something exciting about trying to enrich science for people who didn't have as much access to resources as others.
>
> I was attracted a little bit to working with kids in Denver. It just seemed like you could make a little bit of a difference, what we were doing, and expose them to some neat stuff.
>
> I was rather appalled that students from big cities could kind of slip through the cracks in all aspects of their education, particularly science, as I was interested in. And so I wanted to turn that around, do something about it, and felt that the Science Squad gave the opportunity to go to the local public schools in Denver and try to invigorate it.

Several mentioned a desire to be a role model to children—as a scientist who was also a woman, a minority, or just a person who could make science understandable, relevant, and fun. They felt the Science Squad provided this opportunity.

> I think I took seriously my role as a woman in science and I think I realized I was serving as an example to the students, perhaps, but… I went into the program feeling like that was an important thing…. That was part of the reason why it would be interesting to be involved in this program, because I could serve as some type of an example to women students who are interested in going on in the sciences. But I wouldn't say my views changed dramatically. In other words, I was attracted to the program because it emphasized something I thought was important.
>
> I think that's from my own background in science. I … had lots of physics and organic chemistry and all of that as an undergrad, and definitely was *terribly* intimidated about taking those classes. And I saw all the nerdy guys who always do well (laughs) or who stereotypically, who I thought would always be doing well on those classes. But how surprising that was to me—and I've always done well in school, but for some reason, I just was always very intimidated by taking those sorts of classes…. I think seeing women in the fields that are interesting, interesting to me, has always been really important, and there's a little bit of, like, "Oh, you don't have to be one of those dorky guys to do that."

Others emphasized that scientists had a responsibility to play an active role in improving access to science education and of raising the level of general scientific literacy.

> I also see a lot of people who are really interested in social justice, for whom that's sort of an important theme in their lives… and I think that as a scientist you don't get many opportunities to do something that contributes to social justice. And Science Squad has one way to do a little bit of that, by creating some educational access.

> …we're busy as scientists, but there are places and ways that we can start to get out into the world. We're not making good decisions about how we use biotech and things, a lot of things really—at least I don't think so. And part of that are fear factors, and people not understanding what can happen, and people not understanding what did happen or what the data shows. So, again, that's part of why I was interested in Science Squad.

As these quotations show, many of the Science Squad members interviewed indicated a strong commitment to social justice and educational access. They saw the work of the Science Squad as enabling them to "give back," to aid less privileged communities, and to engage others in thinking about important real-world issues involving science. A few contrasted this with their graduate education, which they saw as more narrow and less engaged, an "ivory tower." Again, we will discuss later the nature of their actual contributions and the benefits to themselves, but this common interest seems likely to distinguish this group from the general population of graduate students in science. We will also discuss in a later section the evidence for benefits to students in the under-served schools cited by Squad members as a reason for their interest.

3. Funding to support graduate work

In addition to the altruistic motivations of improving science education for the under-served and the intrinsic rewards of teaching, many interviewees also cited practical motivations for participating in the Science Squad. In some departments, such as geography and anthropology, Science Squad positions were desirable in part because they provided a secure source of funding for graduate work in a department where research funding was more scarce. In other departments, such as molecular biology, research assistantships were more commonly available and large undergraduate lab courses required a sizeable TA staff, so Science Squad was viewed as an alternative type of funding. However, as these speakers made clear, funding was never the sole motivation.

> The funding was definitely what I needed, but I would have been involved with Science Squad at some point in my Ph.D. program along the way… it was something I was planning on doing somewhere in the track of the Ph.D.
>
> I had to teach something, and most folks did that in an undergrad lab or as a TA for an undergrad course there on campus, but a few of us were able each year to do Science Squad.
>
> And so part of it was that I needed money, part of it was that I really missed teaching….
>
> I was on the long-term Ph.D. program, (laughs) and it ran over a bit. And so there was some concern in my department, that having stayed over an extra year, that I was sort of putting pressure on my department, in terms of TA support. And this is just one of a few different factors. The other was I felt like my experience was somewhat limited, just teaching as a TA at CU, that's kind of a limited experience. I was interested, and still am very much interested in teaching, long-term.

As several interviewees pointed out, the time commitment for Science Squad was in reality greater than that for a standard TA job of the same nominal number of hours. We will say more about this later, in the section on costs to Squad members, but because of this time commitment, interest in the other perceived benefits of joining the Science Squad, beyond just a source of funding, was seen as necessary.

> Definitely Science Squad is a huge time commitment, 'cause I've done both now. I've taught in the department as a TA and a research assistant and then worked with the Science Squad, and that is definitely the most time-consuming and it's the same amount of pay. So in terms of that, it's a big commitment
>
> It was not just, "Let me do this to get some money," because the time requirements were so extensive. You can get money doing something like intro bio—it was the same, and it's a lot less work.

Thus, while funding played an important part in attracting potential Science Squad members to the program and in enabling them to participate, participants were not taking these positions merely to support their graduate work. Rather, they were drawn to the program by the combination of the program's ability to meet their funding needs and its promise of meeting their other interests and needs.

4. Unmet needs and interest in an alternative path

In addition to the attractions of teaching, the desire to aid under-served schools, and the opportunity to explore career possibilities, Science Squad was seen by some participants as an alternative to their current path, which was unsatisfying to them in some way. Teaching with the Science Squad was attractive in part just because it was different from their research and other activities at the time. For some, it simply offered a change of pace.

> I was kind of tired of departmental politics at that time, and I wanted to do something a little bit outside of the department.
>
> Number one, I thought that it was gonna be fun. I thought it was gonna be something that I would truly enjoy. It's nice to have a rest from the everyday grind of dealing with certain people at a university. And to go out and see kids who were laughing and just playing basketball instead of [griping] about this and that, you know.
>
> I think it's people that like being around kids and that enjoy teaching. I also think it's people that may want a break from whatever they're doing at the time, whether they're having a down time in their research or they hit a wall in their research and they want something different to kind of refresh them and re-motivate them.

For some members, the applied nature of the work was appealing, in contrast to the more theoretical or abstract nature of their research work. They needed to see concrete outcomes deriving from their efforts.

> The things that did appeal to me were those instances where I was using science in a very concrete way, to apply to a specific problem…. I had come to a point and recognized that unless I was doing applied work, I just didn't really… you know, the course that I was going and the course of a lot of my colleagues and my major advisor and his lab, it just wasn't the direction… it didn't, if you had to boil it down, it wasn't what made me want to get me up in the morning. …So I'd have to say it was an avenue for me, because it was a teaching assistantship outside of the regular biology department. It meant that I could kind of test out this idea that this was really something that I thought I might be good at and that I could do. And so it gave me an avenue to do something else besides continue to work within the biology department.

For others, the breadth of scope and social interaction that they expected from their Science Squad experience contrasted with the overly narrow environment of the research laboratory.

> After doing a lot of research and being so focused on one specific, detailed aspect of life, with a small group, I really wanted to just branch out more into the social world and deal with kids and people—you know, be able to share a lot of the ideas, and my enthusiasm in science.
>
> And really the research part of my degree, which is the main part of a Ph.D. degree, was really not stimulating to me at that point. I wanted some sort of student interaction. And I no longer could participate as a TA, and so it gave me the opportunity to work on my research, and at the same time get, sort of, *fed*, you know….

In addition to those who reported this motivation for themselves, a number of members had noticed the same appeal to others. They suggested that Science Squad served as an alternative path for those who were already dissatisfied in some way with their graduate education or the future that science offered them.

> And a lot of people, usually, they were the borderline people. "Do I stay in science, do I walk?" you know—[who] push for it or [are] allowed to do it and usually walk afterwards. But those were the people who were leaning that way. I'm not sure people who are thinking "Research research research" even consider it, in *this* department.
>
> I think a lot of people were looking for a little bit more than they were getting in academia. 'Cause a coworker of mine did it a year after me, partially 'cause she says I was always ranting and raving about how much fun it was.

Several as well remarked on the high proportion of women in the Science Squad, and connected this to women's dissatisfaction with the prospects of a traditional scientific career embedded in a traditional, male-dominated, scientific culture.

> I think, from my experience talking with other women who are in science, part way through grad school is when a lot of them start hitting the barriers. Where a lot of them start feeling not so happy about being in science. You know, it's interesting, I think a lot of women feel as undergraduates that there really aren't any barriers to being women in science. Everything's fine, you know. You can do just as well as the guys and there's no problem… and then you get to grad school, and then it hits you and then you realize, "Oh yeah, there really are some differences still, and it really is still an uphill climb." And people start to get discouraged… and so I think that contributes to the fact that we see a lot of people in Science Squad. Because it does attract people who are realizing that maybe this is not the path that they wanna go the rest of their life. They love science, but they can't see themselves long-term as part of an academic community that they don't really feel at home in.

This is an important observation. We shall have more to say about how the Science Squad provided participants, and especially women, with a glimpse of other career paths within science, in a later section, but it is important to recognize that this was not merely an unexpected outcome, but one that some participants were seeking from the program

III. Benefits to Science Squad Members

In this section, we discuss the benefits to themselves that Science Squad members reported receiving from the program. Benefits to their audience of K-12 students and teachers will be addressed in a separate section, as will costs to Squad members.

Science Squad members reported benefits of several types from participating in the Science Squad. The general categories were:

- gains in skills, mentioned by 20 members;
- gains in understanding, particularly of issues surrounding education and diversity (22);
- personal benefits, including confidence and emotional rewards (20); and
- career-related gains, including exposure to and clarification of career paths and opportunities, résumé enhancement, and networking. (23)

We shall discuss each of these groups of benefits in turn, beginning with skills.

A. Gains in Skills

A total of 20 Science Squad members reported gains in one or more skills. Members reported gains in three main types of skills:

- Teaching skills (reported by 18 members),
- Communication skills (15),
- Management and organizational skills (5).

1. Gains in teaching skills

Participants reported a variety of types of teaching skills gained during their Science Squad tenure. These skills included a variety of component skills, including communication and organizational skills, but are gathered together under teaching skills when they are described by interviewees as useful and applicable in a teaching context. We will discuss separately the component skills of communication and management when these skills were addressed in the context of their general applicability.

Most often mentioned among these was skill in explaining and demonstrating complex scientific ideas to a wide variety of audiences. This included finding simple language for complex ideas, and different analogies or examples that would help their audience understand.

> I learned a lot of ways to present different ideas, to try to reach as many kids as possible.
>
> I learned how to present the same presentation to many different types of students at many different levels in many different lengths of class periods under many different circumstances. So yeah, I've learned a lot—flexibility, and bringing my stuff down.
>
> I'm way up here [in my understanding of my topic], you know. And remembering you can't use some of these words that are… how you describe something. So I've learned a lot of that too.

For some, learning to explain scientific ideas also involved new learning about their scientific topic. They needed a deep understanding of the concepts in order to explain the ideas in non-technical language, at different levels, without introducing inaccuracies or misconceptions. By

working with classroom programs that were a bit outside their particular research expertise, they gained a broader view of their discipline and developed new, non-technical ways to think about and explain difficult concepts.

> I certainly had to learn a lot about the subjects that I was teaching about, so that I had enough knowledge to teach it to others. And I had to learn enough about it so that I could teach it at different levels. I was teaching the subjects from kindergartners to seniors in high school, and so you have to be really flexible, and be able to teach at various levels.
>
> I think it broadens my biology a little bit, 'cause I'm a generalist in the biology field, and my graduate work was actually more field ecology and population biology, but I've been I've been teaching microbiology for a number of semesters and years. So this was kind of a way to broaden the biology a little bit and understand a little bit more these other techniques.
>
> It helped me really get a grasp of some of the topics in my discipline a little bit better too, because I had to not only understand them myself, but be able to teach them to other people too, to teachers and students alike.

An important step in developing this skill was becoming attentive to the audience's response and using one's observations to adjust the presentation on the fly.

> …being able to gauge the level of the audience's understanding, 'cause you can present the same activity to a seventh-grade class and a twelfth-grade class, and there will be a vast difference in their background and their previous knowledge and their energy levels, their maturity. And so all those factors can be adjusted for, because you're giving the same material and content each time, but the way that you present it or the order that you present the concept or the things that you emphasize, or kind of just breeze over… can be different. And I think that that really helped me be able to figure out where people are at and teach toward that.

Participants described how gains in the ability to explain ideas and tune their explanations to their audience applied quite broadly to their later work, whether in classroom teaching, in other educational work such as curriculum development, or in seemingly unrelated lines of work.

> The Science Squad is really an opportunity to be very, very creative about how you think about how students or teachers can understand whatever it is your topic is. And I think that's really served me well since leaving the Science Squad. Just keeping that process of how to translate materials and concepts and skills… how can I say this? You know, there's just a plethora of information and textbooks and activities out there for teachers, but I think the reason why I've been very successful is that I continue to translate science in the spirit that I learned when I was in the Science Squad.
>
> I was unsure whether I'd be able to explain scientific topics to non-science people, or potential science people, and I really thought it was an important skill…. I don't think my current employer really focused on this thing, Science Squad, as a good résumé builder—in fact I can't remember if they even asked me about it—but I think it's important and I think that it helps me do a better job in my job.
>
> A lot of the people I talk with [in my work] are not engineers, and sometimes I get to go to homeowners' meetings and explain what our engineering project is gonna do and how it's going to impact them for good or for bad. I respond to their questions, like "What is

> this chemical that you're putting in here?" I love that stuff, and I think it's incredibly important that I don't use jargon, that I can communicate to normal people about their water or their wastewater. … These are people who aren't as schooled in engineering as you are… [so] how best can you explain this or help them discover, by you leading them on to think along a certain path?

Another gain in teaching skills mentioned by participants was their ability to use interactive and inquiry-based teaching strategies. In addition to skill in using these strategies, participants also developed a belief in the value of these techniques and a commitment to using them in future teaching settings.

> Certainly every time I teach, I'll try to add some sort of experiential or hands-on [component], if at all possible, in the lesson. And so I think that was valuable, to have that, to kind of pound it in a little bit more, even.

> Science Squad, when I was on it, they had decided to always try to do inquiry-based learning activities. And that's definitely how I try to base or run my classroom now, is doing a lot more inquiry-based [teaching]—rather than, you know, lecturing or just talking to the kids or "do this, do this, do this"—letting them kind of figure out stuff on their own. So I think it really kind of molded my whole teaching philosophy.

One speaker emphasized how these teaching skills were transferable across different types of classroom settings.

> [When I arrived at my current faculty position,] the fundamentals were there, [but] the students were just not engaged. That was really obvious to me when I arrived here, talking to teaching assistants, for example. They just said, "Ah, no, the students are here, they put in their time, they leave." So we've re-vamped [the lab experiments] to try and engage the students more, and I think we've had a lot more success. So those are the kinds of skills, for example, that I was able to take from Science Squad directly into the university setting. In lectures, even in very large lecture halls, I feel like I have tools that allow me to have the students actively participate in a lecture.

Members also made gains in practical teaching skills, including lesson planning, judging the time needed to complete a lesson, developing engaging, low-cost, and age-appropriate materials, and classroom management.

> Doing something like Science Squad, just the exposure to different settings, kind of gets you in the mindset of, "Well, I've got to have a plan, I've got to have lessons worked out, and I'm going to be dealing with lots of different kinds of people."

> … Honing my skills in terms of what's possible with kids in an hour or an hour and a half, that completely improved. Making a good worksheet for them so they would stay on task and have something to do. That's an art that I'm still getting better at, but definitely those skills [improved].

> That was also perhaps another revelation, that, "Yeah, if you have students with different learning styles, or in different situations, different classroom dynamics going on, you can do some very small things to change what you're teaching." The content's still essentially the same content, but if you do things a little bit different, it can change the dynamic as you go through the day. Just, you know, your physical interaction with them, how close are you, are you up at the board, are you at their desks, are you picking people as

> volunteers to do things, or are you just trying to hurry through the introductions so that they can do their part of the project? And there are a lot of little pace things that I think I got a feel for, and I got a feel for 'em more in Science Squad than I did as a lab TA.
>
> There were some tricks that I just continued to use. I think I just gained skills in being able to read a class. To have the stamina to stay high-energy, but try to keep them in control.

Perhaps most importantly, however, participants were able to link these component skills into a coherent, personal, teaching style. Even those with previous teaching experience found their Science Squad experience an opportunity to refine, reflect on, and improve their teaching practice.

> The way I have advertised it to people is that I think that's where I learned how to teach. I had taught high school for two years, but in those two years, I was still in the scale-up phase…. I found out in my Science Squad time that I hadn't really had or taken the time to hone the classroom interaction skills. In talking to other teachers since then, especially in the context of Science Squad, and now watching myself in this job as well, there's a two- to three-year curve before people can start to do that.
>
> I think I gained a lot of general management skills, just because I was going into a new classroom every time, so I really had to. I think I learned a variety of ways to keep the kids on task and directed and with me. I think I learned a lot of ways to present different ideas, to try to reach as many kids as possible. So I think it helped me figure out what my teaching style was. I think it shaped what my management style was gonna be.
>
> On the concrete side, it developed my teaching style. I mean, you're in the classroom two full days a week. And it doesn't matter if you have a cold, if you're crabby, or whatever, you have to be *on* for that five or six hours, five or six periods of that day. So it definitely helped me to develop my teaching style, and my comfort zone, find my way of presenting ideas, and what works and what doesn't work. Ways of controlling classrooms—I mean, a part of that, even though you don't want it to be, is about keeping students under control to some extent too, keeping them engaged. So from a skill perspective, I learned about classroom styles and managements, as well as about developing new experiments, what's reasonable, what can be done, what can't be done that are age-appropriate, appropriate for the budget that you have, and so on and so forth.

2. Insight into the process by which gains in teaching skills were made

Certain aspects of the Science Squad program seemed to be particularly important in bringing about these gains in teaching skills. Repetition was crucial: by offering a small number of programs in a large number of classrooms, Squad members gave their presentations frequently, with constant minor variations in the audience and setting. This gave them the opportunity to not only refine their presentation and work out the bugs in it, but to become sufficiently comfortable with it that they could experiment with different approaches and observe students' responses closely.

> …getting a chance to take the same lecture and approach it from a number of different angles to sort of trial-and-error to see what works. You just don't get that opportunity most of the time. By the time you've taught, you've used your lecture, it'll be next year before you get a chance to try that one again. But when you're in that really

> intense—especially high school—setting, you've got four or five times a day, the same program you're giving, and you're going to give it in the Science Squad, at least for about two months—'cause you do four programs, divided up over the year, so about two months, two and a half months, you're doing the same program twice a week. So you really get a chance to hone some teaching techniques. And that's been some skills that I think I've developed well. All reports I get back from the students on faculty evaluations [in my current job] have been high in that regard, in terms of my effectiveness as a teacher, and I attribute a large part of that to having had the opportunity in a place like the Science Squad, as well as previous experiential education programs, to just try the same package again and again, to try different angles.
>
> Just getting in front of a classroom day after day… I got really comfortable with the material, so I was really able to—instead of worry about, "How am I gonna present this?"—I could really look at the kids and pay attention to them.

In addition to repetition and refinement, participants had a valuable opportunity to observe "a whole flock of different teachers" as they visited classrooms in many schools. Insight came from both positive and negative examples of how teachers presented material, interacted with students, managed classroom dynamics, and handled problems.

> It was also really informative to me … to see the different teaching styles of all the different teachers whose classrooms I went into. How do they deal with this problem? How do they deal with that problem? How do they present this content? How are students responding to it? Both for differences between schools and just overall differences in teaching philosophy—it was really, really valuable.
>
> It was totally, and utterly, dependent on what the teacher expected—because the teacher is always there with me, the discipline of the kids was really whatever their discipline was with that teacher normally. It was very interesting to me, the huge differences between teachers.
>
> And that was interesting too, sometimes, to see how that teacher particularly acted in that classroom—the management styles, classroom behavior. And I think it goes both ways there. I saw things that I thought were really neat ways to get across to the students, and good ways of managing classes, and then I saw some teachers that their classroom management skills were just horrible. And those were usually the days that I really didn't like that much. (laughs)
>
> I learned, I really learned, from observing the way teachers interacted with their students about ways that teachers could interact with young adults and get things across to them or ways that they handled classroom management situations or various interactions with their students. Things that worked and things that didn't work. And I think that I model a lot of my same strategies after teachers that I thought were really good or really successful.

In the best cases, this was not just accomplished by observing the teachers, but by collegial interaction with them. This occurred in co-teaching lessons, in discussing them together afterwards, and in collegial feedback from the teachers to the Squad presenters.

> The teacher is very important in a Science Squad presentation, in terms of maintaining classroom management.… Because a lot of the things that I did involved small group

> work, where students were designing little mini-experiments and carrying them out. I also really needed the teacher to circulate and help and talk to students and interact with them, and so in the really good situations, when teachers were good at the classroom management and good at being another facilitator to help the small groups of students, those were opportunities for me to observe things that worked well for them.
>
> And just little tricks that I learned from some of [the teachers] and then passed around… about handing out materials and where to put things and when to let folks touch stuff and what to say and when, and what to ask them to read, and what to rely on and all of that—that had not been a part of my curriculum, and so I learned a lot from them. I hope in some cases I taught them some things, but just to have that conversation about what I did, why I did it, their interpretations of what worked and what didn't work, what they might have done differently, why they would have done that differently, were certainly valuable for me, though I can't speak for any of them.
>
> *Squad member*: I really got more feedback and stuff from the teachers themselves, I think, because they're the ones whose classrooms I was in.
>
> *Interviewer*: Feedback in terms of how to refine your presentation? Or…
>
> *Squad member*: Yeah, or, you know, what went wrong in with disciplining a kid or something. Not that I really did much disciplining, but you know, just some of the teachers themselves were great critics, and made great suggestions.

One Squad member did, however, point out that the benefits of observation were limited to certain aspects of the teacher's work, such as classroom management and interactions with students. Because her presentation was a special event, she could not learn from observing teachers about issues such as the daily structure of classroom work or the sequencing of lessons.

> I don't think I really saw a whole lot of their real learning environment, because I was coming in and this is a unique day in their learning sequence. I don't really feel like I got a sense of what their day-to-day classes were like. But I certainly learned something about what teachers were successful, and maybe how they were more successful in communicating with their students. Just because we're going in and we're not there to do classroom control, and so the teacher is responsible for that. So you can see the classrooms that are more under control than others (laughs). But in terms of their day-to-day activities, not a lot.

In addition to repetition and refinement of their programs and observation and collegial exchange with teachers, Squad members received some direct instruction in classroom skills as part of their training. They valued the contributions made both by the BSI staff and by their Science Squad colleagues.

> We don't get a ton of instruction at all in classroom management, and just the little things that we learned in the two-day, really intense, Science Squad classroom management seminar that they gave us, just gave me so many skills that were important for lab classes here.
>
> …both by developing the workshops that we used through the Science Squad, but also through the training that was provided through the Science Squad leaders, through the staff. And the people who direct that program gave us really fabulous advice on how to make our programs very interactive.

> The Science Squad is a team, and even though the individuals of that team are presenting classroom activities or teacher workshops within their own discipline, we really interacted quite a bit on a week-to-week basis. So you would see those individuals in the lab or at staff meeting, and I think that one thing that really made a big difference for me was the fact that there were quite a few other Science Squad members who were in the same boat as I was. So, and what I mean by that is, even though, as a graduate student, you have a lot of experience teaching, that may or may not prepare you for dealing with a classroom of seventh graders... and the kind of classroom strategies you have to use to engage a group of students who is in a completely different place than the college student. And not only that, but there's also teachers who are either really incredibly helpful and supportive or who might just walk out of a classroom and leave you there with their thirty students. And so I really liked learning a lot about classroom strategies and about pedagogical methods just from the kind of on-the ground experiences that I had and then sharing those with other Science Squad members. And, you know, you really got the sense that you were all in it together.

Together, their training, classroom repetition, observation of skilled teachers and group discussions amounted to an intensive teaching practicum. Members could apply ideas learned elsewhere about teaching to real teaching situations in a setting where it was possible to analyze and discuss them afterwards. Even members with extensive teaching experience or formal training in teaching found this combination beneficial.

