

**Evaluation of the Science Squad Program
for the Biological Sciences Initiative at the University of Colorado at Boulder:
II. Career Outcomes of Participation for Science Squad Members**

May 2005

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Executive Summary

This report is the second of two reports 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 & Evaluation Research, also at CU Boulder. The first report is available from the BSI or from the authors and is entitled:

Laursen, S.; Liston, C.; Thiry, H.; Sheff, E.; and Coates, C. (2004). Evaluation of the Science Squad program for the Biological Sciences Initiative at the University of Colorado at Boulder: I. Benefits, costs, and trade-offs.

Project Overview

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 middle and high school grades and 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 during a school year, up to a maximum of four.

Science Squad members typically serve on the Squad as an alternative to working as teaching assistants (TAs) for an undergraduate 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.

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 to interest younger students in science as a college major or career.

Evaluation Goals and Methods

Our evaluation of the Science Squad program was designed to address the program's longer-term outcomes and factors that contribute to its effectiveness. By many measures, including teacher demand for programs and BSI's internal evaluations, the program is quite successful. For this evaluation, therefore, the goal was not so much to determine 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. In our previous report, we drew on both teacher and Squad member interviews to analyze the benefits and costs of the program, the trade-offs of its design, and the processes by which these outcomes arise, to address evaluation questions #1-3 and 5. In this report, we focus on the career-related outcomes of the Squad members (question #4), and thus draw only on the Squad member