> It helped me form some sort of sense of how I would like to do it, in a bigger way than I had had from doing it myself. You're seeing somebody else do it. I'm the sort of person who learns a lot through observation. So telling me to do something is not nearly the same as letting me watch a variety of different situations. So I've had my own experience teaching, and I have my own formative evaluation of that—"I think that worked quite well, I'll try that again. You know, this didn't work, I'll try that again. Do that over next time, a different one." But equally important was just seeing how the teachers worked with the students.
>
> I definitely still learned from watching teachers, and having that [education] background maybe helped me, even, a little bit. "All right, well, that makes sense. I've read about that, or I did that, or we learned about that, and I can now see, you know, this person's been practicing it probably for years, and it's working great. Oh yeah, we talked about that, and that's not working out great." (laughs)
>
> Science Squad was ideal because the content stayed the same, and I moved from school to school to school. And so I found that in that one year in Science Squad, I learned so much more about… it's all stuff people had taught me in my ed classes, but they're skills, skills that you have to learn about watching students, watching their facial expression, really waiting long enough for people to answer questions. Those kinds of nuts-and-bolts skills develop much faster in that context. And I don't know if that's in part because I was primed for it with the two years of teaching, or exactly how that plays out—I've thought long and hard about it. But it was a great opportunity for me to learn teaching skills, and with practicing, in many cases veteran, teachers there at my side. One of the most valuable things for me about Science Squad was lunches with those teachers.

Indeed, one Science Squad member recommended this practicum as a deliberate strategy to learn the art of teaching.

> But this thing is what I think is exactly what teaching *should* be. You should have to go into *tons* of different classrooms where *you* have to teach, and you just get to see what a teacher has done, that has either paved the way and makes it easy for you, or has not and they cut a real rough road when you're trying to get through a subject.

It would be interesting to consider such a model as a special type of teacher education or alternative to student teaching, perhaps for re-entry students seeking alternative certification.

3. Gains in communication skills

A set of skills that is related to teaching and was mentioned by fifteen Squad members was the development of communication skills. While these were often mentioned initially in connection with teaching, as seen in the quotations above, members frequently made a point to distinguish these as communication skills that were generally applicable to a variety of settings, not just in the classroom. We have thus categorized this group of skills separately from teaching skills.

> I think it allows me to be more successful in conveying the information that I want to about [my current work]. Who's to say that I wouldn't have that interest if I hadn't been through Science Squad, but it certainly has made me more successful at it… it's definitely influenced the way that I interact.

Several reported gaining skills in public speaking as well as confidence in their ability to do so.

> I got better at speaking to groups of people—something I'm not very good at, even when it's kids. And certainly that got easier, 'cause I've never done a job where you talk all day. (laughs) You know, in any old day, explaining things. So I hope that I got better at that.

> I was very shy before I did Science Squad. The thought of standing up and talking to a room full of people just utterly terrified me. But going in the classroom and having to do it hour after hour after hour was absolutely what I needed. I never would have known that that's what I needed until I did it—so that was good.

Participants also mentioned specific presentation skills; including designing and planning a presentation and preparing appropriate visual aids. Tailoring one's presentation to the audience and being attentive to the audience were often emphasized.

> Having to communicate information to high school students is a challenge, and it's an experience that a lot of graduate students don't have and wouldn't take the opportunity to have. I mean, there are graduate students that go through their whole career and never teach, and you know, that shows in the classroom. (laughs) Basically, I'd have to say that it did help with my communication skills.

> I think if I had to boil that down, it would be just a real ability to know my audience. So it has to do with how to use that language, understand how to be able to get up in front of an audience and present, but also knowing what that audience might be interested in, either in science or just in general. I mean, what's important to them?

In sum, a substantial number of interviewees noted their gains in communication skills and the general applicability of these skills to situations beyond teaching.

4. Gains in management skills

The third category of skills gained by participants was management skills, including planning one's time and organizing a complex schedule.

> I definitely think my organizational skills got better, having to keep track of all the various details. When you're a graduate student, you sort of keep your own calendar and you don't have appointments you have to meet, as long as your organisms are happy, but, you know, when you have a different school that you have to be at two times a week every week… yeah.
>
> I wasn't terribly well organized, and I think I did learn about how important a lot of organization is, or at least how much easier it makes doing it.

This category of skills was mentioned by five members. As we shall discuss in the section on costs to Science Squad members of participation, organizing their time and managing the logistics of the program was one of the most often-mentioned difficulties.

B. New Understanding about Education and Diversity

Gains in understanding formed a second large category of benefits to Science Squad members, discussed by 22 members. Members reported developing a better understanding of many issues that affect the public education system, including diversity, social inequities in access to education, articulation between the K-12 and higher education systems, student learning and development, and the work of teachers and schools.

1. Gains in understanding of diversity and of unequal access to education

Improved understanding of diversity and of social inequities in the education system that are experienced by different groups was mentioned by 17 members. Simply being exposed to diversity was the first level of benefit for some members. As they interacted with a wide variety of students and teachers in a wide variety of schools, participants experienced the full diversity of the population, and in some cases, realized that their own backgrounds had been somewhat narrow.

> My experience growing up was one where I was in a community where there wasn't any ethnic diversity. So my experiences in the Science Squad really opened my eyes to probably a more representative cross section of what the rest of the country looks like as far as ethnic diversity. I mean, the classrooms that we were going into were a better fit for what the general public in the United States is probably made up of, as far as ethnic diversity.
>
> I got to see a lot of different schools and, and just at least get a shallow survey of what's the diversity, at least in the local area, what sorts of high schools did kids go to. And I did have that experience of seeing small private schools in the suburbs and inner-city schools in Denver. That experience of seeing a diversity of people.
>
> I think just more hands-on knowledge, as far as observing and working with completely diverse groups of people. Not only with different groups of teachers and the diversity of the teachers as far as their styles as well as ethnicity, but in different school settings too and the different school cultures, and being exposed to more of an inner-city and non-Caucasian, maybe a lower-income group of people that I hadn't had a *whole* lot of exposure to beforehand.

> It's a really diverse collection of people there [at my current institution]. Diverse educationally, diverse ethnically, and economically. And so Science Squad was a really nice intro for that. Just to see that, yeah, people are coming from a bunch of different places, and how do you teach to a group that's not all gonna be quite on the same page.

Even for those who had more prior exposure to diversity in general, the differences in the schools were enlightening.

> Even within DPS [Denver Public Schools], you know, the difference between Manual and North is *huge*! I certainly didn't know what an inner-city high school was like… no clue. But I certainly had a pretty big view of diversity. I knew that people could be extremely different, and cultures could be extremely different. I had traveled around the world also, you know. So… it was really fun to see Manual and to see North. I didn't know what those schools were like before, and now I do.

Beyond simple exposure to diversity, however, many participants went on to develop a deeper understanding of how the differences they observed were linked to social inequities in access to high-quality education.

> I came from what I'm seeing now as a very privileged public school education, and so seeing under-privileged classrooms in Denver was definitely eye-opening to me in terms of what kinds of [things] teachers are dealing with, and the students as well, was very eye-opening for me—and definitely more depressing than uplifting, I think. But seeing that programs through the Science Squad also are really important that way.

> I really gained an appreciation for seeing what a number of inner-city populations, which tend to be primarily minority populations, are faced with, and the disadvantages that they have just through their geographic location.

For one person, this included a recognition of the gap between town and gown. From her research experience, she was aware of the knowledge being gathered in the university, but had not realized how little that knowledge might be used in the "real world."

> Working with the students and the teachers at the schools has given me an awareness of a kind of a gap between the ivory tower, the academic world, and then what actually gets practiced or expressed or utilized in the general population and teaching perspective with science…. I've always wanted to help to fill in the gaps between, kind of, the highest and the lowest of the knowledge application. So I really like that about their [BSI's] program… being able to see that there *is* a gap, you know, because I hadn't realized that high school kids just didn't learn the intro stuff to what we were doing in the undergraduate level. I had always thought it was a very continuous spectrum, where I realized it wasn't. And so I think that that led me to explore more of where those kind of disconnects and gaps are.

This kind of understanding came about through seeing the small but telling differences in the everyday school experiences of students, such as whether students had their own science textbook to use in class. They saw vast differences in the outside-class experiences that students could draw on and connect to their learning.

> …just things like the simple fact that the students can't be given a book to bring home. I'm just appalled. I just don't see how those students will ever be competitive with students from more affluent communities, where they have those resources.

> It opened my eyes to what kids in Denver are experiencing. Especially a lot of minority students…Since we were talking about the mountains, and what the environment was like in the mountains versus the forest, versus the plains, we'd ask how many students have been up to the mountains. And it was usually 50% or less, it seemed, who really had gone and spent some time up there.

In the course of working in these schools, Science Squad member's stereotypes about inner-city youth were broken down.

> It took [away] the kinds of stereotypes that I think we hear about, or that I certainly was conscious of, that made me a little nervous about going to the inner cities. It only took a couple visits to inner-city schools to realize that that was a stereotype that I had to let go of, because it was not justified.

One speaker provided a vignette of just how quickly that realization could occur.

> My very, very first Science Squad presentation was actually at Manual High School. Definitely inner-city, very non-Caucasian school, very low-income. The very next presentation I did was at Colorado Academy. Which was almost day and night. (laughs) I mean, it was really interesting to see the differences there, and just what kind of opportunities the kids at Colorado Academy had and the kids at Manual High School didn't have.

Having explained how this experience rapidly demonstrated the differences in the schools, this speaker went on to clarify how this understanding had made a difference for her—both for her work as a Science Squad member, and in her overall understanding.

> And, especially given the subject area that I work with, the inner-city kids, which were predominantly black and Asian, they're at higher risk, according to statistics for heart disease and whatnot, *anyway*. So those kids really need, they *really* need to understand the content that I was bringing to them. So it made me feel like, "I'm really doing some good here. I'm getting to get this knowledge out to these kids who, statistically speaking, are gonna need it, *maybe* even more than somebody else…."
>
> (continuing): It definitely made me, without a doubt made me a little more aware of how much differences there are between schools. And how much, in a cultural or social sense, it *is* easier for the kids who are provided with a really good education to become more successful, become more independent and, you know, go on the successful track in life, if you will. And I don't think the opportunities are quite as clear for kids that aren't in that situation. …[B]ut it has certainly broadened my horizons, as far as knowing what's out there and knowing where kids are coming from. Knowing that, just being a little more empathetic and understanding to certain situations in school districts and with students that I eventually will end up having [in my own classes].

Another participant was particularly insightful about how understanding differences had influenced her teaching. She came to recognize that both students' behavior, and her expectations about and interpretations of their behavior, were culturally shaped.

> I learned that there are real cultural differences. That different cultures promote different ways of, I don't know if it's behavior or whatever, but I noticed that, for example—I know this sounds very stereotypical—but Latino students were incredibly polite. All of them were incredibly polite, and relatively quiet. The African-American students were

> more boisterous, more chatty with you, more kind of back-and-forth in the classroom, and it made me sort of understand that there are obviously different learning styles. And when you're in a classroom, and particularly a K-12 level, you're trying to impose behavioral issues, which means you can't talk. Well, not being able to talk for one kid might be different than for another kid, and the kind of talk you're getting from one kid may or may not be disrespectful. It's not necessarily across the board easy to apply behavioral rules, or expectations.
>
> (continuing): Because I think in the African community, at home, I think a lot of the students are more—people are more verbal, and vocal, and loud. The feedback that you get, or the sort of instantaneous comments that you get from African-American students, should not be viewed as maybe disrespectful, or interrupting you. It's the way that they learn, the way that they dialogue, who they are. On the same token, I think you have to work to engage some of the other students. And I think it's just—certainly it's a stereotype, but I think it's a cultural difference in the home, the way that people are in the home.
>
> (continuing): I mean, I think I didn't realize the implications of cultural differences in the classroom. I never knew that those issues could impact day-to-day classroom activities. And even at this level, you know, at the college level—I mean, I require students to participate, to be vocal in my classroom, and for some students it's real easy, and other students it's not. And to not judge that, and not say, "Well, this is a good student because they're participating, and this one's not good.…" You know, not to attach so much to that behavior, and those expectations.

In sum, the Science Squad members benefited from exposure to diversity by developing a greater awareness of why diversity matters, and an increased recognition of and sensitivity to social and economic inequities in the education system. One interviewee articulated particularly well the connection between this understanding and the motivation to use this understanding to make things better.

> The Science Squad provides an opportunity to get your hands dirty, getting in there and trying to do something, or at least experience what it is like under those conditions. So if the interest is just enough interest to experience the different issues and social issues, cultural issues, educational issues in the cities, then the Science Squad provides that. And if it's someone who wants to do a little bit more, then at least they have an opportunity to try to make a difference in some way.

2. Gains in understanding of student learning

In addition to their growth in understanding of diversity and of differences in access to high-quality science education, the Science Squad members also reported growth in their understanding of a variety of student learning issues. Among these were understanding the benefits of inquiry-based, active learning strategies in helping students learn.

> I had teaching experience prior to that, but this was really the first time that I had been introduced to an inquiry-based model, really. Because that's what's going to hold the attention of students at that particular age group, and so I found that to be an effective model.

By better understanding students' preconceived notion of science and scientists, members could better understand their own role in helping to change these.

> It made me aware that a lot of kids have a really stereotypical image of what a scientist is, and so being exposed to an actual scientist, or somebody that's involved in science, I think, broadens their views a little bit about what it meant to do science. And maybe didn't make them think in such a small box.

Several gained a better understanding of the developmental levels of students of different age groups, and the types of teaching strategies that worked best for each.

> I didn't have even a good idea of the differences between middle school and high school anymore. It'd been so long since I'd been there. But I didn't have an idea of that and how very different a level, just developmentally, there is between those.
>
> Even though, as a graduate student, you have a lot of experience teaching, that may or may not prepare you for dealing with a classroom of seventh graders… and the kind of classroom strategies you have to use to engage a group of students who is in a completely different place than the college student.

For some members, understanding developmental differences helped them refine their career interests. For example, one member planning to be a K-12 teacher was able to identify the age group of choice for her future teaching work.

> I went into classrooms, K through 12, so I went into all the age ranges, but it really helped me narrow down exactly where I wanted to teach. And I decided, basically because of Science Squad, that I wanted to do middle school. That was the age group that I really liked. I liked all of them, but particularly the middle school kids. I like their energy, their enthusiasm, I liked that they still liked science. …So I wanted to be in place where hopefully I could keep the enthusiasm going on at the high school, because it seemed like somewhere between middle school and high school they were losing it.

Those considering college teaching also found this understanding beneficial, because it helped them better understand the previous learning experiences of their future college students.

> That was a big thing on my mind, when I was actually out there doing it. "I'm getting a chance to see where these people are before…." 'Cause it was a lot of high schools, and middle school too. Just informing yourself, "Where are people coming from before they're going to come to have you teach?"

These gains in understanding of learning were additional to the gains in skills in tailoring their presentations to different student groups, as discussed in the earlier section. They were distinct from these gains when they were expressed as new, useful knowledge that could be applied in different settings, and that helped members understand not just how to use effective teaching strategies, but why certain teaching strategies were effective with different groups.

3. Gains in understanding of the work of teachers and schools

Finally, several members reported gaining a more profound understanding of teachers and schools. This included understanding of aspects of the education system such as the nature of a teacher's work day, the organization, administration, and funding of schools, and factors that differentiate schools. Much of this insight came from the broad exposure to a variety of schools that members had as they visited different schools each week.

> I taught in so many different settings—urban settings, rural settings, suburban settings, upper-division classes, freshman classes, and then those lunches with the teachers. And you just hear things about administrative protocol and level of administrative support and just getting that vision, a real scope of what's out there.
>
> The budgets at some of those schools are just ridiculous. I mean, some of them don't even have books, in some of the classes.
>
> I got the sense that there's a certain amount of hierarchy, even in the high schools, where, some teachers, even if you want to teach A.P. biology, you just can't, 'cause other teachers more senior will get it—or with a Master's, will get it.
>
> I really felt that the job that the science teachers at the high school level were doing was very, very different than the professors, or my own job as a TA. I really felt like they had far more responsibilities to the students directly as people than I did at the university level. There's just something a little more impersonal about working at the university level, and since the students are over 18, there's much less shepherding of them… and I felt that the high school teachers spent a lot more time working with the students one-on-one, as individuals.

Again, this understanding came from both observation and discussion with teachers, and served as part of a practicum on the American education system. Some members with teacher training found this experience more effective than their formal teacher training for revealing the range of circumstances within the public schools.

> And Science Squad put me into probably 30, 40 different high schools…. For me, I pulled a lot of information out of those lunches… and learned a lot about what makes schools work and what makes them not work. And why one teacher is enjoying their job and another one isn't. That has been somewhat valuable to me, but would have been *enormously* valuable to me in my student-teaching time.

Many were struck by the challenges that teachers faced and the lack of resources to support them. They saw the different ways that teachers responded to these challenges, and how these issues affected teacher morale. As a consequence, many expressed a "newfound respect" for those teachers who did stick it out.

> There's as much diversity on the teacher level, of their academic preparation and their professional development and their experience, as there are in their students. I mean, they're obviously at a higher level than their students, but there's a huge diversity there too. Some teachers are just incredible life-long learners. They will go to workshops and they will learn this and they will read articles and they'll show you things and they're so excited—and then others are just kind of, "Oh well, welcome, glad you're here today."
>
> I came to appreciate the importance of teachers, their dedication. And you read in the press all the time how ill-trained they are, and they don't care, and this and that. It's so much nonsense. I mean, all the teachers, at least that I worked with, were very dedicated, and it was depressing to see how under-supported they were.
>
> I got an incredible appreciation for the teachers in the Denver Public School system. Just to see what they're really up against in terms of administrative aspects, you know, resources, numbers of students, and also an incredible apathy among a large portion of those teachers. There were some who were clearly motivated, and those teachers are

> unfortunately less frequent than those who seem to have either burned out or don't seem to have the energy level that really is required to get the students to learn more.

The following speaker was particularly articulate about what she had learned about the challenges of K-12 science education. While she understood the benefits of active learning strategies in teaching science, she was able to recognize the constraints faced by teachers in implementing these. She could both candidly analyze the general failures of K-12 science education and draw on this understanding to improve her own particular work with college science students.

> I felt I got a great deal of education about what teachers of science at the high school level have to cope with. I really came to appreciate why there weren't more enrichment activities going on at the high school level. For example, we might say, "Oh, a good way to teach high school science would be to have multiple lab periods," or many hands-on activities, or anything, anything that is kind of above and beyond a traditional lecture or a traditional textbook reading or a traditional homework activity, those types of things. And I came to appreciate that it is difficult for the teacher at the schools that I worked at to do those types of activities, because they have *enormous* demands on their time, just dealing with the individual students and their academic difficulties, and the teachers also seem to have a great deal of administrative duties. They have routine grading, they teach a very large number of students in one day.
>
> (continuing): And that may not sound like a benefit to me, but I was really glad I learned about that, because now that I teach at the college level, I really have a sense of the range of backgrounds that the students may have come from… and what type of science education they may have had, and I can understand now a little bit more of what those challenges are for the teachers and why.
>
> (continuing): I guess I feel that… the experience I had suggests to me that the science education at the high school level is not that good. At least for the schools I was in, and I understand why that is. I don't think it's a failure of the teachers' abilities or enthusiasm. I think it's just them being overwhelmed with other details.

This understanding was particularly valuable to those considering a K-12 teaching career. We shall discuss this aspect later in more detail, of how such understanding helped Squad members to clarify their career options, but we will note here that this understanding also provided direct benefits. For example, one person developed a more sophisticated approach to interviews for teaching positions, and felt this had helped her land an ideal position.

> [When I interviewed for teaching jobs,] I knew better questions to ask. I mean, I didn't ask any of the right questions when I got my first job. And I knew better questions to ask. That actually played out some in my interviews for this position and others that I had.

Finally, one person felt that she did *not* gain understanding of educational issues at the time of her participation in the Science Squad. At that time, she did not find it necessary and appreciated that she was not burdened with this on top of her other duties.

> My understanding of issues and education has come since then. It might be different now, but at that point in the Science Squad we were just providing a break for teachers. We would bring in an activity that teachers might not have any resources to do in a

> classroom, or they might not have the background to discuss a particular subject, and we would do that for them. But at that time I didn't have to, I didn't *need* to have any understanding of benchmarks or standardized tests or any issues that teachers really had, outside of my visit to the classroom. And so all of that understanding of issues that teachers face came after I left the Science Squad. And I think that's probably the way it was set up. I mean, the Science Squad is set up as a teaching assistantship, so like teaching at the college level, your job is to deliver your material. I think that the staff in some ways is very careful to not overburden those teaching assistants any more than they have to.

For this speaker, the Science Squad provided an opportunity to learn about the education system but did not structure this learning in ways that did not seem productive to her at the time.

C. Personal Benefits

Science Squad members reported two main categories of personal benefits. These were quite important: one or more benefit from these categories was reported by 20 of the 24 members interviewed.

1. Confidence

The first type of personal benefit was confidence, a benefit that is personal in nature but, as discussed by the interviewees, carries over to professional situations. In the majority of cases, the gain was not simply improved self-esteem, but increased confidence in one's abilities to do the work—to do and teach science. Confidence was a strong category of personal gain, with 17 members reporting increased confidence—a number that is even more striking given the relatively high confidence that many members expressed from the outset, as in the following example.

> I was never that intimidated right from the beginning, as far as going into a classroom, but I'm sure just getting up in front of new groups all the time had to help my confidence overall.

The most common type of gain in confidence that members described was increased confidence in their ability to teach effectively. This included both confidence in their knowledge, and in their ability to communicate it well.

> I think maybe Science Squad had some impact on that—"Yes, I can teach a room full of high school students, I can do that." Actually, as a late-stage graduate student, you know more than they do.

As noted earlier, simply feeling more confident in getting up and speaking in front of others was important to a few.

> For me, definitely just confidence—I was very shy before I did Science Squad. The thought of standing up and talking to a room full of people just utterly terrified me. But going in the classroom and having to do it hour after hour after hour was absolutely what I needed. I never would have known that that's what I needed, until I did it, so that was good.

Increased confidence was a benefit not only after, but also during the Science Squad experience. As Squad members repeated their presentations and learned from them (a process that is discussed in more detail below), their confidence in their mastery of the material and their ability

to present it grew, they enjoyed their work more. They discovered that they were able to cope with bad days or regroup after an unexpected turn in the classroom discussion.

> The presentation skills definitely improved, and then also my confidence and also my enjoyment of it increased, partially because I didn't have to worry about the material…. So once I got that down, I enjoyed being able to focus more on the students. 'Cause in the first couple classes, you know, the students that would get it, I would kind of latch on to them—"Oh, they're getting it, and that's great." And I didn't really trust myself to slow down and look around and maybe wait for some kids that weren't getting it, 'cause I didn't want to go down a bad path and end up not knowing where to take them. So I think that my confidence, in terms of being able to challenge everyone, improved a lot.

> I gained confidence in my classroom ability. You know, a lot of times you're in class, you're teaching, it's not necessarily your best day. But I know from Science Squad—'cause I did it for an entire year, two days a week—that even on a bad day it can be good enough. It can be salvageable; you can still get the message across. If you're off [the] beat, like how to get back on track—how to make the ideas more clear when you're not thinking so clearly—coping with some of those things that occur when you're in the classroom.

Others gained confidence in their abilities as a scientist in their discipline.

> It gave me, I think, more confidence in seeing myself as an anthropologist rather than just a graduate student, because I was going out and representing my discipline, to so many, in so many different arenas.

> I had less laboratory experience than most of the people that they typically hire. …I did have some of the educational background and stuff that a lot of the other members didn't, but I did have less actual scientific lab experience. So it definitely helped me see myself as a scientist more than I had before. And polish those skills that I hadn't maybe done to the same extent.

These gains in confidence also had professional payoffs. For some, feeling confident and comfortable in the classroom opened new career considerations, while for others, their confidence in teaching settings enabled them to get the teaching job that they desired.

> It also made me much more comfortable with teaching in general, and so more interested in maybe teaching at the college level, which is something that I hadn't given as much thought to, before. So it actually made me much more comfortable getting up in front of a classroom of students.

> I was absolutely comfortable going into any teaching situation and being able to teach. I mean, just off the top of my head without being familiar with the students or the setup, because, again, that was something that I had been doing at that point for two or three months with Science Squad. Going into two or three classrooms a week, or different schools a week, and many individual classrooms on any given day. And simply introducing myself, becoming familiar very quickly with the room, and what the setup was, and then running with it from there. And so I think that gave me a lot of confidence going in and being able to teach and give presentations during my job interview.

For others, the payoff was more personal. The positive feedback they got from students and teachers, and their own sense of doing well at this job, contrasted with other graduate school experiences, where their self-esteem took more of a beating.

> Graduate school is a very humbling experience, after going through K-12 and being considered a good student and stuff, going through college and having success there. Suddenly I got to graduate school and I was pretty much told by everybody, in an indirect sense, "Why are you here?" And [Science Squad] was a really, really fun experience, because I was doing something that, *hey*, I was really, really good at it, you know?

2. Emotional satisfaction

The second main type of personal benefit was more strictly personal. As one speaker put it, "I got a lot of personal warm fuzzies, which are important, you know. They're important rewards." Fourteen of the 24 interviewees reported a gain of this "warm fuzzy" type, which we will call emotional satisfaction.

> There are a lot of benefits that are, like I said, intangible. You know, you're not going to be able to put it on your résumé and get a lot of mileage out of it, but the way that it impacts you on a personal level will forever change the way that you teach, and who you are in the world.

These rewards came from feeling that their work was important and meaningful. For the Science Squad members, the best way to gauge this was through feedback from their audience. We will discuss the content of this feedback in later sections on the outcomes for students and teachers of the program, but it is clear that the responses of students were important for giving the Squad members a sense of their impact. Similar to the teachers' descriptions, observed students becoming engaged and animated, asking questions, and getting drawn into science in a way that they had not before. This was rewarding to see.

> What makes it worthwhile is every once in awhile, or at least once a day, when a kid in the class will come up and talk to me and be really interested. I had brain models that they could pull apart and put back together again, and many of them just loved doing that, finding how the different parts went together and things like that.
>
> It was a big traveling experiment, and kids lit up. And kids would come up after class and they'd say "Oh, man… we've been in here for a year and we've never done three days of experiments just like that." They were like, "I can't believe science is so fun. I hated this until you." (laughs) And it's just stuff like that. Every now and then everybody needs some sort of positive feedback about what kind of a human being they are. (laughs)

Because many Science Squad members returned to the same school several times, perhaps with a different presentation, or in different years, many also had the rewarding experience of meeting students who recognized and remembered them.

> I was sort of a long-term Science Squad person, so I did see students a couple times a year and then even the following year, and so that was very rewarding for me.
>
> But then there are the few students who you can really connect with and that makes it all worthwhile. That's the real payback, the real reward, when you feel like, from a couple particular students. And you can also tell, even the ones who aren't physically giving you the signs that, "Yeah, this is interesting," or "I'm glad that you're here," but when you

> make a reappearance at some of these classrooms, four or five times during the year, there's kind of an excitement that picks up when you show up at the door, and they know something different is gonna happen. You know, "Here's that guy again from CU." And I think that's rewarding in itself, some recognition, just personal recognition, "Oh, here comes this guy, who's got some interesting things to show us," even though they're gonna pretend that they're not interested.

Feeling appreciated by students could reinforce members' enthusiasm for their work and their motivation to continue it.

> There was one group of student that sent me thank-you notes, thank-you cards, and it was amazing how much it brightened up my day. And it was the fact that, "Oh wow, these students..." And it was, I'm sure, largely at their teacher's prompting—they got class time—these are middle school classes—to go ahead and make up these notes. But they actually put into them what they thought was interesting about the presentation, and what was interesting about what they got to do in the Science Squad presentation. And that made a world of difference, you know, to my enthusiasm for doing the presentations, and for getting out there and talking to more kids.

Squad members also felt inspired by feeling that, through their work, they were part of a broader community of educators striving to improve education for disadvantaged students.

> The more intangible benefits are just the feel-good, you know, going into a classroom and making an impact on the students, and knowing that, feeling that, getting that direct feedback from a teacher, or from a student. Watching students get involved that didn't get involved last time you were in the classroom with them. Watching teachers—like for example, we had a teacher at an inner-city school in Denver who used to be a Ph.D. candidate at Colorado, who was a Science Squad member—he got his Ph.D., dropped out of the Ph.D. track and went to teach at this inner-city school—and seeing the way that he's touching his students' lives, you know, his alternative teaching style.
>
> I really got a lot out of interacting with teachers, especially teachers who, in Denver, you know, were very committed and were working in schools with really at-risk populations. And I learned a lot from those teachers. And the high school teachers and middle school teachers that I worked with—'cause I mainly did those levels of activities—were some of the most inspiring individuals that I had ever met.

In addition to feeling that their work was meaningful and important, members also took pleasure in their work. They enjoyed their interactions with teachers and students.

> What I enjoyed about it was, I enjoyed seeing the kids. I enjoyed that bit. It was fun to meet some of the different teachers, though obviously some were easier, and more fun to be with than others.
>
> I mean, I can't emphasize enough… I mean, when I would wake up in the morning, I would be like, "*Yeah*, I'm doing the Science Squad. I mean, this, this is great!"

They also enjoyed their collegial work with each other and with the BSI staff.

> One thing that's really great, that I got out of participating in the Science Squad, was just a real sense of camaraderie. The Science Squad is a team, and even though the individuals of that team are presenting classroom activities or teacher workshops within

> their own discipline, we really interacted quite a bit on a week-to-week basis. …And you know, you really got the sense that you were all in it together. Actually, it's funny, but on my desk, right in front of me right here, I have an award that I got when I was in the Science Squad. It's just a goofy award, but, you know, there's just a really great sense of humor that the team had, that the Hughes Initiative staff had. And there was just a lot of energy and synergy about that whole endeavor that was not the same as just teaching a course at the college level.

We discussed earlier how teaching for the Science Squad filled unmet needs for some of the participants, needs that were not met elsewhere in their graduate school experiences. Participants discussed how the program provided an intensive and meaningful teaching experience, a chance to explore teaching as a career, and an outlet for their desire to work for social justice. Likewise, the personal rewards from this work met personal needs that were not satisfied elsewhere. The work provided a change of pace from work in the research lab, but more importantly, it provided immediate and positive feedback that could be hard to come by in the university setting, where feedback on one's research might occur on a timescale of months or years, and where the academic culture offered criticism more often than praise.

> It was also a nice antidote to the lab, where everyone gets judged by their publications and their productivity. It's kind of nice to see the flip side of science where there's some excitement, and just kind of the awe.

> For me, you know, I need to get filled up… I need to go to the well, I need to get replenished, and I get that from doing outreach, getting feedback. When you're in a classroom with high school and middle school students, you get instant feedback. (laughs) If you're bad, they'll tell you! If you're good, they'll tell you! And so you know where you stand, and it's real different than the academic environment, which I'm sure you're familiar with.

> *Squad member*: It was very flattering! (laughs) I mean, when you do Science Squad, the teachers were so grateful and they said wonderful things! (laughs) It was like I had more compliments in my Science Squad year than I've ever had in my research. But research, you know, you don't expect that! (laughs) So, I mean, that was definitely nice.

> *Interviewer*: Compliments from?

> *Squad member*: Compliments from mostly from the teachers, because it was fun for the teachers. They do such a good job and often, you know, with not much help, and so I think for many of them it's very nice to have Science Squad people come. And so they're very complimentary about it, and some of them were very complimentary about some of the presentations, and others had very helpful comments to make about the presentations, which was good too. So it was definitely a different year.

The following speaker, one of the early Science Squad participants from his graduate department, addressed the linkage between these personal rewards and unmet needs. He also observed the same rewards for others who followed him as Science Squad members from the same department.

> There were a lot of people that, after me, kind of followed in the same path. And they would come out and they'd tell me, "Wow, that was awesome. That was so, just, gratifying. That was—it makes you feel good, you know?" It can make you feel real,

> real good. And at the same time… you can go through graduate [school] on a day-to-day basis and fail at this experiment, have this result turn out poorly, and then annoy your professor with that experiment.
>
> (laughs, and continues): But you work with the Science Squad, and all it takes is, you go in there and you see all these kids who are like "Oh, it's [So-and-so]! Awesome!" …And then they'll tell you, they'll say, "This is great! This is so much fun. I learned so much." And then they'll ask you questions. They'll say, "If I know this, if I wanted to go and study this in college, what would that be like?" And you just feel great, because you say, "Hey, somebody actually got something out of what I had to offer."
>
> (continues): So when it comes to, "What did I get out of this?"—just a whole lot of satisfaction. Both personally, 'cause I was happy to see kids smiling, to take a break from grad school, that kind of thing. And then also in addition to being happy, there is a—you can bang your head and get nothing done in graduate school for months and months at a time. And this is something that was great, 'cause every time you went in, it was instant gratification, as soon as the class was over.

We shall return to this very important topic of how the Science Squad met unmet needs of its presenters. The recurring appearance of this theme points to the important personal and professional consequences that a program such as the Science Squad can have for the particular group of graduate student participants that it attracts. However, it is clear from this discussion that the personal benefits of confidence and emotional satisfaction were important benefits for participants.

D. Career-Related Gains

Members reported several types of gains that were related to their future careers. These included concrete career benefits from their Science Squad work: enhancement of their portfolios that aided them in job-seeking, growth in sophisticated understanding of issues that enabled them to discriminate among job opportunities, improved professional networks that led to career opportunities, and gains in skills, knowledge, and attitudes that benefited their job performance. As we have already noted in earlier sections, many members cited ways in which particular skills and knowledge gained during their Science Squad tenure carried over into their later professional lives.

Members also reported positive effects on their personal career decision-making. These effects included new understanding about their career options: exposure to new types of careers that they had not been aware of, and better understanding of their own career interests, strengths, and weaknesses, and how those were compatible or not with particular careers. Many members reported that their Science Squad experience had influenced their career decision-making and their subsequent career path. For some, the Science Squad experience confirmed their existing career interests and gave them confidence in pursuing this career. For others, the experience clarified and sharpened their career choices. And for a few, the experience introduced an entirely new set of career options. Their Science Squad experience enabled them to make better decisions, drew them into a particular line of work, or helped them rule out another.

These gains were important: twenty-three members reported at least one of these career-related gains. Members had a lot to say about how these gains came about, and how their current work built on and drew upon their Science Squad experiences. As the interviewees elaborated on this

aspect of their experience, it became clear that the Science Squad experience had been a career turning point for some, and a career accelerator for others.

The interview data set contains a rich and nuanced body of observations on career issues. Much more than the other types of benefits discussed, the career-related benefits are sensitive to the Squad members' previous experience and career goals, and to the particular blend of choice and circumstance surrounding their later career decisions. Members' career outcomes are quite varied, yet show some common themes if we use a wide enough lens. There are subtle differences between, for example, whether the experience confirmed a path that the Squad member had already started down, refined the direction of a career path, or revealed a new path altogether. Thus, we must more closely examine the career trajectories of the Science Squad members—their initial career interests that influence their desire to participate in the Squad, their later career trajectories, and the variety of ways in which these trajectories were influenced by their Squad participation. Rather than analyze career benefits cursorily as part of this discussion, we have chosen in the preceding discussion to catalog the types of career benefits noted by members, but not to illustrate them here. A separate analysis, using different analytical strategies, is underway, and we will report separately on that analysis.

IV. Benefits to K-12 Students

In addition to the benefits to themselves from participating in the Science Squad, we asked the Science Squad members to describe the benefits to the K-12 students and teachers that they were serving. We will describe the student benefits first.

Science Squad members identified a variety of benefits to students. These benefits included both those that Science Squad members could observe directly, and those that they believed, expected, or hypothesized to stem from this program. Because the Science Squad presentations were, by design, short-term in scope, lasting one or two classroom sessions with any particular class, and the Science Squad members were not present in the classroom to observe and respond to students' later reactions, recall, or application of what they learned, most benefits to students are of the latter type, i.e. hypothesized rather than directly observed. However, Squad members did also report direct evidence of student benefits, including comments made by students in class, their observations of students' verbal and affective responses to their programs, follow-up reports such as thank-you notes and teacher comments, and contact from students after the program, sometimes even years later. In this analysis, we do not distinguish between these two types of benefits, but it will usually be clear to the reader from the quotations when speakers are drawing on direct observations.

Benefits to the K-12 students in their audience that were reported by the Squad members included:

- Science learning opportunities that were otherwise not available, including access to physical resources (lab equipment, samples), intellectual resources (the Squad member's expertise), and learning activities that used these effectively (mentioned by 20 members);
- Increased interest in science, which came about through the structure and effectiveness of the learning opportunities made available (22);
- Learning new scientific knowledge, including science concepts, scientific inquiry skills, and making connections between science and students' own lives (8);

- Changes in attitude, including attitudes about science and scientists, exposure to future education and career possibilities in science, confidence and empowerment, and individual interventions (24).

Each of these types of benefits to K-12 students is described below. Many of them overlap strongly with the benefits to students reported by teachers that were discussed in an earlier section.

A. New Science Learning Opportunities

Many Science Squad members cited the benefits to students from learning opportunities that were not otherwise available in their science classrooms. This included the materials and expertise brought to the classroom by the Squad members, and the learning activities they led that drew on these materials and their expertise.

> The resources they have would allow me to do some things for the students that they wouldn't have otherwise—bring in some materials that they wouldn't have from their school.
>
> I felt very much that that's not something they would have done if I had not been there. They would not have had the chance to actually see stomata under the microscope and things like that. So that's what I mean by variety. I felt like I did enrich the classroom in terms of providing activities they would not otherwise do.

Part of the value of these outside resources was their novelty. By being new and different, these resources made science class more exciting and stimulating than the everyday routine.

> …the access to resources that they just don't have. In a high school or a middle school classroom, in terms of just the laboratory equipment—in our case, some of the bones that we would take in. Just things that they absolutely can't get their hands on in a public school. So that, I think, is invaluable, 'cause they really get to see some of the really exciting things about science that you might not be able to come across, just as part of a normal K-12 curriculum.
>
> From what I've heard from the students themselves, a break from the monotony of the teacher (laughs). Materials that they normally would not have, and discussions at a depth greater than they would get from their teachers.
>
> I gave a presentation on viruses. And I actually brought in bacteria and viruses that would infect the bacteria, had the students mix it together and put 'em on a plate. And I brought back the plate with the plaques in them, so you could see where the viruses had destroyed the cells. Certainly on a very technical level, a teacher's gonna have a [darn] hard time pulling that off. And so it was really cool, it had cool factor. Students get to work with actual bacteria. (used with permission of the speaker)

More important than mere novelty, however, the materials enabled the Squad members to provide authentic science experiences for students. By working with real equipment and samples, students were able to do science, not just read about it.

> One of my major roles was bringing in concrete things to the classroom. Either slides that I had of unusual environments, or lab demonstrations, microscope preparations…. The schools that I worked in, I felt, would not—the students would not have seen live organisms. They would not have seen these type of preparations under the microscope.

> They would not have had their lessons enriched in that way. So they would have been exposed to the information, but they would have done very little hands-on work… without my participation.
>
> The kids have a level of sophistication… they do know that science might have some interesting applications, but they don't really ever get a chance to do it.
>
> And the kids really loved that presentation because it used real, what looked like real science things, you know, not pretend stuff. It was real stuff that they used in the clinics, and so some of them thought that was very cool and really enjoyed the presentation because they got to do real stuff. …So the [experiments] were cool because they were real science.

Learning from a real scientist gave the information extra gravity and placed emphasis on the scientific discovery process.

> …having someone new come in as maybe a scientific authority. You know, this is a scientist who's working in science, and this is what they're teaching, and it's kind of an insight into maybe what scientists are doing.
>
> And sometimes I think maybe the Science Squad people maybe have a little more authority than your biology teacher, you know? (laughs) You're with your biology teacher every day, and they have a certain amount of authority about what they know, but you've got a scientist coming in and telling you this, you know? That's pretty exciting that this scientist will come in, and teach you about DNA or water quality or forensic science.

Members also recognized that direct experience with real materials helped students in these age groups to learn better.

> I seem to remember, when I was in the Science Squad, the idea was these people would bring things to the school that the school did not have itself or were too expensive for the school to buy or whatever. And I think… having the students see instruments or see animals or see plants is really key.
>
> If they're talking about something that they're actually doing, or they actually have, or that they're intimately connected with, then I think that makes it seem a little bit more real. You're not just talking about, "Well, out there in the world there are people..." (laughs) Kids want things to be more immediate than that. At least that was certainly my impression. They responded best to things where they could actually see it.
>
> (continuing): So with the forensic botany, I was bringing in whole parts of plants that they were identifying. And you just tell them, "Well, these different kinds of plants are from different environments, different plant communities in Colorado. And we found different types of things on different suspects, and on our victims. And can we match up, hopefully, the victims to the suspects?" It was something that they could get their hands on. And it's something that they could walk out on the playground the same day and say "Oh, well, here's a plant, and I may not know what this one is, but I know I could figure out what it is by doing one of those dichotomous key things." (used with permission of the speaker)

As the following examples illustrate, some of the most powerful learning moments occurred when students were able to make specific, personal connections with the science discussed.

> I had a presentation on diabetes. And there was a girl who came up to me after class and she says, "You know, I'm a diabetic, and nobody has been able to explain to me what's going on with my disease like you have. I've never understood before." So I don't know who their doctor was, what clinic they were in, what school they had been in. But I was clearly able to have the effect of giving somebody the ability to understand their own disease, that they hadn't gotten before. Now that may not be so good for the future of science education, but it was good for an individual. (used with permission of the speaker)

These examples were rare, and could not be planned intentionally, but the possibility for them to arise came about due to the Squad members' attention to choosing interesting material and arranging engaging learning experiences, and their belief that science was and should be relevant to everyone. In the following example, a presenter helped a student see the benefits of animal testing of drugs without realizing that the student had direct personal experience with drug use.

> There was one kid in a very rough school. It was very interesting, because in the [presentation], you talk about experiments you do on animals, and he was really upset about animals being used and asked me why animals had to be used. And I said they need to be used because we need to know what to do if people take overdoses. You need to know how to treat them, so you need to know what the drugs do. And the teacher told me later that he had been hospitalized with an overdose for about two or three days, so he was really quiet after that. You just hope, you know, that every little bit goes in, even if they don't always respond to it. (used with permission of speaker)

Finally, in a few cases, the Squad member was able to provide a specific, additional enrichment opportunity for students, beyond the Science Squad program itself. For example, one member took some high school girls out in the field to help with her research the following summer. The students pursued the opportunity through their teacher, who helped facilitate the connection. In another case, the Squad member was invited by the teacher to return to the classroom to help students prepare for an advanced placement exam. These extra learning opportunities were not built into the program, but did result from student and teacher interest in the initial opportunity provided.

B. Enhanced Student Engagement and Interest in Science

An important benefit, reported by 22 members, that the Science Squad members perceived for students was engagement and interest. They felt that, although their visit was short, they were able to generate interest in science that would last beyond the day's presentation. As discussed earlier, the teachers' interviews corroborated this idea.

> It was nice to be able to get into some of those science classes and… be able to do some hands-on stuff, [activities] that were encouraging, were interesting for kids. And kind of piqued a spark in them or piqued an interest in them, to maybe learn it a little bit more, in the science area….
>
> Everybody teaches a little bit different, so the new person with a different teaching style and with a fun science activity, a fun hands-on, they're actually getting to do stuff, and learning from it. And hopefully piquing somebody's interest in maybe pursuing science,

> as a career, or, if not a career, maybe at least taking some more classes and see if they are still interested in it.

A variety of factors contributed to increased student interest: the presenter was new, someone different from the students' everyday teacher. The presentations were deliberately designed to be engaging, often novel, and to involve students in working with scientific materials and generating and discussing scientific ideas.

> One, that there is somebody novel coming in, so it's not their everyday teacher—a guest speaker, if you will. And just bringing in something from a science field that hopefully is interesting for them or fun for them—now, probably not for every single kid in there, but… to spark an interest with them doing an activity that's kind of fun, maybe encourage them to want to do more, learn a little bit more about it. Maybe they do a paper two weeks later on, something that's interesting to them in that unit. And maybe they choose to pursue that particular area because it was interesting for them, it was fun.

Some topics were inherently interesting to students. A personal connection of the speaker to the subject added to this interest.

> I really felt like I could go into the classroom and spark some interest… I would do things on primate behavior and primate evolution and human evolution and spark some interest in things that they hadn't really thought about before, and come in with a very enthusiastic presence and spark some interest in science that way. And also being a young woman who goes out and walks through the forest with primates—that's not something that they would be exposed to either. I feel like that was engaging to them. Many of them had heard of Jane Goodall, and many classrooms had gone to see her speak at the museum in Denver, and so they had that connection too. And you know, seeing somebody like Jane Goodall who's a little bit more removed, and then seeing this younger woman who is actually doing that as well, I did feel like I had an impact that way. (used with permission of the speaker)

> I had altered-vision things, where I had the glasses that shift the world, shift everything 15 degrees to the right or left and then you have to throw beanbags. So they really show you how well your brain adapts to different circumstances. They happen also to be the glasses that the police use to simulate being drunk. Or if they were good and if they finished the whole class in time, then they could try and walk along a line with the glasses and it was just always really fun. So there were lots of fun things in the classes, but hopefully it got across a serious point about what the brain does and how it works and how to treat it well. That was always, that was the aim in all of them, I think, to show them how cool their brains are. And to emphasize how they need to be taken care of! (used with permission of the speaker)

The interactive pedagogy built into the Science Squad presentations was also important in engaging students. This included using hands-on, minds-on activities that required students to think for themselves, and offering a variety of types of activities throughout the lesson.

> My impression was that it was a very positive experience for these children, because it was very hands-on, and they were required to participate in ways that they aren't normally participating in their daily school activities. You had to actually go through, you had to experience what they were learning about. They couldn't just sit there and

> read the book or be taught something up on the board. They actually had to do it in order to see what the results were. So it's the hands-on and—well, my impression is that they didn't have that opportunity as much in their day-to-day activities, and so it was more of a discovery process for them. And when they found the end, they're like "Wow!" Or just really impressed that *they* could figure it out. And so they were becoming active in their own environment, to discover things.
>
> We designed them specifically to try to engage students who had different learning skills and different learning styles. So we had them doing things that were desk-based and interactive and kind of role-playing, and then reflecting on that and making interpretations as a group in the middle of the role-playing exercise. And so we had, on several occasions, the teachers comment on the fact that the students were engaged in many different ways and that all of the students in the classroom benefited from that, from that variety of techniques.

Moreover, with school-age students, simply having class with a new person, different from their regular science teacher, made class more interesting. The teachers also articulated the same idea. Not only did it offer a change of pace, but things were less predictable, and the students more alert and intrigued.

> …seeing a level of enthusiasm from somebody else than the person they see every day. I think that any time you just get some new chemistry going in the classroom, it's helpful. And you bring somebody in from the outside, somebody from a college, a university, that's exciting, I think, to the students, so I think there's a level of interest that picks up.
>
> One thing that may not be as emphasized as it should is, no matter how much a kid likes his or her mom or dad or teacher, there comes a point where you don't want to listen to them any more, you know? So one thing it offers them is a break—where it's not someone coming in juggling or anything like that, it's someone who comes in to get work done—but it's a break. And it's just great, 'cause you'll sit there and, with very few exceptions, you'll notice the people *are* paying more attention. They are kind of curious, 'cause who *is* this person, you know? And they're not gonna act up, because they don't know how the person's gonna respond yet. They haven't figured them out. (laughs) So, the person, him- or herself, the presenter, is in a lot of ways an attraction from the get-go.

In fact, some Squad members felt that their classroom visits had more impact than would a teacher who presented the same information or activity. Their expertise was assumed to be weightier, and the presentation more profound than if it had come from the regular teacher.

> I had a different blanket of authority than the teachers do. I didn't have the responsibilities for managing the kids in the way that the classroom teacher does. Classroom teachers can do that lab too and maybe have the same effect with it, I don't really know—but there was something special about coming in from the outside.

We will discuss later the disadvantages of Squad members' not getting to know the students individually, but occasionally, not knowing the students already was an advantage. It enabled Squad members to hold high expectations of everyone, and to engage students who normally assumed a less productive role in the classroom. Sometimes this surprised both the student and everyone else, as in the following example.

> There was one girl—I remember her being as a leader of her group in the classroom, but maybe a disruptive leader. And, again, because I didn't know her before coming into the classroom, I called upon her to be the leader of her group and really expected her to get something out of it. And I think that really shocked a lot of students in the class. They were surprised that she was involved. And I remember her, later, maybe in an offhand comment, just saying, "This is pretty cool," or something like that. Which, if you are a senior in high school or a junior in high school, you don't really admit that kind of stuff readily, because, you know, that's very embarrassing if you're in high school.

In sum, most Science Squad members agreed that a major benefit to students of the program was increased interest in science. Factors that contributed to engaging students, in their view, were the choice of relevant topics, engaging activities that incorporated effective learning strategies for a variety of learners, and the novelty of a guest presenter with special expertise.

C. Understanding of Science: Concepts, Skills, and Connections

Evidence of student learning was harder for Science Squad members to gather, because they were not in the classroom after the presentation to observe changes in students' understanding in daily work or on assessments. For that reason, the teacher interviews provide better insight on this topic. However, eight of the 24 interviewees cited gains in student understanding of science as a benefit of the Science Squad program. These gains included understanding important scientific concepts, as in the following example.

> My favorite story is that I returned for a second visit to a Denver school that I had been to in the fall, to work with a different teacher's classes actually, with a different lab. I had done the genotyping lab with them, with one set of students in the fall, and then was back at the school, and one kid came up to me in the hallway and said, "Are you the one who was doing that DNA fingerprinting lab?" And I said, "Well, yes." And she talked and talked and talked. Apparently she hadn't been in that class, but she and her friends had been talking about it at lunch…. She had so many questions she wanted to ask—and that's just *huge*. That high school kids were talking science on their own time and not because they had to, and they'd gotten most of the details right. They'd learned real stuff from that other kid.

Members also reported seeing students develop scientific skills, such as collaboration, critical thinking, and problem-solving skills.

> It depends on what they're used to in their classroom, but sometimes with these activities they had to work in groups…. You had to facilitate those groups, but they had to learn they had to work together on things.
>
> Sometimes analyzing, if they got results back from a lab, sometimes looking at the results collectively as a class and trying to interpret them. I guess maybe critical thinking skills, trying to think a little bit more.
>
> I like to share that with students. That, "Yeah, it's not all the machines, really, it's not—it's about your way of thinking, and about eliminating possibilities."

Also important were the connections between science and everyday life that students were able to make.

> I think we educated them about pertinent, germane scientific issues going on today. Like there's some genetics work that was done in some of the classes, some genetic testing type stuff, like, "What do you do if this disease runs in your family? You could get a genetic test, and this is how it works." Education about air pollution in the Denver area, which is a big issue. Things like that.
>
> Depending on what the activity is, I think they sometimes maybe get a better sense of science and its role in society. Maybe they understand a little bit more about themselves and how they fit into science. You know, even if they don't want to go *into* science as a career, at least maybe they understand a little bit more in terms of understanding the headlines and news stories and things that they might hear.
>
> To me, what they really got out of it was that there was science in their lives. That there was science that was actually not that far away from them. I think people see, and kids too, see stuff on the news about whatever cutting-edge science, whatever's sexy enough to show on TV, and that's always pretty far removed from what you can see, feel, touch, smell, taste, outside your door.

Students benefited as well from seeing how science connected to their other classes.

> And I think some of our activities in Science Squad maybe showed students that these things were important and useful in the real world, and maybe *why* taking chemistry class helps you understand biology. I know a number of the programs involve some math, and some analysis, and maybe they might start to see why taking these courses and classes at the high school level might be important, and some connections between classes—like, it's not *just* your science class. Even being able to communicate and write a good sentence, communicating an idea, you know—"Why do I have to write? This is a science class." Well, scientists need to communicate. So maybe some of those connections that aren't always obvious to students at that level.

In addition to specific science concepts, both scientific investigation skills and an understanding of how science works and its role in society are specified in state and national science standards as learning goals for all students. Thus, while gains in science understanding were not the largest group of student benefits reported by either Squad members or teachers, the gains that were reported were well aligned with community-sanctioned science learning goals for students.

D. Changes in Attitude: New Views of Science and Scientists

Science Squad members described a variety of changes in attitude that they believed their classroom programs helped to generate in students. One such change was breaking down students' stereotypes of science and of scientists. As noted above, the success of the Science Squad in giving engaging presentations that drew students' interest was also important in changing their preconceived notions about science.

> … that science isn't just watching lab rats in a maze, that it's also this really cool stuff about nutrition, and all really neat stuff that they get to see.
>
> Some of the times I felt most successful as a Science Squad member were when I felt like I managed to convince kids that science was cool. You know, because it's so often perceived as nerdy and very un-cool. Not many people think of science as cool… and then when the really cool kid in the class comes up after you [present] and says, "Oh wow, that was cool!" you really feel like you've accomplished something. You've made

> this something acceptable, socially acceptable to the high school students, so that it's okay to participate in it and have fun participating in it… and, yeah, to me that's a huge success.

Squad members also saw changes in students' ideas about who could be a scientist.

> It made me aware that a lot of kids have a really stereotypical image of what a scientist is. And so being exposed to an actual scientist, or somebody that's involved in science, I think broadened their views a little bit about what it meant to do science. And maybe didn't make them think in such a small box. [That] lots of people, in lots of different places, can do science. And that science covers a really broad, broad variety of topics that they might not have thought about before.

The most powerful force in changing these ideas was the Science Squad member him or herself. As we noted earlier, many Squad members were women, and some were minorities. As teachers noted, they were young and fun, compared with students' stereotypes about scientists. Squad members were aware that they dispelled some stereotypes simply by showing up—by being themselves and by making science accessible and fun.

> Sometimes it's hard to know exactly the impact you're having at any moment, especially because you see these kids for an hour, their class period. But I guess I'd like to think that being a woman up there, who did science and liked science, could at least maybe open their eyes to that being a possibility. And they sort of seemed interested. I mean, I think that they learned something. And hopefully learned that science could be fun, and not all something frightening that they couldn't understand.
>
> I think that if an ethnic group can see that there's an example of someone they know who's close and fun and happy and everything, who did a particular thing, they might say "Hey, maybe you're not gonna turn into a robot if you go into science." Or "Maybe you can be a teacher and still have fun and not have everyone hate you." (laughs) Things like that.
>
> I mean, being an engineer and being a woman is a little bit different, and they had a lot of female students who might look differently at engineering, or be encouraged—who knows? …Here's a woman, she's an engineer, and this is what she does and how she behaves and how she speaks with you.
>
> I don't think that a lot of kids were surprised, 'cause I don't think we're at the point where it's a complete novelty that women are strong in academics and in science. But I think it's still really nice to reinforce and to kind of make it more real, by bringing it close to the students, so they aren't just aware of it at a distance, but wow, they really interacted with one [a woman scientist], and, "Hey, they're human too."

Some members made a point to insert their own stories of becoming a scientist into their presentations, and, as we have noted, many teachers also made a point to ask them to do so. They looked for ways to enable students to identify with them, through their personal and family background, schooling, or cultural background.

> I think definitely, my experience growing up in … a smaller community, people don't oftentimes leave and go and do research [overseas], or whatever. So I think having somebody who's sort of like them come back and say, "Look, I did this, and this," it sort of opens it up. 'Cause otherwise you get used to your little narrow world of, go to high

> school, and maybe go to college, stay here and get married. You don't really see a lot of other possibilities role-modeled for you.
>
> They're really excited to figure out who you are, and what your background is in. And in my case, having also been a graduate of [a local school], that was kind of neat to be able to go back and say, "I went to your high school, I graduated from here, and now I'm doing this."
>
> I did a lot of talking with those high school students from my own personal perspective and just pulled the story of a female scientist in school making child-rearing decisions and did that spiel in my introduction, just so they could hear a different version of the story. …The high school students are really too young to be thinking about that, but I guess I was hoping it would plant the seed in somebody's head, that they would at least have a role model of somebody who had tried to do this….
>
> The fact that I can say stupid little Spanish phrases and do stuff like that, it will always make somebody feel a little bit closer towards possibly, for example, becoming a scientist, in this case, or becoming a teacher, or things like that. It was never an issue in terms of the content or the subject or anything like that. I never really brought it up. But, there'd be kids who asked, "Well, tell me about your family and stuff." And, you know, when you talk about eating tortillas and beans and rice and stuff, they're like "Oh, I know how to make that, but I like to add these ingredients." (laughs)

In addition to serving as role models themselves, Science Squad members also drew others into this role. Sometimes they used students in expert roles, or brought in other scientists with whom the students could identify.

> There was one gal who had seen this presentation before, and she's Hispanic. And this was a pseudo-bilingual class. And she said, "Oh, I remember you, you did this…", you know, and I remembered her after she said that, and I said, "Great, you can be my assistant." And so, I was using overheads and stuff like that, and she remembered the vocabulary words… and she was terrific, she remembered enough that she helped with that. And then she participated in the activity and kind of guided her group a little bit better than some of the other groups. …It was very, very neat to see her again. And she just jumped right up [when] I said, "Oh, you can be my assistant." I didn't know what she would do, and she was like, "Oh, okay!" …And so, when the more Spanish-speaking students would have an issue with a word or a question, she was able to help me translate.
>
> My best day in the classroom was when I was at… an English as a Second Language class, and I was teaching [a certain topic] that day. And I brought a friend of mine from the University of Colorado who's from Mexico to the classroom with me, 'cause I don't speak Spanish, and I just thought it would be kind of a neat thing to do, and she was doing research on [the same topic]. So I just gave her the information, and I let her do the class. Well, she's sort of fair-skinned, and her eyes are kind of light, and so, you know, she walked in and they didn't think anything of it. And she immediately started to speak Spanish—not just ESL Spanish, but Spanish in a dialect from Mexico, because she's from Mexico where most of these students are from. They cheered! They responded, and that was the ultimate example for me of a role model. This woman came from where they're from in Mexico, and she's getting her Ph.D. …and they lived in the same part of the country, in the same sort of communities, and had the same sort of

> experiences…. So that was the best day. And it didn't involve me really at all, (laughs) except that I sat in the back and watched them respond to her, and engage with her. And at the end of class all of the girls lined up to tell her what they were going to do with their lives. It was just—that was the most amazing.

Seeing that women and members of other underrepresented groups could be scientists was felt to be important for the students who were also members of those groups. Seeing role models could enable these students to think of themselves as future scientists. However, Squad members—like the teachers—thought it was just as important for those in the majority group to see people who could expand their definition of who could be a scientist.

> I think that the girls in particular really enjoy Science Squad, because most of the presenters are women. And I think that a lot of the ones that are maybe thinking about science for later on, just think it's really neat to see somebody, a female, doing something that they might want to do later on. But I also think a lot of the boys think it's really interesting that it's all these girl scientists that come in. It might change their image of who a scientist is, a little bit.

> The idea of promoting, especially women, going into scientific fields—that stereotype isn't necessarily limited to the inner-city type schools, by any means. I think that young women in even the private schools get that message at some point, and don't tend to go into math and science, so I think it's equally valuable for promoting women in the sciences for any of the students.

> I always thought that I made a difference in the sense that—you know, we always wrote down how many minority students we had met, 'cause that was part of the goals of the project. But I always had written in my reports, "That's fine and dandy, however it's also very important too, for these kids…" And I want to go to see kids, schools where there are Anglo students as well as minority students, so they know, first, the Anglo students know, "Look, the minority people can do it too." 'Cause I'm their teacher now. And then also the minority kids can see, "Oh, look, he did it, he did it!" But I mean that was always the push that I always told them, "Well, why don't you send me to some schools that are primarily Anglo, so they know that we can do it also?" (used with permission of the speaker)

We shall discuss in more detail the issue of what benefits can accrue from limited-time interventions such as the Science Squad, but it is worth noting now that this area was one where Squad members had seen that a single visit could make a noticeable impact on students.

> Sometimes the teacher has all the students write thank-you notes, right? So you get this big packet of thank-you notes and typically 99% of them say "Thanks for coming to the class, it was fun." But, you know, I do typically read all of them, and I had been to this seventh-grade class and it was actually in Boulder. And there was one black kid in the class. It was a seventh-grade class… and I got this note from him, amongst all the generic thank-you notes. He wrote that he'd thought it had been really meaningful to him to see someone who was a woman and scientist, because, he says, "I know not a lot of scientists are women, and I think it's really great that you're in science." And he said, "As a black student, I feel out of place a lot, and you must feel out of place, too," and there was this sort of sense of identifying with that. So that was really cool.

Our teacher interviewees also discussed the importance of a variety of science role models for students, and emphasized this as a benefit of the Science Squad for students and an intentional goal of theirs in choosing to use the Squad.

E. Exposure to Opportunities for Education and Careers in Science

In addition to breaking down stereotypes of science and scientists, Science Squad members perceived that their work introduced students to the possibility of a career in science. Squad members often discussed their own career and educational paths with students. They could explain to students that it was necessary to attend college to pursue science and discuss how to prepare for college academically and practically.

> There was a real career aspect to it, so after the presentation was over in some of the longer class periods, students would ask questions about what my career was like at different points. …One girl said, "Did you ever feel discriminated against as a woman?" So there were all sorts of questions that would come up. "How long did you stay in school? How did you manage to live [overseas]?" Just different options that are available to students that I don't think they would've been aware of otherwise, from a career standpoint. And then if they asked, "What do I need to do?" you know, it would be, "Well, go to college."
>
> I think that having representatives from the university actually go out and be in the classroom helps students realize that that's a potential route for them to take—to go to the university themselves. Especially when we went to places like the inner city schools in Denver. …They all wanted to ask me about the University of Colorado. They wanted to know if I went to football games (laughs) and what it was like being at the university. And so it was actually novel for them to actually talk to someone who was a student at a university or the University of Colorado in Boulder.

Squad members could relate students' interest in the classroom experience to future opportunities, such as a summer job in science, or combining a science career with a family.

> They were interested in, certainly, when we did move on to the career options—a lot of students were really interested. "What was it like as a woman?" And they were thinking about what they could do with this information. So I think that, yes, from my personal instances that I could cite, some individuals were touched by the material in a way that furthered their interest in science.
>
> I also remember … some students coming up to me after, and, "How could I do a summer job in science? I never thought I liked science and this presentation was really cool. Could I do something like this this summer?" I mean, I think they liked [the topic], but they were interested enough to want to stay after class, talk to me about it.

Many of the teachers specifically asked the Squad members to address their career and educational path as part of the presentation.

> Often, with the grade 11 and 12 classes, the teachers would ask us to talk about what it's like to be, first of all, a student at the university. What's expected of students at a university? What is it like to go to a university to study? They would ask us to talk about our career aspirations—were we going to become a research scientist or a professor? And what sort of steps did it take to go from being a high school student to becoming a professor at a university? What sort of opportunities had that allowed us in our lives?

Squad members felt they could provide students with both encouragement and realistic details about how to go about pursuing a scientific education and career. They were able to point out a variety of scientific career paths, not only those involving extensive schooling.

> I think seeing a successful young woman is always inspiring or can be inspiring to some of the students. And just discussing what the options… I think the students, especially in the lower-resource schools, just aren't even aware of what their options are in terms of what kind of education does it take to get a certain job. And so just kind of helping to get a more realistic view on things, that you don't need a Ph.D. to do *everything* in science. These are the kind of jobs you can get after a college degree and… so I think that helped them out a lot, 'cause I'm not sure the teachers were even able to provide that kind of information.

Squad members felt that students at some of the targeted schools benefited in particular from these career discussions, because they may not have had as much exposure to people with a university education or with a science degree.

> Potentially, lower-income female Sasha is going to see, in my case, a female up there in the sciences, enjoying what I'm doing and providing for them an opportunity that maybe she's enjoying as well. Saying, "Hey! Maybe I can do this!" …and maybe, you know, maybe up until that point, I'm completely generalizing here, but maybe up to that point she had always heard through her social group or her family or her culture or whatever, maybe not much about science, period. Maybe it's not even an option for them. Or maybe they just haven't thought about pursuing any kind of interest or career, even further classes or a degree in a science field. And so I think maybe a role model might be one benefit [for] our target audience.

They were concerned that the teachers and counselors in these schools may not be encouraging students sufficiently or giving them exposure to a broad array of career options.

> A lot of students have said, "Oh, I never thought about doing this." And I would always ask, "Okay, how many of you are interested in doing this, or doing that? Why? Why not?" And you'd be surprised at some of the answers. A lot of times their counselors tell them they can't!

To further enhance students' exposure to career options, some suggested that the Squad members carry more career information with them to provide to students. One member suggested a brochure outlining the steps students should follow if they are interested in a career in science, from the types of classes to take in high school to the application process, financial aid, college life, and career options. Other suggestions to enhance the career exposure for students are made in the last section of this report, with other advice from Squad members.

F. Gains in Confidence and Empowerment

In addition to altered views of science and scientists and new ideas about career and education paths in science, Science Squad members believed that their work helped students gain confidence in their own abilities to do science or to become a scientist. Students' enjoyment and success in a fun and interesting science activity, combined with new views of who could be a scientist and how to get there, empowered students to visualize themselves as scientists, they argued.

> I think keeping them focused on the task at hand, but showing that that science can be fun, it can be something that they can do well at, and that they can succeed with. Just a few skills can take them a long way. They can problem-solve on their own.
>
> Oh, I think it's the idea of possibility for some of them. That there are other things that they can do, that they could be good at. I don't think many of those students have the opportunity to do hands-on stuff a lot. I mean, we all know that there are several different ways to learn, and to teach, and I think some of the students that maybe aren't the good, studious, read-and-learn kind of students, [but] who are able to excel in some of the hands-on experiments, gain some confidence in themselves.
>
> I mean, any time a student gets to do an experiment, then they realize, "Oh wow, I did that, I did that experiment. I could actually do this—it's plausible for me to be a scientist." Now whether they really *want* to be one in the end or not is going to be pretty variable. But I felt like that's what I was doing in Science Squad more than anything. And especially for kids in disadvantaged areas, was this notion that, "Yeah, you can do this. It's not something just for people with advanced degrees, you can actually do science at home. You can actually make observations, and you can tell things." And it was sort of this idea of, "Science is really all about figuring out mysteries, figuring things out, uncovering information, uncovering facts, and you can do it this way."

As these quotations highlight, a crucial element in students' gaining confidence was doing science in an authentic manner, by observing, solving problems, and giving explanations. Thus the same factors that engaged students' interest and helped them learn science, also boosted their confidence and enabled them to visualize themselves as scientists.

G. Individual Intervention by Caring Adults

Science Squad members reported a number of examples in which they felt they had had a specific positive impact on an individual student. A common thread in these examples was that the Squad members, as visiting adults, took the students seriously and addressed them as unique individuals.

> Having students learn science and having students like science was definitely part of the experience, but if I had to boil it down, it was also just... in some ways, just being present enough in some classrooms where you could remember someone's name. And, you know, in some of these schools in Denver, these are students that were at risk of dropping out or getting expelled, and it was just an incredible impact that you could make with these students if you just remembered their name—if you went in and said, "Hey, I'm so glad to see you, Micah," or whatever that person's name was. I never realized how much of a positive impact adults who cared about whether that student was there or not, how much of an impact that could really make in a positive way.

Because the Science Squad members were adults from "outside," these instances could have an impact on students beyond what might be expected of a short-term encounter. These impacts were not limited to scientific topics, either. In the following example, the Squad member intervened with a student whose behavior she found unacceptable.

> I was in a rural school, and one of the boys was just being a jerk and saying rude and inappropriate things in the classroom to the girls, and always when the teacher couldn't hear him. But I happened to pick up on one of them, and there I am an adult female

> scientist, and I took the kid out in the hallway, and I told him he wasn't gonna do that anymore, at least not while I was there. And that one was actually close enough to my house that I saw that kid—he was working at Wal-Mart, I don't know, six months later. And his little eyes dropped. And I just happened to run into the teacher one time later too, and she said, "I dunno what you said to that kid, but it changed stuff."

These stories of individual impact remind us that, in most cases, Science Squad members did *not* have a way to follow-up and find out how their work might have affected students. Thus, the few glimpses they did gain into how their work was important to students were especially meaningful to them.

> The quiet students who you don't necessarily always hear from. Or sometimes they come after you, after everyone has left the classroom and say, (softens voice) "Thanks. I really liked that. That was cool!" and then they run out.

> One day last year I actually had this young man knock on my door. And it was this young Mexican-American man and he walked in and he said, "Oh," he said, "I kept meaning to drop by your office…." He said, "I remember you from when you came and presented in my high school class at West High School in Denver… and, you know, I really enjoyed that presentation. And now I'm a student here at CU and I'm a junior and I'm majoring in science, and just wanted to drop by and say hi." So, you know, it's really nice to see that. To see that people that remembered that event or remembered that exposure to that event enough that they fixed to stop by and say hello….

> In fact, two of those students that I met when I was actually in the schools are here now, and they came here because... they called me. I had … left my number and, "If you guys want to come to college, you have to call me, so we can see what we can do." And several did, and two actually made it. And I think one graduated already.

From these few, often coincidental encounters with students who had benefited, Science Squad members were able to feel confident that, by extension, other students had also benefited, even if they did not have direct knowledge of other possible cases.

> I mean, you never know when the little thing you say in passing changes a student's life forever. You never know, unless you see them years later and you're like, "Oh, yeah". And they're like, "Well, you know, I heard you talk about that thing and now I'm doing it". You never know that. And that's what's neat about that kind of experience—the ability or the possibility to influence somebody, and you don't even know.

These examples of student benefit are thus tied to emotional satisfaction, a benefit for the Science Squad members that we have already discussed.

V. Benefits to K-12 Teachers

As we have discussed, teachers saw benefits to themselves as well as to their students. Likewise, Science Squad members saw benefits from the program to the teachers, and these were of two types—benefits to teachers' work, through the benefits to their students, and benefits directly to teachers themselves.

First, the benefits to students that we have discussed are also, in some sense, benefits to teachers, because they help the teachers do their work of teaching science and helping students learn. What teachers could offer to students was enhanced by new learning opportunities for their

students that they could not provide otherwise and that were effective through their use of inquiry-based pedagogies. Teachers were glad to see their students get excited about science and discover new possibilities. The following quotations illustrate ways in which the Science Squad members saw benefit to teachers through the benefits to their students.

> I guess from the teacher/student dynamic perspective, it's really engaging to the students, [to] have someone come in who is expert in the field and involve them in participating in an exercise. And, of course, the teachers are not experts in every field, that's just not physically possible. So I think from that perspective, they get the benefit. I mean, they benefit, as do their students by having us coming in as experts and contribute to their program. So I guess that expertise is something of a benefit to them.

> I think it's an opportunity for some of them to be able to let their students do something more inquiry-based… because with a classroom of thirty kids, it's really hard to do open inquiry ah, because it requires so much one-on-one interaction, or the interaction of a teacher with a small group brainstorming with them or helping to facilitate their thought process. So with one adult to thirty kids, that's really tough, but if you can bring in one other person it makes it all that... more easy. And if that person's bringing in some structure and bringing in all the stuff and the equipment and… knows how to make this system work and has done it already fifty times that school year, then it's all that much easier.

Teachers' first-hand reports of these benefits to their students are, of course, discussed in detail in the analysis of the teacher interview data.

However, the teachers in the classrooms visited by Science Squad members were as important an audience as the students, in the minds of some Squad members, because it was through teachers that their work would have lasting impact.

> I always felt like a bunch of my Science Squad work was outreach to teachers, as opposed to outreach to students. And that things that we could do to show them other ways of doing science and being scientists, I always hoped would come across in their continued interaction with their students in their classes. That was at least part of my thinking in making that a very public statement in that setting.

Thus, in addition to the benefits that teachers derived from seeing their students' benefit, teachers gained a separate set of benefits, as seen by Science Squad members through their interactions with teachers. These benefits are discussed in detail below, and they include:

- Gains in teachers' understanding of science topics and ways to teach them effectively (mentioned by 24 members);
- A break or change of pace from teaching (9);
- A variety of emotional benefits, including being supported and validated by support from the program and interaction with colleagues, having fun, and getting help with handling politically sensitive topics (6).

A. Improved Understanding of Science Topics and How to Teach Them

The major benefit to teachers, as seen by Science Squad members, was new learning. This included both gaining a better understanding of science topics and gathering new ideas and resources for how to teach them. Teachers benefited when the Science Squad members shared

their scientific expertise, teaching materials and resources. The Science Squad visit also provided an opportunity for collegial learning by taking the lead in their class and allowing the teachers to observe and participate. All 24 interviewees mentioned one or more of these learning gains for teachers, which are discussed in detail below.

Because the Squad members had more interaction with teachers than students, their reports of teacher benefits are more often directly observed, and less often hypothesized, than were their reports of student benefits. Evidence of teacher benefits that was discussed by Squad members included direct statements by teachers, follow-up questions or requests from teachers, and interaction with teachers at workshops. They observed teacher behavior before and during their presentation, and they saw how rapidly their calendars filled with teacher requests for their programs.

One type of teacher learning was, just as for the students, an improved understanding of certain science topics. This included better understanding of technical or cutting-edge topics, and new applications of scientific concepts. As the teachers described, they are responsible for knowing a wide-breadth of material covered in their curriculum, so often do not have in-depth knowledge of specific areas.

> With teachers, I feel like definitely it's more my role just to help them stay current in what's happening in science. The recent advances in science, and to provide them as many tools as I can, to teach those concepts in the classroom.

> There were some cases where I taught content to teachers in that setting. One time when I walked in, I was just teaching the last half of the classes and got there before my time, and the teacher was just making a mess of X-linked inheritance, a total mess of X-linked inheritance. And I mean, you can't stop him in class, and of course I didn't, but between classes, I did. I said to him, "You know, you look like you were having a little trouble there. Do you want me to run you through it?" and he said okay, and I did. And he actually had me teach it to that next class that was coming right in, and then I watched him teach it to his next class after lunch.

Sometimes Squad members provided technical advice on how to make particular experiments work better.

> I do remember telling some teachers specific information that that they did not know. For example one teacher was growing some plants, and they were not doing very well, and I was able to make some suggestions that helped them grow better—just in terms of where they were growing them and how they were caring for the plants.

While some topics were difficult scientifically, others, such as human evolution, were difficult in other ways. A better understanding of such topics could provide teachers with both new teaching approaches to sensitive topics and greater confidence in handling issues surrounding such topics, if they arose.

> I think in our case it was even new content, because given that anthropology is not necessarily one of the top topics often included in the K-12 science curriculum, I think there was a ton of new content. And particularly because human evolution can be a little bit of a testy topic that some teachers aren't sure how to negotiate, I think they thought it was very helpful for us give an idea of how to structure some of those lessons, and how to deal with something that might be a little touchy for some students. Because,

> depending on your background, you may have never taken an anthropology course, and so information on non-human primates or on human evolution or on the evolution of taste perception or whatever—I think there really was some new content.

In addition to learning new content, teachers could see new approaches to familiar content. Sometimes they gained specific ideas for classroom activities to use again, and other times simply a new perspective.

> They can also see how another person presents some concepts that they may be familiar with teaching in the past, like scientific method, or they may not be, like gel electrophoresis. So they get to learn new things too, another person's presentation style or new concepts, experiments and activities.

> …maybe just somebody else's opinion or a take on an issue. Some of the things I was talking about, or how I chose to demonstrate some kind of scientific point, or something. I don't know that they would replicate the things I did.

Squad members noticed teachers both absorbing the information from their presentations and paying attention to how the information was presented, as they participated with the students in the activities. Learning occurred through teachers' hands-on involvement, just as it did for the students.

> A lot of occasions, teachers were definitely kind of going around and helping the students, but like, participating on their own and learning the methods.

> Probably in over half of the classrooms that I went into, the teachers ended up participating in the activities. So they would take the information from what I did, and to try to recreate that for themselves, or if they want, participate with me. They don't have to; they usually hang out in the classroom just to do discipline. But they would actually get involved in learning, and get excited about the information that was being presented.

> But the vast majority of teachers were actually pretty involved in the project. They were getting, on the very surface of it, at least the same thing that the kids were getting. They were getting some science, and they were doing some science, and you could kind of see the gears turning.

Moreover, just as the Science Squad members benefited from observing teachers and working with them as colleagues in co-teaching the lessons, teachers benefited from the same opportunity to observe another teacher in action, working with students they already knew well.

> In addition to resources, I think that I did bring in new ideas for presenting material that they might not have thought of. So I think that some, not all, teachers use the visitors from the Science Squad for a time where they could kind of step back and maybe observe someone else interacting with their students and get new ideas about how that worked. I remember a few teachers telling me that they really enjoyed having a new perspective after having Science Squad members visit them.

> Let someone else do the teaching and—'cause I had a few teachers that said that it was fun for them to see how some of their students were responding, and they could read that it was a different style of teaching or a different environment for the students. So I certainly got the impression that some of the teachers liked that different perspective.

> Most of the teachers participated and really helped out. I think it's still fun for them. I mean, it's not a day off, but it is sort of, because there's someone else doing the class and they wander around and help. Many of them had worked very hard in preparing the students for the class, and then they help out with the class, and so for them I think it just is someone who can bring in a bit of different equipment, perhaps a slightly different perspective, and some different experiments.

Furthermore, because they did not have to be the expert, teachers could enjoy seeing their students benefit from the Squad member's expertise.

> And yeah, I think they also get to do something with their students that is a reward for their students.
>
> I guess from the teacher/student dynamic perspective, it's really engaging to the students, have someone come in who is expert in the field and involve them in participating in an exercise. And, of course, the teachers are not experts in every field, that's just not physically possible, so I think from that perspective, they get the benefit. I mean, they benefit as do their students by having us coming in as experts and contribute to their program. So I guess that expertise is something of a benefit to them.

Squad members also felt they provided good pedagogical models to teachers. Their programs reinforced those already experienced with inquiry learning—as was described by the frequent-user teachers—but also inspired and provided models to those with less experience in designing labs and inquiry activities for their classrooms.

> …I hope that some with less experience got some confidence to do more labs in their classes.
>
> There were some teachers who were kind of thinking about using experiential learning in their own classrooms, and just looking at Science Squad as another instance of experiential learning that they could modify, or even use aspects of in their own exercises….
>
> And I think also that some teachers who, especially who hadn't had Science Squad presenters before, it seemed like they saw their kids doing an experiment, and they were taking notes and thinking about, "Okay, what are some experiments I could do with my students, what are some different things I could do?" … You know, "Could we run some version of this next year if I can't manage to book one of the Science Squad presenters?"

Many Squad members reported that some teachers planned to use the same activities themselves, next year. Activities were appealing for adoption and implementation when they were new to teachers, when they were seen as effective with students, and when they represented authentic science.

> Teachers borrowed some of the ideas. "Can you tell me how I can set things up to do this myself, in the class?" I don't know if it was [because it was] hands-on, inquiry-based or the technology or a combination. But yes, there were teachers who wanted to be able to do that themselves.
>
> But then I also left them with an exercise that they could use in [the] future in the classroom, that actually applied research techniques that we use in our research lab…. And they felt that that one, that exercise in particular, engaged the students in many ways.

> You don't pass up success …if people like a song you're gonna hum it and hope that they can follow along with it (laughs). But, no, if, if the work was good, teachers would use it. And there was occasional stuff where you were like, "Oh boy, that thing bombed in here," you know?

Squad members felt teachers were most likely to implement activities that were also simple and inexpensive to set up.

> One of my experiments was really just kids smelling different smells, different odors, and noticing that the smell wears off as you smell it for longer times. So very, very simple experiments. Very easy for teachers to set up, and some of them did say they'd set those up.
>
> [Some of my] presentations were always extremely simple, and so I think many of the teachers will use some of them. So it was a way to use very simple and very cheap apparatus to do an experiment that's interesting for the kids.

Most Squad members made a point to assist teachers who wished to use a particular lab or activity again on their own. They provided teachers with extra copies of their handouts, materials lists, and instructions. Many had contact with teachers afterwards, who asked for help in replicating an activity or sought additional enrichment opportunities for their students.

> I did have some teachers that did call up and say, "Hey, can you fill me in a little bit on this again?" or "Can you e-mail me the lesson plan?"
>
> I took quite a bit of time and effort to put together the programs that we went into the classrooms with. We also had little write-ups, and extra copies of them, for example, so we were quite happy to distribute those teaching materials to the teachers. So if they had felt that it was a really valuable program, and one that they could follow up with, and do next year with their own classes on their own, we left the teaching materials with them to go ahead and use them to their benefit.
>
> I've gotten e-mails from teachers asking me where I get the algae or how to culture it or where to get the material, how to do it. …And then I've had teachers call and say, "My AP class is doing an experiment with fruit flies—would you be able to help them, or can they come up and visit you at the university?" So a lot of teachers have even facilitated opportunities for their students to do more…. They always ask, "Oh, can I get a copy of that handout?" or " Can I get a copy of this or that?" to keep in their portfolios.

Teacher learning from the Science Squad was further augmented by other BSI-supported opportunities. For example, seeing a particular Science Squad presentation might give a teacher some concrete ideas on equipment she'd like to acquire and how to use it—equipment that could be obtained through the BSI's program of small grants to teachers.

> … to give them an idea of maybe some new things in the field, or some new ways to represent some of the concepts that they try to teach, and ideas, I think, of how to build lesson plans…. And given some of the grant opportunities through the BSI or through other organizations, how they might choose to allocate some of those resources if they did get a grant to buy, to purchase materials, that they would have maybe a better idea of what would be really useful in their classrooms.

Teachers also had opportunities to learn from the teacher workshops that many of the Squad members also gave based on the classroom programs they had developed and presented.

> We also taught seminars for the teachers, so that they could learn about different science activities that they could take into their own classes. So it was a little more broad-reaching, because you're hitting maybe 25 teachers all at once and they're taking it back to their classrooms.

Squad members saw the teacher workshops as an efficient way to share their programs with a number of teachers at once, and to disseminate the materials and resources that they had developed. The workshops benefited in return from the extensive classroom testing that the programs had undergone, as their experience in adapting the program to various age groups or settings could be shared with teachers.

> I think we did two of their workshops, actually, for teachers, and there we got a lot of positive feedback. And they said they did learn specifics, and some of the issues behind it. So, in some ways, I think that the longer time period with teachers, that was oriented specifically towards them, was probably a more positive experience for them, in terms of learning. But it was nice to have the balance. And it was nice having gone and sort of tested these programs out in their classrooms. And if we had elementary, or middle school, or high school, we could say, "This works better with this age group, and…."

They observed the benefits to teachers of collegial interaction in a professional community and enjoyed seeing their work reach a receptive audience.

> Attending the workshops, they seem to just get more and more excited over the course of the day. And there was this really incredible energy, actually, in the room, much more than I had anticipated going into the workshop, that they were just thrilled and so I think it was kind of a professional renewal for them. And, you know just some ideas—again the mission of the teacher workshops in the first place, is to kind of get them back in touch with their fields, or with you know, fields that are relevant to what they teach.

That said, however, implementation of Science Squad programs by teachers should not be the sole measure of success of the program. This is a useful benefit that contributes to the lasting impact of the program, but not one that all teachers could accomplish within the means of their classrooms. For teachers who could not immediately implement the same labs or activities the next year, there were nonetheless lasting benefits from learning.

> I think they get at least one new kind of way to ask a question to their students or get their students to think. It kind of gives them one more tool, either to connect into what they've been teaching in the past, or just totally random…. Some of the teachers definitely were in a place where they were able to, almost, for future years, perhaps able to replicate some of the experiments we did. Some schools were... obviously, it wasn't gonna be an option right away for the teachers to do the same kind of questions next year without the help of the Science Squad.

B. A Break from the Daily Grind

A second type of benefit to teachers was a break in the routine. When a guest speaker visited, the teacher had a day off from leading class. This was not necessarily a bad thing, in the eyes of the Squad members. They knew the teachers worked hard and they knew that they provided

good value for the students and a chance for the teacher to learn and observe his or her students, while taking a secondary role.

> So for a lot of them it's a nice opportunity to just have a day where they aren't having to be the ringleader, and they can just say, "Okay, well, let's see." So somebody else gets to take their classroom for the day and they don't have to teach. They have to be in the room with you, but they can be just kind of not having to be in charge for a day.
>
> At that point in the Science Squad we were just providing kind of a break for teachers. So you know, we would bring in an activity that teachers might not have any resources to do in a classroom, or they might not have the background to discuss a particular subject and we would do that for them.
>
> I think they recognized the value of having someone else come in, and teach these things. And I don't think it's because the teachers themselves couldn't teach it. They probably have their own hands-on activities that they provide, but we're providing different ones. And I think also, you know, having someone new come in as maybe a scientific authority—you know, this is a scientist who's working in science, and this is what they're teaching and it's kind of an insight into maybe what scientists are doing.

As discussed earlier, many teachers also used the break as a chance to learn something new, to watch another educator's approach to the material, and to notice their students' response to the teaching and learning strategies chosen.

However, Squad members did encounter a wide range of teacher attitudes. They noticed differing levels of engagement of the teachers during the presentation and met differing degrees of student preparation for the session.

> Teachers, their participation, or non[participation] or what they did during my presentations, it varied greatly. I think the more hands-on teachers were in the bilingual classes or the Spanish-speaking classes, because my Spanish is very poor. I understand a lot more than I can say, but they were there to help a lot, and I think by necessity, they were there to translate and help. And then sometimes, teachers would just sit in the back and grade papers. Or they would listen to my presentation and then for the activity they would help students figure it out, or they would help me solve, or answer questions. It just varied so greatly.
>
> Certainly some teachers talked to me beforehand and asked me what we were going to cover and said, "Well, it'd be really great if you came in April, 'cause that would fit in when we're talking about," something to this effect. So certainly, in a lot of cases, the teachers, I think, were able to incorporate it into their curriculum. And then sometimes it also was clearly that the teachers viewed it more like a fun day for their students, like a day after a test, for them to just get a breath of fresh air.
>
> Most teachers were really good, and were in the classroom, and assisted and were your partner during the time you were there. And you had a real—you'd set up some discussion ahead of time about what the activity was about and what the expectations were and that kind of stuff. And a few teachers, they took it like a coffee break. (laughs) They would leave you in the classroom, and you have no rapport with these students initially.

> There is enormous variation. Yeah, there are people who would invite me to come in and they didn't even know what I was gonna talk about. They had forgotten what I was gonna talk about by the time I got there. It was just a chance for them to kind of check out… and have a little time off and have a guest speaker. So that's one range of the extreme. (laughs) But there were also teachers who I knew were really excellent teachers, and who do a lot of inquiry, and sometimes it was for them that there was a particular presentation that they wanted either because of the content or because of the equipment involved.

Because of the variety of teacher behaviors they encountered, Squad members particularly appreciated the efforts of teachers who had taken pains to incorporate the presentation into their curriculum and to prepare their students for the session.

> I think the good teachers, the motivated teachers, the ones that usually made the arrangements to have me come to the schools, worked their lectures into what I was gonna do. And so what I was about to bring, they were prepared for, the students were prepared for what it was I was about to discuss. They had already had background materials, so they were prepared and that gave the teachers something to kind of build off of, build up to and then build off of. And for a number of programs I would send sort of pre-class information and then post, follow-up information… so they could sort of lead into and out of very easily.

Cases of teachers who blatantly abused the system to get a day off were relatively rare, as a fraction of any one member's experience, but common across the data set, in that many members had observed this happen at least once. Observations of teacher apathy, disinterest, or lack of engagement in preparing and supervising their students were reported by twelve of the 24 interviewees. What disturbed the Squad members most was that some of the benefit of the program to both teachers and students was lost when teachers did not take it seriously.

> I didn't have anybody who just left, but honestly, sometimes I felt like there were teachers who weren't maybe really all that into it, or all that into what I was doing. …Not that they're bad for worrying about other things, but sometimes it seemed like maybe they weren't really all that into it. It was just, "What can you come and do here?" Not so much, "What can I get out of this interaction?"

> There were a couple of teachers—one in particular, who I felt just used Science Squad to baby-sit her classes. I remember her comments at the end of my presentation on the written sheet—what was it? …the hands-on activity didn't work very well. One of the reasons it didn't work very well was she played no role in helping me discipline the kids. Every other teacher, I'd been with them, I'd done the same presentation—if the teacher even stands up in the room, the kids behave better, I think, than if she's up in the corner paying absolutely no attention.

One Squad member remarked that, when members shared these problems, the BSI staff would make a note of them, and when problems recurred, they would remove this teacher from the list of eligible teachers. This was not viewed as punitive, but appropriate in making the opportunity available to those who would use it well.

C. Emotional Benefits

A variety of emotional benefits to teachers were reported by Science Squad members. These included validation of the teachers' work through support from an external program and by collegial interaction with the Squad members, having fun, and being supported in handling a politically sensitive topic.

Several Squad members observed that teachers benefited from the emotional support and validation that they provided. Teachers expressed their appreciation for the support of the BSI in providing resources and excellent programs that stimulated their students. Working with a colleague who also cared about science education and students was personally reinforcing for the teachers and validated their professional work as meaningful and worthwhile, especially in the difficult circumstances that Squad members observed in the schools.

> They really communicate very clearly how much they appreciate your service to them—you know, if we were able to energize students who may not have been very interested before. And they just were very happy to see you and really appreciated every resource that you could bring to them. And you know, that was a huge, a big thing that made it worthwhile.

> There's a lot of pressures on teachers, and a lot of uncertainty about teachers' careers and funding and class size and academic school year length and everything else. And I don't know how much of that was really on the minds of teachers back when I was in Science Squad, but I definitely felt like teachers really were glad to have someone else in the classroom with them, and that they weren't alone in their desire to bring good science or good teaching to their students. And so I think that, in that way, you know, there was a kind of a support system for teachers, in that there just was another person there who was happy to see them as much as they were happy to see me. …I think that teaching is a profession that you have to have extreme dedication to stick with it, and people sometimes go through periods where they really feel overwhelmed by not being supported… and what I saw was that all the teachers I interacted with were just genuinely happy to have that support, not in a resource sense but in a kind of a collegial sense.

As these quotations highlight, when Science Squad members were told by teachers that they appreciated and valued their work, this was meaningful to them. Similar to cases when students expressed their enjoyment and interest, the evidence of benefit to others was emotionally rewarding to the Squad members themselves.

In addition to teachers' sense of being supported by the resources of an outside program, teachers also felt stimulated by interacting as colleagues with the university educators, and by understanding how their work would help students later on.

> Sometimes, if I saw some things that were really neat in the classroom and you got a chance to talk with the teacher during their off period or their lunch or something. 'Cause when you're at a school, sometimes you do four, five presentations but you'd have a class period in between where you'd grab some lunch or something and relax. Sometimes I think just talking educator to educator, you know, [was] mutually beneficial. Sometimes I think the teachers liked to hear that what they were doing was actually what was going to help their students post-high school. So, sometimes those discussions were valuable, I

> think, on their part. If you complimented a teacher on how they did something and how that skill was going to translate into those students' successes later on in life and at college, the teacher liked to hear that. Sometimes teachers would actually ask you—I mean, even though they have a set curriculum that they're supposed to teach, there's different ways to go about doing that. And they would ask you questions sometimes, because again it gave them a different perspective than their high school colleagues.

Finally, in a few cases, having a guest presenter was beneficial as a way to negotiate a politically delicate topic, such as human evolution, where students' religious beliefs might conflict with the biology being taught. This provided teachers who were worried about this issue with an "out"—as one member put it, "I think a lot of the teachers were like, 'Ah, phew, I don't have to do this!'" A second member elaborated on how a guest presenter could diffuse the political sensitivities.

> I think for the touchy subjects, like human evolution, it was a good way of handling it so that they don't have to, maybe, directly—I don't face the wrath of a parent, or whatever. They think, "No, I just brought in a guest speaker, and try and present each side," so they don't have to actually say, "This is what I think," or whatever. It's sort of a neutral person coming in and diffusing the situation.

It should be noted, however, that one Squad member also asked for more guidance from the BSI staff on how to handle sensitive issues.

> There weren't always clearly defined [guides to] what was OK and what was not OK. …I remember some teacher asked for something about HIV and politics of HIV…. And there wasn't even time for me in my schedule to consult about that. … Nobody said a thing; there was never any complaint about it. But after, I thought, "Hmm," you know! You're in the all-Catholic school and you say, "Yeah, a condom will prevent HIV." Oh well. But I don't know that there were really guidelines about that. As I say, I felt like a loose cannon, and I was presenting my opinion.

In addition to evolution and HIV prevention, race and ethnicity were mentioned as other difficult issues raised in science classes.

In sum, the Science Squad members saw that most teachers benefited for themselves, in addition to the benefits they perceived for their students that kept them using the Science Squad year after year. These benefits were perceived as minor, relative to the benefits to teachers, but included a mixture of things that were valuable to teachers professionally and personally.

> I think that sometimes they got out of it seeing a different way of presenting something, maybe, that they hadn't thought of before… and so I think sometimes they would recreate things that I had done as a Science Squad member. Every now and then they would tell me that they actually learned something content-wise from the presentations as well… and you know, I think it's just fun for them to have another adult in the classroom.

> Some of it was information. Some of it, I think, was validation, like recognizing that they were working hard, and that they have a hard job, and that they're doing a good job, and that they're putting in a lot of effort. I think there's a lot of little pieces that they got. The satisfaction of watching their students get interested in new topics, being able to do experiments they wouldn't normally be able to do. To be able to learn things they wouldn't normally be able to learn.

As one speaker pointed out, it was easy to identify that the program was beneficial to teachers, simply from its popularity and the high rate of repeat use.

> I think that it's a lot easier to see an impact with teachers…. I can give a specific example… by the time I was in Science Squad, from the moment that the new brochures went out for the topics for Science Squad for that particular year, within a week my entire year's schedule was booked. So I was booked for every single hour—every single hour of my teaching assistantship was booked for the whole academic year by teachers who were waiting for the Science Squad to announce what their topics were. And I feel like *that* makes the BSI Science Squad very effective, because they were in a place where they really didn't really even have to advertise anymore. Word of mouth had become so strong in support of what the Science Squad could do to improve the classroom learning… that they were standing in line waiting. And they would continue to call and ask, "Oh, have you had a cancellation?" so that they could schedule in, get you to come to their classroom. So in that way, I thought teachers who had used the Science Squad year after year, they really saw the Science Squad as a resource… and the BSI staff didn't have to do anything to promote their product, and that's very unusual.

VI. Costs to Science Squad Members

We have discussed, at length, the benefits to Science Squad members. However, members also incurred costs by participating. In this section, we will discuss those costs and the tradeoffs between costs and benefits that participants experienced in participation. We will also address Squad members' advice to the BSI staff and to potential future Science Squad members, where it addresses these problems.

The costs to Squad members were categorized into three main groups:

- Logistical problems with time, travel, and organization, and the difficulties these caused for members (mentioned by 17 members);
- Emotional costs, including feeling unappreciated, frustrated, and disturbed by the quality of science education that they saw (15), and
- Feelings of being marginalized by their research advisors, departmental faculty, or peers because of their choice to participate in Science Squad and perceptions of the effects of that choice on their career options (19).

A. Logistical and Time Problems

Issues with logistics and time were the largest category of costs to Science Squad members. One or more of these issues was mentioned by 17 of the 24 interviewees.

1. Time

The main logistical problem discussed was time, an issue discussed by 14 Science Squad members. In addition to the time to travel to and make the school presentations, Squad members had to develop the presentations up front, prepare the equipment, materials, and handouts, plan their calendar, and work with teachers.

> Clearly there's a time involvement that can be a challenge at times, and I think you need to be aware of that going into it. Okay, this is a one- or two-day commitment per week, approximately. Maybe it's three one week and not the other week or, one one week, I

> dunno. You certainly have a lot of flexibility with it, but yeah, it is definitely a time commitment. Right up front you have to develop all the presentations, which certainly takes time. Make sure you have all the copies ready to go for all the handouts to the kids and your equipment ready to go. They do have lab techs that can help you set up equipment or set up, or doing copies for you, which is just another part of the BSI as a staff being very supportive and trying to make it easy, as easy as possible, for us. And as less time-consuming as possible. But there is a certain amount of time—I mean, you take on responsibility.

While the position was nominally a half-time position, the same as a standard TA appointment in support of an undergraduate course, members described it as in fact taking more of their time than a TA appointment, in general.

> There were difficulties of getting down to Denver and getting around and spending that kind of time doing the program…. Definitely, being a TA on campus requires fewer hours each week—which means you can get more research done.

> It takes far more time to plan and organize and drive for Science Squad than—you know, I walk out of my office [on] campus and teach for two hours.

Some members suggested that the inequity with half-time TAships on campus was due not to the fact that Science Squad required more than 20 hours a week, on average, but that normal half-time appointments did not usually in fact require as much as 20 hours per week.

> It was much more time-intensive than a typical graduate 50% appointment, for a graduate student being a TA or something. I think we spent a lot more time. I think I in particular—I had labs that needed extensive prep work prior, every single time that I did them. And so I think that there was more work involved than in being a TA, and the compensation was the same.

> Even a 25% [Science Squad] position ends up being more like a 50% [TA] position—in our department, it would be. So it is a little bit more time than a lot of other positions on campus.

Squad members asked that this inequity be addressed by the BSI staff, but did not have concrete suggestions of how it should be solved.

The nature of the time spent was also an issue. Science Squad work was intense and mentally draining, and members found themselves too tired to do productive work at the end of a day in the schools.

> People don't realize how tiring teaching is. It's not a physical tiredness necessarily, but your mind is just shot. Then you gotta sit down, and do your schoolwork, and prep your experiments and that sort of thing, and stuff.

> I would come home from Science Squad and take a nap, I was exhausted! Three o'clock in the afternoon, I'd get home, I would be beat. I mean, it takes a lot of energy.

> It's a long day, definitely. You will not get any homework done, or anything thing else done, after Science Squad day. You'd go home, pop open a little bottle of wine, and then you watch TV and think… you're spent. It's really draining, that day.

Another difficulty with the time requirement was lack of continuity. The long Science Squad days broke up the week more than did TA work, so it was harder to maintain one's train of thought in research or to keep long experiments running.

> I didn't get as much research done that year. (laughs) You know, I was supposed to be doing research at the same time, but I didn't get that done. …Yeah, it's very time-consuming. Yeah, and it's supposed to be half time, you know, twenty hours a week or something. It turned out to be a little bit more than that, but it was reasonable. But just for continuity, when you're doing research in a lab, continuity is helpful. But when you're out two and a half days a week working on something else, it's hard to get the stuff done in those other two and half days. But yeah, I can say those were the costs. It was exhausting. It gave me a newfound respect for teachers at all levels.

The help provided by the BSI staff in developing presentations, and by the student lab assistants in preparing materials and making photocopies, was greatly appreciated. While this was mentioned by too few interviewees to establish a distinction clearly, it appeared that lab prep assistance was mentioned only by later program participants, while earlier Squad members reported doing their own lab prep. This may reflect a change in the program, with increased prep support offered in response to earlier participants' feedback.

In addition to the support they received that reduced their planning and preparation time, members developed various individual strategies to cope with the time requirements. Recognizing that if one week demanded extra time, they could back off during another week, was an important realization for some.

> I remember a few weeks, it became rather overwhelming. I mean, I finally decided I had to average it out—one week I would spend more time and the next time I would spend less, because sometimes I did have to spend more time prepping a new activity or something of that nature. And then other times I think I indicated to the teachers at the school I worked at, I was like, "Okay… I've got to turn in a draft to my advisor and I'm not going to be that available."

Some members took care to establish clear personal boundaries on their time commitment.

> I was very clear that it was not to become my life. It was to be 20 hours a week.

> I really was taking great pains… this might be how I settled it with my advisor, is that I actually kept track of the hours I spent doing Science Squad, and I didn't show it to him, but I thought, "Okay, I'm going to have to make sure I work no more hours than I would work as a teaching assistant."

Time could be a particularly sensitive issue with research advisors, and, as in the preceding quotation, some participants took pains to be able to defend their use of time if asked. The perceptions of advisors and others in the department of members' involvement in the Science Squad is an important topic, because it communicates attitudes about more and less valued careers in science. We will discuss this at some length in our forthcoming, separate report on the effects of Science Squad participation on members' career paths.

Members gave strong advice that it was crucial to provide potential Squad members with a clear and realistic understanding of the time requirements before they made a commitment to a Squad position.

> I would ask them about what their time frame looked like. I would ask them what they had going on in that year. If they told me, "Oh well, I have three shifts at the hospital and I'm taking two graduate courses, blah, blah, blah, and I'm…"—you know, if it just sounded like they were all over the place as it was, I would probably just recommend to them to only apply, or see, if a quarter-time position was available. Because I feel like, for a half-time position two days a week—that's a 6 AM until 3:30, maybe 4 PM in the afternoon kind of commitment for two days a week, and there is also preparation and planning time—and so I would just want to make sure that the participants or the potential candidate understood that it was a opportunity that they needed to put some effort, and allow time for.

The time requirement was often expressed as a tradeoff, a cost that weighed against the other benefits of participating, but it was the tradeoff most emphasized by Squad members.

> The first question I would ask is, "Why are you doing it?" And then if their answer was, "Because it's just a TA.…" And I've heard that before, and I've told that to, so this is real, it really happened, I told them, "Well, no, this is not what you want, because it's too demanding on your time, and your responsibility to the schools that you go to is too great, and you can't do it. So I would recommend just going to intro bio, or something, just repeat what we teach you." (laughs) And then, but if the student says, "Well, I want to teach," or, "I'm exploring teaching as a possibility," or, "I want to do more hands-on [science], and community involvement," then I would say, "Okay, then that's the program for you." But then I will always warn them about the time commitment. It is a lot. …I mean, given what students are required to do within the department, that's a lot.

2. Organization

A second set of logistical issues, mentioned by twelve Squad members, surrounded the organization needed to plan their schedule and prepare all the materials needed to support their work. While, as discussed previously, the high level of planning and organization needed to manage a Science Squad position helped some members gain organizational and planning skills, these requirements were a challenge for others.

Scheduling presentations was one aspect that was difficult for some members. It was difficult to fit everyone in, and hard to make commitments far in advance without knowing about other life events or being able to anticipate the demands of one's research project so far in the future.

> But making all of the appointments and making sure that they'll work and trying to get it so that it'll fit in with the teacher's schedule of when they're talking about something similar. But you're limited because you have to fit these appointments in. You can't do *all* of 'em in one week, you know. You have to spread 'em out over the semester. And so it, almost kind of that secretarial work was a little more frustrating.

> I always have a little bit of a hard time with setting my schedule in stone that far ahead of time.

For a few, talking to so many unfamiliar people was personally uncomfortable.

> I always felt kind of exposed out there. Just the whole making the contacts with the teachers… just kind of, I don't know, kind of on my own. And that made it sort of difficult, at first. I found myself sort of struggling to get myself out there and make those contacts, and do that stuff.

> Every time I would go out I'd have to call these new teachers, and call people on my list, and set up a time, interacting more and more with strangers. Which is probably good for me, (laughs) but it wasn't ever something that I found comfortable.

Travel was an issue for several Squad members. They found it stressful to plan their travel and transport their presentation materials. Travel time combined with the early start to the school day meant they were driving early in the morning, in commuter traffic, and had to make decisions about "I-25 in the snow when it's still dark, practically."

> I did not like getting to the schools. I found, even though I would do a MapQuest search and talk to the teachers, when I was going to a new school, it was always stressful in the morning trying to get there and trying to get to the classroom…. And I had a fair amount of equipment for most of my presentations, so I was trundling along a lot of stuff and it wasn't always fun, so that would be one down side.
>
> It was just stressful for me, not being a morning person, having to get up so darn early all the time. One of the things that was really hard, and I think this is true of the whole Denver/Boulder metro area, is just estimating how much time it's gonna take to get somewhere, and there's gonna be construction or there's gonna be bad weather or traffic or whatever…. Sometimes it was a level of stress, like, "Gosh, I hope I get there in time." That kind of thing. So that was just kind of hard.
>
> Maybe the biggest negative was the commuting, the driving. Because especially you really had to plan your time, exactly when you thought there'd be traffic, and get down there early so there was always that moment of stress. Moment of buffer time that you had to try to fill it in.

In addition to the travel to schools, members who did not live in Boulder, or who were not otherwise on campus regularly, found it particularly hard to organize and prepare their materials and to work with other Squad members or BSI staff on particular projects, for example to prepare a teacher workshop.

A final aspect of organization mentioned by Squad members was the reliability of lab prep support. While Squad members appreciated the support in preparing lab materials from undergraduate students, occasionally the quality of this support was not as high as needed. Carefully laid plans could go awry if a lab result were not available on time or was not of adequate quality to support the classroom work.

> … sometimes if you needed a student to run a PCR reaction for you and you needed consistent results, and maybe the person who was hired was a freshman and they didn't have the best time management skills or maybe experience, getting the work done—that sometimes led to not having results that I could share with classrooms, and so that was not a good thing.

Several Squad members requested additional help from BSI in organizing their time, particularly in scheduling issues.

> [Graduate students have] a lot of other things on their plate. That's the other thing, is, you know, your committee is growling at you that you don't have enough data, or you need a whole 'nother chapter for your dissertation… you can have a lot goin'. And then you get home and you realize, "Oh, I've gotta call six teachers, and schedule appointments, and I need to go out in the field and get more data for the project." …To

> my mind, one of the easier ways around that, is to have things be a little more structured. And if somebody else provides some of that structure, that's not something that I mind, personally.

Members did not, however, make particular suggestions about how to go about this. However, the suggestions made by the teachers, such as a web-based scheduling tool, would likely ease this problem for the Squad members as well.

Members also provided practical advice to each other about these organizational issues. They had good advice to their colleagues about organizing materials and planning presentations in advance. They suggested organizing the materials kit very carefully, with help from a colleague.

> When you're organizing your box of stuff to take out there, just *really* try to think. And sometimes it's good to brainstorm with another person if you're not necessarily good at this, or haven't done it before…. Try to make it as organized as possible, so when you're ready to go out to a school, you grab your box of stuff and you go. That you're not trying to reinvent the wheel every time you go out to a high school.

They recommended getting an early start on preparing all the presentations for the year, and drawing on the BSI's resources for past presentations both for specific presentations to adapt, and as a source of ideas and models.

> Start early on all your preparations if you can, so that you're not getting requests for programs that are in your brochure list and then you don't have one ready yet. I mean, once you do it a few times you get used to it, but that first couple months was pretty hectic, trying to get everything going.

To reduce the stress of travel and negotiating new places, one Squad member suggested that the group create and distribute a restaurant guide for Science Squad members, listing places to eat near regularly-visited schools, for "when you need to escape and eat, [and] you don't want to eat in the cafeteria."

B. Emotional Costs

Just as there were emotional benefits to participating in the Science Squad, there were also emotional costs. These came from receiving negative responses to their work and feeling disappointed and frustrated with teachers who did not use the opportunity effectively or with students who did not respond. Some were disturbed by the amount and quality of science that they saw being taught in the schools. One person who had sought exposure to diversity as part of her motivation to participate was disappointed at the level of this exposure that she was able to experience. Members were not always confident that their work was making a difference, and sometimes felt that their work was not valued by their departmental colleagues.

The quality of interaction with teachers was the most common source of frustration. Direct negative comments from teachers were rare, but were distressing when encountered.

> There were some days that weren't so fun, and sometimes somebody would offer what they maybe thought was being constructive criticism, where, you know, I really didn't want their constructive criticism.

> Some teachers, just different personalities, a couple of 'em acted rather snooty. And like you were their public servant, kind of. And that was kind of awkward sometimes. One of them I remember, there was actually a pretty good storm going through, and you know

> how snow can be very different on one side of the city compared to the other. And apparently there wasn't a whole lot of snow on the ground over there, but there was a whole lot of snow on the ground over here. And they were closing roads and having problems out here, so I actually called her and said, "I think we'll need to reschedule." And she just made a lot of snotty comments about my ability to drive in the weather. And it's like, well, you're not over here and you don't see what I'm looking at, you know. So that was not a *big* deal, but it was actually a little awkward.

More often, however, it was not teacher criticism but teacher apathy that disturbed the Science Squad members. Teachers were seen as the mediators of the student experience, so a teacher who used the opportunity effectively and had already established a good learning environment was able to bring the maximum benefits to their students.

> It definitely can be a hit or miss. So it can depend on whether the teachers have rapport with their classrooms and how the kids are going to respond to a guest speaker that day. And a lot of the underlying classroom dynamics—that can't be necessarily adjusted for or taken into account—influence greatly the receptivity that the kids have to the program.

As we have seen in the teacher interviews, teachers also viewed this as crucial in making the most of the Science Squad visit.

Because of the importance of the teacher role, therefore, Squad members felt that their time was not well-used when teachers had not prepared students and did not participate actively in making the presentation effective, by maintaining discipline and assisting with the lesson. Teachers' level of engagement could vary greatly within a single school as a Squad member went from one classroom to another.

> A few teachers, they took it like a coffee break. They would leave you in the classroom and you have no rapport with these students initially. And so you get this group of students and you're some stranger… and this happened to be in some of the classrooms where they really needed a whole lot of supervision and instruction, and they'd not really done a whole lot of labs. And then the teacher leaves—you really need two people sometimes to do those activities and have them be at least somewhat successful.
>
> *Squad member*: You just get the comment, "Oh, what are you here to talk about today?" You know, they weren't even ready. The students weren't ready; they weren't ready. All I was, was a break.
>
> *Interviewer*: So you were under-utilized, in that sense?
>
> *Squad member*: Yeah, and that was extremely frustrating because the person who set it up was ready, and then you'd go to the next classroom and you'd realize this person's just operating on a different plane. And the only difference between the students in one class versus the other class is that random selection they get in high school—and it's just appalling.

Because the quality of the students' experience depended so much on the teacher, communication with teachers was seen as one way to improve the effectiveness of the program in a particular class. Squad members recommended to their peers that they make a point to communicate with teachers in advance, even though it was difficult to make contact and sometimes personally daunting. Squad members benefited by setting clear expectations about student preparation and the teacher's role, and by understanding the teacher's needs and

expectations. Teachers who used the Science Squad likewise appreciated when members recommended ways to prepare the students—so this communication really benefited both sides.

> That's the best situation, when a Science Squad member can talk to the teacher ahead of time and work that out. Definitely, I always made sure they knew they had to *be* in the classroom, but still sometimes they weren't. Most of the teachers, though, know that… they know that you're there to implement this learning experience for the students, and that in order to make it a good experience for the students, they really do need to be there and be involved, and are very willing to negotiate with me what the best level of involvement was.

> …Before you go, when you're setting up the schedule, even if one teacher at that school is coordinating with several of the teachers that day that you're gonna be there, try to maybe talk at least briefly with each teacher. Just because you can then explain what your program is, a little bit more than that little blurb on the brochure. You can explain your expectations of what the students are going to do. And you can make some suggestions, as teachers sometimes ask if sometimes you can just make suggestions as to what topics and things would help the students get the most out of the program. If they have a chance at *all* in the week or two before the program to address *this*, or to do *this*. Sometimes just a *little* bit of preparation, not even like a full committed class period to something, but a little bit here and there, just makes that program go a lot better. And then you have a teeny bit of rapport with that teacher, so you're not just walking in completely cold that day. And then you can also address your expectations of the students that, "Hey, Mrs. Smith, this is a pretty intense program. We *can* get through it in a 50-minute class period, but my best experiences have been when the teacher and I both work together on the classroom management. And there's a couple spots where we really need to have the students all kind of on the same page, and your help on that will be appreciated and blah, blah, blah." You're just kind of setting the tone, and it just makes for a better day.

One person gave an example of a successful intervention with a teacher after an initial problem, but in most cases it was best to work these expectations out ahead of time.

> That only happened a couple times, and I think, in both cases by the second class period I had talked with the teacher and said, "Look, if this is going to be successful, we've got to *both* be in the classroom." I mean, they just took it like they were going to go grade papers for that hour, and that didn't usually work out real well. So the students seemed to respond best when, both, I was there, the Science Squad person, *and* the teacher, and we seemed to have a coordinated effort, and the students did best with that.

Conversely, teacher input was also beneficial to the Squad member. It helped them develop and refine programs, and fine-tune them to each classroom audience. A Squad member who was based in a single school found teacher input very helpful in developing activities and integrating them into teachers' lesson plans. As trust grew, the quality and usefulness of the interaction improved.

> Establishing a relationship with the teachers and finding out what they *need* is important. I do remember doing a lot of that—I came in with some ideas of my own, but I remember asking a lot of questions like, "Well, what would you like? What are you teaching the next couple of weeks?" And so there was a lot of brainstorming where they would say,

> "Well, we're gonna be working on this," and I would say, "Oh, well, you know we have a lab that we do at University of Colorado that looks something like this… we could bring it in and we could have that as part of the module," and… if I had been kind of in and out, those types of conversations wouldn't have happened. So I remember making an effort to kind of integrate into their lesson plan. So I think that is effective, and also they come to trust you… and yeah, just get to know you, so they feel comfortable saying, "You know, this really isn't working, when I taught it in the past," and "Is there anything we can do to make it more interesting or get the students more involved?" or whatever.

Squad members did recognize the value of the advice they had been given by the BSI staff about communicating with teachers, though they had not always heeded it.

> A lot of the advice that they gave us at first was very good in terms of, they said, make sure that you talk to the teachers, and you establish some kind of relation with them before you show up, so that you have some sense of where you need to be, when you need to be there, and it's not all last-minute panic. And of course I heard that and I said "Yeah, yeah, yeah, whatever." But it's true. …It *does* make a big difference to talk with the teachers ahead of time, 'cause then you can really cater, or try to adapt, at some level, your presentation to what they're doing.… That's not really advice for them, 'cause they gave that advice. I just didn't listen to it very well!

As noted earlier, teachers also asked for more communication with Squad members about preparation and follow-up for their students, and just in fixing details of the presentation to enable them to prepare effectively. Because this is useful to both parties, and improves the effectiveness of the classroom program it appears that more thought as to ways to facilitate communication between teachers and Squad members would be of benefit to both.

In addition to problems with their interactions with teachers, Squad members incurred some emotional costs from their interaction with students. One motivation for many Squad members to participate in the program was their enjoyment of working with children, but some of that enjoyment was lost when they did not get to know the children individually and build a personal relationship.

> Part of my frustration with it, the bit that wasn't so much fun in it, was that I didn't get to know the kids. …The ones that were very interested and the ones that thought it was very cool that came and talked to me, I know that they really enjoyed it, but I didn't get to see the kids from week to week.
>
> The fact that I was teaching to a different group of people every time I went out started to really be difficult for me. And I realized while I was in Science Squad, I realized how important to me the continued relationship was.

Others felt frustration when the students were not interested or did not respond to the presentation. Most often this was reported as a mixture of responses—while some students were not engaged, others were. The rewards from those positive responses usually balanced out the disappointment from less positive interactions with other students—perhaps not on any given day, but at least over time.

> Part of what I gained was some frustration—just that there were students out there who really just don't care, as much as you try, they just don't want to tune in. But then there's the few students who you can really connect with and that makes it all worthwhile.

> Occasionally you'd have a class that you were frustrated with, but mostly I felt like the teachers were so appreciative that you just felt good, even if the students weren't completely tuned in.

More disturbing, however, was the quality of science education that Squad members saw taking place in many schools. Students had not had the preparation they needed to take best advantage of the Science Squad opportunity presented, and teachers were too overworked and under-prepared to teach science effectively.

> It was really challenging to try to do a lab with these students, because they had no skills. I mean, none. And so, what would take you 20 minutes in a classroom where students had done labs on a regular basis, could take you an *hour* in [another] classroom. Because they had a hard time staying focused, they didn't know what to do, they needed a lot more supervision, a lot more instruction. I got the sense that some of the DPS classes just didn't *do* labs. …Very discouraging. Their idea of labs was worksheets, and reading as a group from the textbook, which is pretty boring. No wonder students don't like science.

These problems seemed overwhelming, and while Squad members felt their own efforts were good and valid, they were a drop in the bucket compared to what was needed.

> I guess I really do feel that the teachers in these particular schools that I worked in are just not at a good advantage for teaching science effectively… and I do remember feeling discouraged about that…. I felt like what I did, did make a difference, but… it would be nice if there was something else that could be done, and I'm not really sure how to fix it. I mean, I just felt like they needed fewer students, fewer classes, more time, and that these programs that we were doing—I mean, it was helpful, but it really wasn't getting to the crux of the problem which was… they were just overwhelmed.

> There weren't really any down sides except for… you know, the whole… the rude awakening that there was really a serious problem. What we're really doing isn't even scratching the surface. That, *that* was the down side of it.

Given the magnitude of the problem, and the limited intervention possible within the structure of this program, some members felt disheartened. Without ongoing contact with students, they were not able to observe students' progress. It was hard to remain convinced that their work was doing any good.

> But I found it hard by the end of the year—by the time you've given the classes so many times, it's not so much fun. Talking to people who are teachers, they say that Science Squad doesn't get any of the fun stuff of teaching. So you never get to see the kids improve. So you just see the children once and you do this lesson and you go away. So that was the bit that wasn't so much fun, I think. That I would never get to know the kids well enough to know them by name. That I'd always be teaching a sea of unknown faces.

> Sometimes it just felt very ephemeral, like you'd go into a class, and you do your thing and you'd leave. And you'd go into class, and do your thing and leave…. And after a year, I just didn't want to do that again. Even if I teach a class for a semester somewhere, I've got a group of students with [whom] I'm working over a period of time. And, even though in teaching you don't often get your rewards right away, you do at least see changes in student behavior, skills, knowledge, how they can apply that knowledge over

> a semester's time, for the most part. And so, if you're attuned to looking for those things you do get some rewards, and sometimes it's just hard, because you just didn't know.

This critique of the program and others designed like it—that the intervention is too short-term to have much in the way of positive effects—is a valid one, and one that we asked every Squad member to address. We will discuss this critique separately, but it is worth noting here that even the Science Squad members, enthusiastic as they were about the program and as positive as they were about the benefits to them and to their audience, at times were discouraged by not seeing the rewards of a more intensive interaction with students.

C. Marginalization

A final type of cost to Science Squad members was marginalization and its consequences. Most Science Squad members reported at least one way in which they had lost status in their departments due to their participation in the Science Squad and its implications for the career choices they made later. In the eyes of some of their faculty, peers, and family members, their interest in teaching was less valued than research, and teaching in K-12 schools was less valued than higher education. Therefore Squad members' choice to teach in the K-12 schools was a very low-status choice. In some cases, this was communicated to members as genuine concern about how the choices the Squad member was making would affect their career options. In other cases, this work was devalued outright, and members were treated as being "not serious" about science.

Marginalization had negative psychological and practical consequences, ranging from feelings of self-doubt, lack of support, and extra hassles and time in finishing their degree. A few positive consequences were also reported, in which an individual's participation raised the consciousness of a faculty advisor or peer and gained some respect for the individual, the Science Squad program, or the BSI as a whole.

While they also told stories of supportive advisors and interested peers, marginalization from some individual or group was widely experienced. This issue is strongly connected to the career paths and career decisions of the Science Squad members, because in most cases, it is not participation in the Squad *per se* that is at issue, but the motivations and career plans that surround the choice of participating that are being questioned or devalued by others. Having outlined these issues briefly here, we will discuss them at greater length in the second report.

VII. Bang for the Buck: Advantages and Constraints of the Science Squad Program Design

An important issue in evaluating any program is to determine whether it is providing sufficient value relative to the resources expended to run it. In other words, what is the "bang for the buck"? This question is important to those who develop, carry out, and fund the program, to determine whether their time, energy, and money are well spent. As we have also seen, perceiving value from the program also has a close relation to the level of personal satisfaction of program deliverers with their roles in the program, and thus to the intrinsic rewards that they derive from participating.

> If I didn't think it had an impression, and it didn't make a difference, it wouldn't have been such a rewarding experience.

Thus far we have discussed the quite substantial benefits of this program to the Science Squad members themselves—gains of skills, understanding, career benefits, and intrinsic rewards. We have also described the benefits to K-12 students and teachers, from the points of view of both the classroom teachers who are frequent users of the Science Squad, and the Science Squad members themselves. The program provides engaging and effective learning opportunities that increase students' interest, teach students and teachers new ideas about science and the scientific process, dispel stereotypes about science and scientists, and support teachers professionally and personally. We have also examined some elements of the program that make it effective in these ways.

We shall now discuss these benefits in the context of two major elements of the Science Squad program design. Like any choices in the design of interventions, these choices constrain the benefits and costs of the program. Thus examining these choices reveals tensions between existing benefits from the program as it is currently designed, and the different or greater benefits that might come about if different choices were made.

In other words, we have already addressed the question, "How well does it work?" Furthermore, we have provided some insight into a second question, "What makes it work?" The question that remains is, "Could it work better?"

The two elements of program design that we will consider are:

1. The choice to provide short (one- or two-session) presentations at a large number of schools throughout the region and the school year;
2. The choice to target under-privileged schools with high-minority and high-poverty populations, particularly in inner city Denver.

We will discuss Science Squad members' responses to these two elements of program design, their assessment of the trade-offs involved, and their arguments for or against each. In this discussion, we will also include the suggestions and advice of Science Squad members about how to address these constraints and improve the program's "bang for the buck."

A. A Lot to a Little, or a Little to a Lot: Responses to the One-Shot Criticism

A common question for anyone designing a program intervention is the choice of whether to provide a small intervention to a large audience or a deep intervention to a smaller audience. As one Squad member put it, "There are different approaches to life. You could give a lot to a little, or a little to a lot." There is certainly no linear relationship between these two—investments of more time or money does not guarantee more benefit, but there may also be some threshold of investment that is necessary to see any meaningful benefit at all. Like many other science outreach programs, the Science Squad model is based on providing a little to a lot—a small, "one-shot" intervention to a large number of schools. We must thus ask whether the impact is sufficient at each school to be worth the trouble taken and cost incurred to reach a larger number of schools. We asked the Science Squad members to respond to this criticism, which we referred to as the "one-shot argument."

1. A valid argument

Many (11) Squad members recognized that the one-shot argument was a valid criticism. They recognized that their comments about benefits to students were based on their beliefs and on

extrapolation from an incomplete sampling of students' responses, but that they really did not have good information about whether and how students benefited in any lasting way.

> I can't tell you in depth what they got out of it, and I think it's because of that, that one criticism that you really just deliver a class and then you go away.
>
> Students were always glad to see me when I came back, but as far as what I think students really got out of it… I don't know that, because I don't, I wasn't, I never saw—those students that I interacted with, I never saw them graduate. I never talked to them again, personally, after that year and had any of them tell me, "You made a big difference in my thinking or in my attitude or in my anything." I didn't see any of that. …My interaction with students was really limited in that way. You would see a student several times, but in the grand scheme of things over the course of their K-12 experience, you're just a blip.

As we have noted, one of the benefits to Squad members was learning more about the realities of science teaching and learning in the schools. While this helped members do their work more effectively and sensitively and led them to appreciate the real difficulties for urban schools, teachers, and students, this new understanding had emotional costs. Some became discouraged at the difficult realities of the situation and the enormous magnitude of the problem. So not only did they recognize the validity of the one-shot criticism, some Squad members agreed with it. They questioned whether their efforts were making any difference against such a large and difficult problem. The following quotations illustrate how understanding the problem could also highlight the limitations of this approach to solving it.

> I looked at these people in the AP class, for example, and I had a sense from the teachers of the personal issues they were dealing with… and I looked at what was happening in the classroom. And you could see that they were not going to accomplish what they were setting out to accomplish in science. There was just no way to do it. Even though I was there doing whatever I was doing. So I think that's just important for the Hughes program to realize kind of what they're up against. If we are going into these schools to provide resources… what we have to offer, I think, is helpful, but it may not change a lot for a lot of people.
>
> *Squad member*: I think it's the reality of the situation. It's the same problem we have in higher education, too. You like to think you can overcome some of the obstacles that these students face in terms of just their learning, and sometimes you can't. I mean… it's really hard, especially at the high school level, for us to interact with the students enough to get them out of that mindset, or away from the negative influences long enough to… to show them that there's a different way. Or, you know, it's okay to be a science nerd, or whatever it might be. We just didn't have contact with the students long enough throughout the school year to really make an impact, I don't think.
>
> *Interviewer*: Yeah, yeah. Well, actually, you're getting right away to a meaty question that I've been raising with everybody, which is, that is one of the main criticisms with programs like the Science Squad. However wonderful you are at presenting your lesson, and however hands-on and inquiry-based and whatever good things are about it, it's a one-day deal. And it sounds like you're recognizing limits of that.

> *Squad member*: Right, I would have to agree with that. And especially because most of the schools don't have the resources to match any of those activities on a day-to-day—let alone even once a week—basis. I mean, the school that we went to, not even every student had a textbook. Which I thought was really bad. So I mean, when you're dealing with a situation like that that it seems… it seems like we're not really addressing the right issues.

The mere magnitude of the problem in comparison with the small efforts that they could contribute was one factor that led Squad members to see validity in the one-shot argument.

2. Counter-argument: Multiple exposures add up

Members also, however, responded to the one-shot argument with counter-arguments. First, they said, it's not really just *one* shot. Squad members go back to the same classroom multiple times, both with multi-day presentations and with different programs.

> In a lot of ways I think it's a valid criticism. I think it's it is true it's a one-shot deal, we're only there once. Although in many instances, I did go back to the same classroom multiple times and I think that… the way we construct Science Squad, a teacher can request four presentations throughout the year, so it's very possible for a Science Squad member to go to a classroom multiple times. And I think that relationships with the students get better each time you go… and the impact is greater when you can go multiple times.

> I often was in a classroom more than once during the course of the year, and so they're, "Oh, you're the bone lady!" and so they absolutely remembered… and then would get out their textbook and show me that they'd figured out that there was a picture of a ring-tailed lemur in their textbook and now they knew what a ring-tailed lemur was, and that kind of thing…. So I think we often saw the same students more than once in the course of the year.

Squad members observed that, even on a second visit, students were more relaxed and curious. There seemed to be more time for discussions about going to college and pursuing science careers, and more personal contact that provided opportunities for students to identify with a role model. One simple recommendation made by some Squad members, therefore, was to deliberately design more of these two-part sessions.

> I really enjoyed the two-part experiment, where I got to go back into the same classroom a week later and do a follow-up, because then I had met the students. They knew who I was, we had been able to establish a level of trust or rapport, and they could ask more interesting questions. And on the second follow-up visits, they generally ask a lot more questions about me personally—what did I do at the university, how did I get there, what was college like? So at first, I don't know if the time frame didn't really allow it to be so, or just they were hesitant, but we really didn't get into some of those career conversations, but on the second time we did. So I think that it would be really neat to have that program be able to have more kind of follow-up opportunities.

Another person pointed out, however, that having to routinely schedule multiple, linked sessions with the same classroom would raise the level of complexity of scheduling, already the most difficult aspect for both Squad members and teachers, as we have discussed.

> It seems like, though, the level of complexity—if you wanted to go back… if you schedule a Science Squad presentation and then, "This person's gonna come back and do something else with you"—it increases the level of complexity that's somewhat difficult to deal with at all. …I don't see it being feasible for a presenter to go back, like two, or three, or four times, to have this repeated thing.

3. Counter-argument: Novelty increases impact

In addition to arguing with the definition of Science Squad programs as a one-shot intervention, Squad members also argued that such an intervention could have substantial impact despite its short time frame. One argument made by many members (15) was based on the importance of a novel event in stimulating students' interest. Because the experience was engaging and different, they suggested, it would be remembered, discussed, and reflected upon. A special and memorable event could thus arouse not just momentary interest but curiosity and inspiration that would set someone on a different track.

> There are different approaches to life. You could give a lot to a little, or a little to a lot. And here we're giving a little to a lot. And that little can clearly spark an interest in many students, across the board. Get 'em thinking about things that you wouldn't have thought of.

> I don't think that a one-off experience is necessarily not important. So people talk about great experiences they had that inspired them to a career by, you know, visiting a national park once when they were kids. The impact of a single event can be huge, and I don't think it should be dismissed.

As we have discussed, stimulating interest in science and changing students' attitudes about science were widely reported benefits of the Science Squad program. Observations of students learning science, however, were less commonly reported. This is consistent with what Squad members saw as the possibilities of a single-shot experience: A single, high-quality, classroom program could not teach students many science concepts, and might not even give students enough practice with a single concept to really learn and remember it, if not reinforced by the teacher later. However, a single program *could* spark an interest or a change of attitude that would be lasting.

> If you can just sort of create that moment for a student, where they realize that this is not something that's completely sterile and boring, that this is something that can be creative and challenging and exciting… that moment can have lasting impacts. It's a moment of realization… and that has lasting impacts… just awakening that, the idea that you actually could have fun doing this.

Squad members discussed what it was about their programs that they thought enabled them to stimulate such an interest, even on a single encounter. The "cool factor" of Science Squad programs was important: by introducing students to something novel and exciting, they would be intrigued to investigate further or to seek out other experiences with science.

> And so I think that it really does appeal to kids who have never maybe seen a lot of the technological aspect of science and, you know, they like the machines and the tools and the ideas and stuff. So I think that it works well as far as just kind of a flash intro, or to sort of let them know that science can be fun or that that was a neat thing that they did. And I think that if it's just out of that alone, you know, maybe they'll have a positive

> experience to take with them in the future—so that when something on TV about science is on, they might tune in a little or be interested. So I think that it does at least give them a really positive view of one activity or one aspect of science, so that they will be able to say, "Yes, science isn't stupid, it can be cool or fun."

Exotic technology was not the only way to achieve coolness, however. A Science Squad presentation could make this kind of impact, they argued, as long as students were doing real science and seeing how it was relevant to their own lives.

> You think about learning math, or learning science, and you're learning about a plant cell. And well, who cares? You can't see them. And so, "Well, why do I have to know this?" "Well, hey, look! You can use these plant cells to help you solve a crime." How cool is that? That is *so* cool. And so you really grab these kids' attention and say, "Hey, science can be really cool because it can help you solve this crime." And they really kind of, they latch on. And you know, even it's *for* that hour, I still think it has a lasting impression, because the next time they go watch that crime-solving TV show, they're going to say, "Hey, did you know that you could look at the stomach contents and you could probably help figure something out about that?"

By delving into one example of how science was important and relevant, they argued, students would be able to carry this experience to later encounters with the same ideas, and realize that they knew something pertinent already.

> DNA is such a huge part of our lives, and you know, even if these kids aren't becoming scientists, who knows, maybe they're gonna be on a jury where they present DNA evidence. And these kids, when they're adults, they're gonna be a little bit ahead of the game because they've had the experience. And so even if was for just a short period, I think it's probably gonna spark some of the kids and they're gonna take it a little bit further. And then some of the other kids are just gonna have a little bit of extra information to interact with their surroundings everyday. So I think it's just kind of sparking interests, and allowing these kids to look at their world in a different view.

A subtlety of this argument emphasized by some Squad members was that it was not necessary that *every* child have such a memorable, inspiring experience.

> You know what? If I'm in there one day and if it sparks the interest of one kid, I've done my job. I mean, it's kind of unfortunate that we can't go into every school, every classroom, a couple times a year more—but the fact that even just the novelty of the experience that one or two or three kids had during a presentation, if that has an impact on them, then that's worth it.

Another variation of this argument pointed out that this type of learning experience was *necessarily* limited to a special event, because it could not be sustained on a daily basis. Science Squad programs could serve as opportunities to recap and apply concepts learned previously, but this was an intense type of learning and one that required students to already have had exposure to some of the concepts. Learning those concepts had to go on in more mundane ways the rest of the time.

> I would disagree [with the one-shot argument], because children couldn't learn at this level all day every day. There's basic things that they're learning on a regular basis, and I think the opportunity—it's like a special opportunity for them to be able to apply some of

> what they're learning on a day-to-day basis in their classes, and to have it put into a special context.

Finally, another speaker pointed out that the outcomes of a special event might be greatest for students who were at risk—perhaps students who were not traditional "good students" and might be labeled by teachers as not worth the trouble to teach. She explained why:

> The students that I think I impacted the most were students who might have been the most at-risk students. Maybe they had already caused problems in a classroom and teachers already had expectations about what they could do or could not do as far as working with the team, or completing an activity or any of those things. And because I didn't have any of those preconceptions what I saw, and what teachers told me, was that students who *they* had written off long ago were more engaged, because I didn't know who was the student who I should be wary about. I didn't have any of those preconceptions. I did have a few students who were surprised and told me so. They were surprised that I called them to the front of the class or wanted to know their opinion….

In this case, the intervention is most effective with students most in need of it, perhaps most likely to be dismissed by teachers as not worth the effort to teach, and thus at risk of receiving a poor education or dropping out.

4. Counter-argument: Stereotypes are dispelled by a single counter-example

A related but distinct version of the novelty argument was about the importance of the Science Squad members in reshaping students' ideas of what science was and who could be a scientist. Novelty was also a factor here, but its importance was not in stimulating continuing interest, but in striking down preconceived notions. If students imagined that all scientists and engineers are white and male, for example, then a single counter-example of a woman engineer or a Latino scientist could change this notion. If they thought science was boring, a single fun science experiment could change their minds.

> Sometimes it's hard to know exactly the impact you're having at any moment, especially because you see these kids for an hour, their class period. But I guess I'd like to think that being a woman up there who did science and liked science could at least maybe open their eyes to that being a possibility.

> I think introducing students to the idea that a girl can be a practicing scientist can happen in one meeting. I [knew] Jorge Moreno, who was Hispanic, and … he told stories. He was doing some research on interventions as part of his Science Squad work. And he told stories of classes where he would have the teachers, before his arrival, [ask the students to] draw a scientist, and they were all white men in lab coats. And then at some point after his presentation, and with no prompting or no discussion of the connection, ask them to draw a scientist again. And they just got out more pictures that look like people, like… some look like Jorge and some look like just other people… it was less stereotyped to what a scientist is.

We have already discussed, in the section on student benefits, the ways in which Science Squad members made a point to address students' stereotypes—not through explicit instruction, but by sharing both their science and their own stories.

> The longer I was in Science Squad I really felt that my biggest impact in Science Squad was just being a competent, enthusiastic person, a good role model, and that some of my excitement about school or about science, might have impacted students in a positive way.

Changing stereotypes, members argued, was a benefit that was possible to realize within the time constraints of the program.

5. Counter-argument: Teacher involvement makes it last

Another very strong argument against the one-shot criticism, made by 17 interviewees, surrounded the role of teachers. As we have discussed, the role of the teacher was seen as critical in mediating the benefits to students. Teachers could enhance the impact of Science Squad in a variety of ways. In the classroom, this included their control over classroom discipline, co-engagement in the lesson with the students and the Science Squad member, preparation of students (which was often obvious to Squad members) and follow-up (which was not). Teachers could learn new ways to approach topics, improve their understanding of inquiry learning, and adapt and re-use the same lesson in future years, with the aid of the materials provided by the Squad members, teacher professional development workshops, and equipment grants from the BSI. The role of teachers was thus viewed as critical in increasing the impact of Science Squad beyond the single visit—"leveraging up," as one member put it.

The simplest way that teachers could increase the impact was by repeat scheduling of the Science Squad presentations in their classes.

> There were a number of teachers that *really* utilized the Science Squad program. And sometimes you'd go back into the same classes and the kids would recognize you and you'd have a little bit of rapport built up, so there's *some* opportunity for that continuity. Just using Science Squad on a semi-regular basis and tying it in with their curriculum, maybe going to the workshops.

As we have noted, many teachers did this, signing up early and often. Squad members' calendars filled rapidly. Indeed, it is this behavior that led us to choose frequent-user teachers for our interview study, for the best possible insight into the benefits they perceived from the program.

We have discussed already Squad members' perceptions that the programs were less effective when students were not prepared. This included not only academic preparation with the particular concepts and terms that were prerequisite to the program, but also providing scaffolding for this experience as part of the class as a whole, and sign-posting to the students how this activity would fit in to what they were learning, and why it was important. The teacher's job was critical in making these links.

> Why would they take a student on a field trip to some location if they haven't prepared them for what they're about to see? Otherwise they're just gonna run right outside, or wherever. They're gonna go on the field trip, the museum—if they don't have some structure to what they're gonna do, what they're gonna see, what they're gonna learn, then they're not going to get much out of it. The long-term gain is gonna be minute, but if they've built up to it as a special thing, getting prepared for this scientist coming from the University of Colorado, and this is the kind of thing you're gonna do, and then afterwards doing some follow-up and review, then it makes a big difference.

Teachers' strategic planning was particularly important. "If they build around it, then it means something," as one member put it. Many teachers tried to schedule the Squad visit at a time that would relate the presentation to the topic they would be teaching, and this was seen as particularly effective for students' learning.

> I know there were times where I came into a class that was doing something similar during that section, and that had, I think, a pretty big impact. And there were other times where I know I was taken, and then it was like, "Well, if that's the only day you can do it, I'll take you, and we're doing a section that's completely different, and we won't be doing what you're talking about until the end of the year," or something. And the kids liked having this experience—it was out of the regular sequence of events, they liked that. But when it was something that they were studying at that moment, they were watching you, and they were into it, 'cause they'd already learned some stuff. They felt like they were *using* some of the things they had already learned to understand your program.

Even when complete integration into the curriculum did not work out due to scheduling, however, Squad members felt they were more effective when teachers were able to link the presentation to what students had already learned or to use it as a springboard to a future topic.

> When I was able to talk to some teachers about what they were up to, or if I had a break in between my classes, you'd look around at the bulletin boards or the other paraphernalia hanging about in the classroom. And a lot of times I felt like what I was doing fit into some theme the teacher was developing. So I don't think my things were just isolated, individual activities. I don't even know what percentage of time, maybe sometimes they were—you go in, you have a guest speaker, no big deal, you never see that topic again—it could happen and probably did. But in some classes, I know that my thing was part of the topic they were doing, like ecosystem or water analysis, or atmosphere or pollution. I'd say something or I'd bring up a term, and the teacher would tell me, "Oh, this is great. We talked about this last month. Now we're on to this, but we did talk about this," like it was a reinforcing kind of thing.

While the program offerings changed somewhat each year with new personnel, certain topics were perennial favorites and often re-worked by new Squad members, in part due to their popularity with teachers. These were easiest to integrate into the curriculum, because teachers knew they had worked before. But creative teachers were also able to find ways to link new topics offered by the Squad to their curriculum.

> I know that the high schools have so much curriculum that they have to cram in there, that it's nice to just have a little fresh space to teach something that the teacher can then play off of. And so I think that the best lessons will hopefully be kind of reiterated a little bit, over and over. It's not entirely a one-shot deal, even though you've only gone in there once.

The ways that Science Squad members saw teachers optimize the effects of the Science Squad presentation—by repeat use, linking to the curriculum, preparation, follow-up, and signposting—were very similar to those reported by the teachers themselves. Thus any program enhancements that can facilitate this activity are likely to be effective.

Of course, the other way for teachers to create lasting impact from Science Squad visits was by continuing to use the activities and lab experiments in their own teaching in future years. We

have already discussed how the Squad members and the BSI tried to support teachers in doing this, through sharing materials, conducting workshops, and awarding equipment grants.

> We've tried to make it carry on a little bit more by giving the teachers descriptions of the activities and the handouts, so they can hopefully continue that with the rest of their classes the next year, or whatever it is. So for longevity, I think that's been the effort, anyways, to try to make it applicable and give it some longevity by giving the teachers what we've done.

A key element of making this integration and adaptation possible was communication between Squad members and teachers. As we have discussed, both groups felt it worked best when this occurred. Science Squad members advised that more thought be given as to how to increase the communication between Squad members and teachers, so as to optimize the lasting benefit to classrooms. They wanted ways to work collaboratively with teachers to increase the coherence of the Science Squad presentation with the rest of the curriculum, and to support teachers with the resources they needed to integrate and build on the presentations.

> And it seems like the thing that could make it better is sort of the level of communication between teachers and presenters. …Because I don't see it being feasible for a presenter to go back, like two, or three, or four times, and to have this repeated thing. But the thing is, if the teacher and the presenter are a team, doing, working towards a goal—it's the teacher who's really going to see those kids on a nice, regular, repeated basis—and if you had a way where you were a little more coordinated with the teacher, and doing your presentation, and the presentation were sort of leveraged by other things that were going on in the classroom, either before or after or both….
>
> And I think that's what I noticed of the difference between, "How could you make this, even though it's just a single event, how could you make it more powerful?" was, "Does it fit in? Is it something that's supported by other things that they're learning, or does it just stand alone?" And the way I think that you would do that is to have the teachers do what they can, or even be given some tools to help, to help make it something that's reinforced or supported. I don't know if that's asking the teachers to do too much, but that was my take.

One person suggested that, as a step toward this greater communication, the teacher feedback forms might be used in a more meaningful way. They could be used not just to gather data but to encourage teachers to reflect on how the Science Squad program could be better integrated into their classroom program.

> But it might be useful to have them reflect back on that too, and say, "How does this presentation fit into what I'm teaching? How does it make my section on human organ systems, or botany, how does it make that more powerful? How can we integrate it into something so that it really does have an impact?"

A final comment on the importance of teachers in providing lasting impact out of the program also recognized the importance of the long-term relationships with teachers that underlay the program.

> And I think that Julie Graf has done a tremendous job really cultivating that relationship with the teachers in the Denver school district. I mean, she knows them all by name and has a really good rapport with them, so I think that has been—the combinations of

> Science Squad, and Julie's knowledge of and the relationship she's built with those teachers—those two things together make, I think, the longevity work. I think it is successful, not just a one-shot deal.

It should be noted that this trust and rapport is also implicit in the popularity of the program. Teachers would neither desire to use the program, nor be able to find ways to link the programs to their curriculum to their classes, if they could not rely on the program's offerings to be well organized and of consistently high quality.

6. Counter-argument: Absence of evidence of impact does not mean absence of impact

Another argument made by Science Squad members in response to the one-shot criticism was that, while we may not know all the effects on students, that does not mean there are no effects. This argument focuses on the fact that Squad members are not present in the classroom afterward to observe and assess learning.

> Because I feel as though Science Squad did do definitely some good, definitely had some kids interested, and it was a lesson that some of them will remember. But because I walked away at the end of the day, I can't definitely tell you that.
>
> What makes it worthwhile is every once in awhile, or at least once a day, when a kid in the class will come up and talk to me and be really interested. I had brain models that they could pull apart and put back together again, and many of them just loved doing that, finding how the different parts went together and things like that. But I can't tell you in depth what they got out of it, and I think it's because of that, you know—you deliver a class and then you go away.

They also recognized that some of the impacts might be even longer-term in nature than the academic year—even the classroom teacher might not see them. The effects of inspiration, curiosity, or a new interest stimulated by the program, for example, might take a very long time to bear fruit.

> Someone might be glad to see me and be glad that I was back and that I was doing science, but whether that translates into having better representation in scientific professions, I have no idea.

While, as we have discussed in the section on costs to the Squad members, this lack of knowledge about the outcomes of their work could be frustrating, it was also a source of optimism. Members knew there was no way to know all the ways their work might influence students, and therefore they could always feel hopeful that they had made a difference not obvious at the time.

> Even though some of your classroom experiences may not initially show you that you've made a difference, that maybe down the road you really have and you gotta keep that in the back of your mind. You *might* have reached a couple students that just didn't give you any indication that they really connected with you. (laughs) And that's true of teaching in general, is that we often don't see our rewards immediately.
>
> You never know when the little thing you say in passing changes a student's life forever. You never know, unless you see them years later and you're like, "Oh, yeah". And they're like, "Well, you know, I heard you talk about that thing, and now I'm doing it".

> You never know that. And that's what's neat about that kind of experience. And the ability or the possibility to influence somebody, and you don't even know.

Of course, as one person pointed out, only partly in jest, sometimes not knowing about the results of one's work could be a positive thing.

> I guess I've been thinking about it in kind of a self-centered sort of way… not getting to know them [the students], and not getting to see anything happen. I suppose it would be just as discouraging to go back and see that they really hadn't gotten anything out of it at all!

In sum, many Squad members recognized the one-shot criticism as valid, and some agreed with it. But they also responded to the one-shot criticism with a variety of counter-arguments. They pointed out ways in which the programs were reinforced by multiple exposures. They identified a variety of ways in which teachers could magnify the impact of the program, by how they planned for, built on, and learned from the presentations. They felt that some of the most significant benefits for students—increased interest in science and new views of science and scientists—were gains that could be made, and even intensified, in a one-shot experience, and that these gains might have lasting, life-changing effects on students.

> When I look back on my own learning experiences and reflect on the kinds of things that I remember both from public school and from my undergraduate degree, the things that were memorable to me were the kinds of things where we did active learning. Where somebody came in and did a special program with us. And when I begin to make the links back, and I think of how some things actually very much informed the choices of the career path that I'm on, and influenced where I've gone, literally and figuratively, in my life, it's often going back to those special events, you know, that were linked to my education.

The Science Squad members also made some perceptive comments in discussing the trade-offs between the model used by the Science Squad and other models that might be possible. Because some of these trade-offs are also linked to the second element of program design, the targeting of under-served schools, we will return to these remarks after discussing that issue.

B. Targeting of Under-Served Schools

A second program choice that had influence on the value received for the effort invested was the choice to target schools with high-minority, low-income student populations. In this region, these schools are largely, though not exclusively, urban schools in the Denver Public School system. The reader should be aware that, in the quotations used in this section, Science Squad members often referred to DPS or the "Denver schools" as a gloss for the general situation of urban schools, not to indicate any particular issues with that school district relative to any others. Likewise, references to schools in Cherry Creek or Boulder are used to gloss suburban schools in areas with higher socioeconomic status. It is understood that these are generalizations—not every school in these districts represents an affluent school without problems, nor that every DPS school is a beleaguered urban school.

Science Squad members commonly reported the impression that their efforts were more meaningful at the targeted schools than at the more affluent schools in the area.

> Sometimes I felt like I was really making more of a difference in the DPS schools. And actually I feel that way now, when I do school programs sometimes or take things out to high schools. Sometimes I'll feel *much* more appreciated in some of the Aurora schools or the DPS schools, than I do if I go to a Cherry Creek school.

Science Squad members found the inner-city students to be enthusiastic and engaged. Because these students had fewer opportunities for interesting, hands-on science work, they relished these special opportunities more than did students to whom this was old hat.

> Those were also a lot of times the most fun school to be in, because the things I was doing, usually, those were things I was doing the students had never seen before. So it was very exciting for them. And the kids at Boulder High School or Fairview [also in Boulder] are a little bit more jaded. They've seen a lot of this stuff before. Half of their parents are scientists or working in high-tech, so that leaves less of the awe and wonder about it.

> I really enjoyed working in the inner-city schools, and, in fact, I found the students there to be more engaged and more involved than, in fact, some of the suburban schools were. The impression I would get from the teachers is that they had these extremely, exceptionally bright students and it was going to be a fabulous experience to come to this suburban classroom. And they were really hard to engage—there was a little bit of attitude there. I found that inner-cities, where I had anticipated I'd be confronted with attitude, was where in fact I found that students were most keen. And they wanted to hear about what it was like to go to university, and they were very involved with the exercises.

Members were struck by the ways in which students in these schools appreciated even what seemed to them to be small things, such as having their own copy of a class handout.

> Most of my programs didn't have a lot of budgetary issues, in terms of purchasing materials, and so I often spent some of that, a lot of money, towards making handouts that students could take home with them. And they seemed to really appreciate that, having like, "Yes, you can keep this paper, it's yours. You can write on it, put it in your notebook, take it home." And I think that they were a little surprised at that, in at least in a couple of schools I can remember distinctly.

In addition, the choice to focus on particular schools concentrated the number of Science Squad programs available to students in those schools, thus amplifying the benefits to them, as we have discussed.

> …Because a lot of the same schools and the same teachers bring them in year after year. I would go to the same school and see the same kids in the hall, over, and over, and over again. …So it's not like a one day, one hour, that I see a kid with Science Squad, because they do have "target," quote unquote, schools.

While several members felt that the students in the target schools received the programs with more enthusiasm, some made a point as well to acknowledge the positive effects on students in more privileged settings.

> I do think that there was probably a little bit stronger response in some of the schools where they just don't have nearly as many labs. But I do think that even—like I went to

> Colorado Academy, I think, a couple of times, and did a forensics lab with them, and they still thought that was just the coolest thing to have these bones out on the table. So even though they're on a campus that's as nice as CU's, I think that they were still equally impacted by it.

One suggested that even more effort to connect with students from underrepresented groups be made, such as developing presentations that are culturally relevant to the students involved.

> I think a lot of it is that it does provide opportunities that they wouldn't have otherwise. When I was on Science Squad, I don't think it was something that I consciously tried to do, is to create programs that were going to be specifically of interest to the population of students who are under-represented in the sciences. I think that's a cool idea though, to try to create Science Squad presentations that are more culturally relevant for the students that we work with.

The BSI is experimenting with this approach in the CardioHEADS project, where curriculum on heart disease and diabetes is being developed to teach science in schools with high populations of black and Hispanic students, who are statistically more likely to suffer these diseases.

One minor disadvantage of this program design element for Science Squad members was that they occasionally had to deal with teachers at the better-served schools who were disappointed by their lack of access to the program. Some of the suburban teachers communicated attitudes of superiority to the urban schools and students.

> [One teacher], at this junior high school up in Boulder, you know—I'd be *much* better up there, his kids are just *so* smart and they were just *so* this and *so* that. And I convinced him that, no, I wasn't going to cancel a DPS program I already had scheduled, that I had these days open, remaining, and that he could pick from those days, but I wasn't going to *not* go to a DPS school in favor of his school, you know. And he just didn't seem to really understand that. (laughs) And then when I got to that school, these kids acted like little prima donnas. I mean, they were smart, I wouldn't say they weren't smart, but they were still seventh and eighth graders, they were still bazoo-ey. They weren't really all that respectful.

Squad members found these attitudes both inappropriate and unjustified. Occasionally, as well, teachers' own stereotypes about scientists slipped through, as in this encounter reported by a Hispanic Squad member.

> I've had some weird experiences. I had experiences where I went to a classroom with my stuff, and the woman looked at me and said, "Oh, I'm waiting for a researcher from CU. Are you here to pick up the boxes?"

In sum, however, Squad members felt well received at the targeted schools. They felt that their work had greater impact because it provided inspiring learning opportunities and new science experiences to students who would not otherwise have had access to them. They were supportive of BSI's choice to target these schools, and personally committed to the goal of increasing the representation of minority students in the science work force...

> That's one of the major goals of BSI, is increasing the number of students from underrepresented groups. Increasing the number of the students who enter the sciences. So going to those schools was a huge priority for me. I mean, I made that a major

> personal priority to make sure that I maximize the time that I spend in schools that were under-resourced.

C. Weighing the Trade-Offs

We have summarized the arguments made by Science Squad members in response to the one-shot criticism, and their observations about the extra benefits incurred by targeting high-need schools. Many Squad members could see the benefits of "lot to a little" programs as well as of the Science Squad's "little to a lot" approach, and they summarized the trade-offs made in each model.

We have already summarized Squad members' arguments that Science Squad's "little to a lot" was not in fact so little. In discussing the tradeoffs, several pointed out the sheer numbers of students reached. If the program did benefit students, even in a small way, the number of students affected multiplied these benefits many-fold.

> As far as sheer numbers of students that we reached, I felt like we had a huge impact—because, you know, in one year, I think that I personally saw over 5,000 students. …And a lot of those were repeat students, but still, I mean just contact student time—I saw a lot of students in one year. But again, whether that had an effect on their behavior, I don't know.

While they could see benefits of alternate approaches, they defended the Science Squad's approach, arguing that the combination of observable benefits and high numbers could balance out models that offered greater benefits but to fewer students.

> I think you need to think about what, where is the biggest impact? Do you want to have breadth, or do you want to have depth? And I think that Science Squad shoots for breadth, it shoots for impacting as many kids as possible, giving as many kids as possible the opportunity, the insight—and teachers—to be involved in this program. To participate, to explore some of their skills, or some of their possibilities. And I think you have to make a decision, whether it goes one way or another, and, and I think Science Squad really wants to impact as many as possible. I know they do! We track, we keep track of numbers of students, that was part of our protocol every day, you know—"How many students did you impact, or did you see today?"
>
> And I think there's a power to the novelty of it. Something that happens once has a novelty that something that's a repeating intervention doesn't have. And there's power to that novelty, and that's not to denigrate at all programs that put somebody in every week for a semester, or—I think there are different benefits to those programs. But I think that there are some benefits of the Science Squad model that you don't get out of some of those other interventions, and then sheer numbers. I don't know the number, I would love to have it, but if I had worked with the same class every week, I would have interacted with, well, probably a full teacher's set, but 30 times five or six or whatever the load was. And instead I would expect that the number is closer to a thousand. It's a different intervention.

They also linked the one-shot argument to the targeting of schools, pointing out that, in the absence of the Science Squad, the students in many of the targeted schools would have none of these opportunities at all. While this intervention might not be intensive, it was better than nothing at all.

> Well, I think it's a valid criticism, but, at the same time I think the target audience of the Science Squad is the DPS school system. And you're talking about a lot of classrooms that don't have very good resources—and even though Science Squad can only come in a couple times a year, if we weren't around, then they might not even get that. And so I do, in a perfect world, yes, see what [you might do] longer-term, maybe go in a few times, to develop relationships with the kids and things like that. But I think that the way the Science Squad is set up now, it's the best way to reach the most number of kids in an effective way.

On the whole, they could see both limitations of the present approach and benefits of more intensive approaches to making lasting change in a particular school, but they recognized the high cost of these approaches and the necessity to make compromises. In essence, they argued for diversity—that a variety of programs should be available, and that every good effort was valuable in its own way.

> I think that's a valid criticism, but it's also a realistic, logistical, reality thing. You can't—the ideal situation would be to adopt a school, or a teacher, or whatever, and follow up on that teacher, providing training to that teacher. That's one of the things that I advocated in the past. "We can't go everywhere, so let's train the teachers also, and maybe get some money to provide some materials and equipment to the teachers, so they can take up that role in that subject matter in the future. Maybe we can go in in the future and do something else." So the scope is limited the way it's done. I don't know how it's done now, but the way it was done then.
>
> (continuing): But I always thought it was invalid to criticize that approach, because if you go out there, you know that that's the only way to do it, with the moneys and personnel available. A lot of the critics, "Well, give me more money and I'll do something different." But I thought that it was a valuable use of money with what we had to pay for it, okay. Over the years, I remember, the first time… there were only three [members]… and then there was more and more. So I don't know, I've never adhered to that criticism. I thought that things could be done better, but things were being done in that way because of the situation at the time.

VII. Squad Members' Advice to the BSI

While, on the whole, Squad members were very supportive of the program as it was designed, many did have suggestions to improve the program.

A. Ideas for Program Expansion, Extension, and Dissemination

Many Squad members, particularly those from more recent years, had had to turn down teachers, and knew the program was fully subscribed early in the year. They advocated expanding the program in order to reach more schools. They knew that demand for Science Squad presenter slots among graduate students exceeded the number available, so the presenter positions could be filled. They suggested expanding the program to include other science departments, perhaps by collaborating with other campus programs.

> I'm a 100% supporter of that program and hope that they're able to maintain funding sources. I understand that it's expensive, but I think it's incredibly valuable and hope that somebody keeps on paying for it. And I would love to see the model expanded

> outward into other schools—and I certainly keep talking about it at conferences and places!

Some were also aware of a new model being experimented with, where Squad members could work more intensively with a particular school and where a school might have a longer-term affiliation with a series of Squad members for several years at a time. They felt this gave more potential for making lasting change at a school.

> I think the Science Squad worked hard to have that not be the case, because we were actually assigned a specific school for a year. Now most of my experiences come from working with one school over the course of an academic year and… I thought that was a pretty effective way to go. The other thing that happened with Science Squad is that a Science Squad representative was continued to be stationed there, as far as I know, for two or three years… and I think that would be enough time to actually make an impact. But I do remember the Science Squad members having different approaches or there were options depending what the Squad member wanted to do. Ah, I know that one person did a lot more traveling around. They had kind of a DNA preparation that they could take from place to place and that's how they did that. But I had chosen, I had said that I wanted to have a target school that I was going to work with… and I ended up working with several different teachers in that school. And yeah, I guess I feel that I didn't make as much of a difference… as I could have, but I guess I also felt like… certainly within the role that I had… some differences were made.

Another model suggested to increase the impact was to spend continuous time at one school before moving on to another school. That way, a Squad member might reach several schools in one academic year, but still spend focused time with each and have time to build relationships with students.

> It might be easiest to try to schedule one month per school and say, "This is going to be my Manual month or my George Washington month." And then that way you are used to going to the same place every week or every couple days, and the kids see you and they can hear from their friends, "Yeah, this month this person from the university is here doing some science stuff with us." And then, you know, maybe they can be able to go into the other teacher's classroom during the free hour to come in and see what you are doing that day or ask questions, so maybe on a month-by-month thing.

Another member suggested that a more intensive engagement with particular groups of students could have greater influence on students' exposure to careers in science and their ideas about their own career paths. These issues could not be addressed easily during the school day, but might be explored in after-school programs

> Because coming in once a week for a science lesson is great, because it gets kids doing things, but… it doesn't really instill a sense of purpose in terms of, for a career focus, for instance. Sometimes you don't really know how to apply this in the outside world… and for minority students in particular, if you have any aptitude in science and math at all, you're always steered towards the pre-professional or professional schools like medical… because there's the incentive to earn money. Well, kids at that age need to be exposed to other career paths and some of them, you make a fairly good living—but students, they don't know this…. You automatically equate, at least when you're at the high school age, "Okay, if I'm interested in science, I'm gonna be a doctor," you know. And so that's

> the one thing, and for some kids that's just not very appealing, but if they knew that they had other options it—I think it would be much more attractive.

For example, Squad members could lead after-school or weekend programs that would enable students to explore a wide variety of science careers with a peer group.

> There could be possibly workshops for the students, and maybe it wouldn't be in a huge class with 30-plus students, but just like Science Squad had workshops for teachers. Maybe there could be special programs either in the summer or on a Saturday… I don't know what would work time-wise for high school kids, or junior high kids too, but maybe there could be workshops where they do something a little bit more in depth than what they did with the lab activity. Or they go to the university and actually get a feel of what a college campus feels like, and looks like. And you know, even walking through a lab and seeing people doing real research and starting to feel comfortable in that environment, a lot of kids just don't feel comfortable in a science lab—they feel intimidated by it. So that might provide continuity and also address some other issues.

> I think it's important to get students involved… I don't know if you want to call it a club or some sort of an organization where students could come together on a regular basis and participate in activities that were maybe science-based, discipline-based, whatever they might be. But that kept the students in touch with one another and provided a support group when the people who were actually running the program weren't around. I mean, so it could be something that could be carried on… outside of the presentations or the activities… and that might be one way. Just giving kids a sense of belonging and being able to provide information outside of the classroom or experiences outside of the classroom that that they would remember and would impact them…..

The types of after-school programs suggested by Squad members have a strong resemblance to the existing MESA program (of which members were likely not aware). If this idea is worth exploring as a future direction of the program, an alliance with MESA might be considered.

A Squad member who had spent focused time in a particular school advocated more collegial exchange for both Squad members and teachers, in order to share the effective presentations that each had developed. Teacher learning was enhanced, she argued, when good work was catalogued and shared.

> We would try to coordinate it so that any presentation we didn't have in our *own* classroom, we would go into *their* classroom and we would just observe it, because we just didn't want to miss out on anything. Through word of mouth, we would try to kind of catalogue what was good, what was worthwhile, and what wasn't. I kind of wish that the Science Squad would recognize that maybe even right on par with teaching students and entertaining students, they—I don't know if they realize just how important their role is with educating teachers.

Another Squad member was concerned about the same issue of preserving and sharing the good work of the Squad members, and recommended a more formalized effort to capture the Science Squad programs so that they could be disseminated to a broader audience of teachers. Over time, many creative activities had been developed and tested, but when the Squad member moved on, these were no longer necessarily available to teachers. By developing an archive of, for example, downloadable print and video-recorded materials, including videotapes of how the

programs work in the classroom, and perhaps classroom kits that could be borrowed or purchased, the BSI could share the knowledge base developed over the years and amplify the impact of the program.

> I guess the message I'm trying to convey here is that the Science Squad has so many things going for it. They perform such a valuable service, but I would encourage them to push themselves into the field of maybe working harder to archive. Because if they could, then you know, every single thing that those people have done—and year after year after year they've got these three, four, five scientists who are working with them, and what's so cool is that this is not just one discipline. You've got people from the chemistry department, you've got people from [environmental biology], you have people from [cell and molecular biology], you have all these different groups and heck, I didn't know, I didn't know half the stuff that these, that these [environmental] people were talking about. And then they do these experiments and I'd say, "Whoa, I've never heard of this. What a cool way to present it!"

Another Squad member pointed out that this type of archiving would not only share excellent materials, but would also help support teachers to integrate concepts within their curriculum by mapping out the concepts addressed in various programs and the linkages between concepts.

> Another thing that might be interesting would be to put together some sort of a Science Squad do-it-yourself book or something… so that the teachers can bring these labs into their own classes. I mean, you lose some of the benefits, but still I think these labs that we were teaching were really very fun for the kids and *did* spark their interest. And then, in that sense, the teachers could put it in when, "Okay, well, when we're learning plant cells we can do this and we can learn about microscopes at the same time", you know. Well, "We're learning about digestion, why don't we learn about diabetes at the same time and have this lab?" So that they can put it in at more appropriate times.

B. Recruitment, Training, and Support of Science Squad Members

In addition to the ideas for expanding the program and deepening and preserving its benefits, members had some suggestions about the recruitment, training, and support of Science Squad members. They emphasized that it was very important for potential Squad members to understand the time commitment and the nature of the work. One suggestion was to have applicants "shadow" current Squad members before signing on.

> The Science Squad staff definitely had us shadow people before—well, actually, I think they did that after we were hired—and that might have been really useful just even in the application process, while we were in the process of applying, to be able to shadow current Science Squad members. Because it is so different than anything else that most grad students encounter in the course of graduate school, t that actually might have been nice to do a little earlier on. And I think that would help people make a very informed decision about just how much time it was going to require and whether or not [it's] a good fit for them.

They felt it was important for the BSI to choose people with diverse scientific interests for the Science Squad.

> Try to pick people that aren't real narrow in their interests, because I think the best programs, I think, are the ones that show students connections. And if that person

> leading the program and being a Science Squad member can make a connection between biology and physics, or biology and chemistry, or ecology and molecular biology, or different things, if *they* have a broad background and can make those connections, they're going to be more likely to bring those connections out in their program, and *they* can offer a variety of programs.

Several members asked for better communication among Squad members. Monthly staff meetings received mixed reviews: While some found these helpful and collegial for exchanging ideas, others had a sense of their work as independent, not collaborative, and did not find the meetings useful. They did however appreciate the small ways in which the BSI staff showed their appreciation and inclusion of Squad members.

> We had fancy cheeses and cheesecakes and grapes and sparkling water, and you know, it's a small thing, but it just made them happy staff meetings! We didn't get a lot of work done, but they were something that everybody looked forward to also.

Several members would have liked, however, more time with their Squad colleagues and the BSI staff up front, while they were developing and practicing their presentations. One suggestion made by these members was to hold a Science Squad retreat to develop and share presentations among Science Squad members.

> One of the things that I've always thought would be neat is to do like a little retreat before the semester started… and this would be like in a dream world, 'cause people don't have the time and stuff, but sort of an intensive presentation-creating time. Where like people like Sam and Kristin [BSI staff members with Science Squad experience] would be there too. To help us out, and you'd have specific blocks of time to work on things… together… 'cause they do a little bit of that they, we do like a two-hour presentation workshop, and it's helpful, but you could use about ten times more of that in the beginning. So I always thought that that would be kind of fun.

> It would have great if we had some sort of a multi-day—though I don't know if it's plausible at all, but some sort of a multi-day thing where we went through our presentations, all of them and did them for the other people. And then of course, if you did that for the other presenters, or this other staff, you'd get some feedback, and you could refine your presentations. Or maybe find some tricks that made it a whole lot easier.

One member suggested that, because of the emphasis on high-minority schools, diversity training be included as part of the Squad members' formal training.

> …They're in the schools full time… and there's a lot of students that are either African-American or Mexican-American, and if they're not comfortable with the diversity issues, it's going to be a disaster.

Some members made suggestions of ways that the BSI staff could help them negotiate issues in their departments and help raise the general status of Science Squad and K-12 outreach. They suggested that the BSI staff could talk with advisors, send congratulatory letters to department chairs about their department's Science Squad members, and help to publicize the Squad members' participation, by supplying, for example, information to be included in a department newsletter.

> I guess it's just always going to be ongoing work to keep selling the concept to the faculty and to the students, and that probably needs always to be just ongoing, one-on-one work in conversations with advisors of potential Science Squad members. And for them to stay in contact with those advisors through that year, so that they hear if the advisors start to stress out about this or that… and can help to mediate some of that. I guess I felt like they're doing what they need to do.
>
> Maybe a letter to the head of the department or something… [my department chair] knew quite well what was going on but I can see, if [someone else] was head of our department at the time, [s/he] would be clueless about what we were doing. So yeah, maybe a letter to the head of the department, and just to make sure that we were getting kudos for doing that… and kind of explaining what the Science Squad is about.

We will address the issue of departmental impressions of the Science Squad activities and the consequences these had for Science Squad members, in our second report on career influences.

C. Impressions of the BSI Staff

Science Squad members were unfailingly positive in their assessment of the BSI staff with whom they worked. They reported that the staff members were enthusiastic and knowledgeable about science, pedagogy, and teachers. Many members commented on the commitment to their work that they saw in all the BSI staff.

> …Those individuals just had and have an amazing ability to make very difficult science topics accessible. So they really had a gift that not all scientists have, which is to not only do and understand research, but how to translate it. And so I always felt like there was just a really great academic community there on that level.
>
> They're just a phenomenal group of people who are committed to support their staff and to delivering their message. Being able to get science out there, specifically to a group of people who doesn't, or who typically hasn't been exposed to it so much.

The staff received high praise for the professional and personal support that they gave Science Squad members in doing their work.

> They are… so incredibly supportive and so much want to help you be successful in what you're doing. We had monthly meetings to make sure everyone's on track and [they were] very much involved with not just what you're doing, but who you are. And if it's working well for you, and how can they help you make it better and, I mean, just bending over backwards, practically, trying to make our job easier, as far as going out and doing what we need to do.
>
> I felt that they were very organized and very willing to drop everything and help you with anything that you had questions about—questions about teachers, questions about your presentations, if you had a difficult teacher, unconditional support and understanding with any problem that you had. And they always had great diplomatic suggestions to use when dealing with—if you had a difficult teacher that was really demanding or something. And we had monthly meeting where they would go through business things, and if there were things that they might have been concerned about, but would always balance any slight criticism that they would have with enormous praise and thanks for our energy and commitment to the program and incredible enthusiasm for all of us and

> whatever presentations we were doing. They had food at every meeting, which was always awesome!

Members also had high praise for the Science Squad infrastructure and logistics that supported their work.

> Everything was very professional. We had the support we needed. We had the materials we needed. We had photocopying when we needed it. We had access to resources, to books, to other people's write-ups of the things they had done in previous years, nationally disseminated books and reports and ideas, regular meetings to de-brief, re-hash, try again, start over, report on problems. It definitely felt like the organization provided full support for what I need… what I was trying to do. And often before I knew I needed it.
>
> They had a system that was clearly explained to us, they had a really good support system for helping us become organized, introducing us to teachers, visiting some of the schools ahead of time before the bookings for our programs began, having us do shadowing, for example, very good quality training so that we'd know what to expect when we fist started as instructors in the program. I thought that the infrastructure that they provided was very good.

Members were impressed with the way the BSI team members interacted with each other, and expressed admiration for the support for individuals' personal needs and professional growth that they saw in the organization—not just for themselves, but for the team members as a whole.

> They are just a really, really, highly innovative team and… they support each other a lot. And I think that they're very flexible and understanding, and that they know that in order to have an effective team that you have to understand and really integrate that person's personal and family needs into the professional environment. So they will be flexible if you have an emergency or a family need or a medical need, so they're very understanding about that and they… have a lot of… I guess, just opportunities, as well, in the organization for people to expand or move, move forward or grow. So there definitely is a lot of potential there for people to learn a lot and move around.
>
> On the other level I think that, organizationally, I think that the staff of the … BSI now, I think that they did and still do, probably, do a really good job of having everyone know what their rules are. And so having clear expectations of how everyone is supporting everyone else as a staff, and that made my job a lot easier. So not everyone is research scientists, or not everyone started out that way, who is currently working for BSI, but the folks who *are* there are very, very good at what they do. And whether that's directing or being a program coordinator or being an administrative leader, it doesn't matter. Each one of those individuals, you know, they are excellent in what they do, and I think that really, their whole community is one of the reasons why I think that they are so successful.

One member described noticing improvement in the program organization over time, and had praise for the way the staff had learned from their experiences and applied this learning to improving the program.

> I saw, as the years went by, more dedication by the staff to try and train the new people coming in, more interaction. When I was there it was at the beginning, and you learn,

> you learn, you're always learning. And the problem would be if you do a program and you don't learn from it. But I saw a learning curve—it got better and better and better. Although I never had any problems, I just never thought there were any very serious problems, I just saw an increase in the ability of the staff to deal with issues as they arose. 'Cause many of the issues that arose were never anticipated.

Several Squad members recognized that this type of supportive and committed organization was not common. They valued their interactions with the staff members as one of the benefits of working on the Squad.

> The Science Squad staff was incredible. …They couldn't have possibly provided any more support or encouragement or troubleshooting. I mean, they were fantastic. So the fact that they had lab staff on hand to help with that prep work who were fabulous, and incredibly detail-oriented and never once dropped the ball on anything, even with incredibly short notice, so that was a huge level of support. And just the administrative staff was fantastic as well. So they did everything that was humanly possibly to make sure that our jobs were as easy as possible and also that we were not only supported in logistics but also I think just in, kind of processing different experiences, or having help dealing with really difficult teachers, or, anything like that. So they, they made it much more easy than it would have been without them. They were fantastic. And just cheerful, exciting, fun people to be around too. That it was such a great environment of colleagues. That's something that I really value too, and I would have never gotten that from being a TA.

> I couldn't give the staff high enough marks. I adore every single one of the people that I interacted with on the staff. They're really wonderful people, professionally and personally. And they're real, they're in it for the right reasons, you know. They're making choices to be where they are, choices that are very different than what other people in their field would make.

As these quotations suggest, Science Squad members were aware that many of the BSI staff members—particularly those with advanced degrees in science—had made the choice to pursue a non-traditional career in science. These people provided glimpses to Squad members of so-called "alternative" careers in science and were role models for some who pursued similar work. The BSI staff were also role models to Squad members for their leadership style and collegiality, and for the workplace environment that the group collectively set. In the second report, we will have more to say about the importance of the BSI staff as role models for the Science Squad, and how these interactions influenced members' career ideas and goals.

D. Concluding Remarks

Throughout the interviews, the former Science Squad members had very high praise for the program. Negative comments were very rare, and superlative language was not uncommon in the interviews.

> Those years with Science Squad were some of the best in my life, in regards to teaching. It was really… I mean, I always think back with fond memories to that program.

> So it was very fulfilling in many ways—from the staff, from the support, from the ideas and the synergies and the developing great and creative ways to present science to the teachers and students—the whole thing was just, it was great.

Their advice to graduate students considering serving on the Science Squad was simple:

> Do it! If you're interested in teaching and you love your science subject area… do it. It is 100% an awesome experience, for… well, for anyone who has any interest in teaching, and loves their content area. 'Cause, I mean, basically, that's what you're doing. You're being able to spread science, what you love, to other people and hopefully encourage them into it, and you're able to teach. I mean, you know, what else can you ask for?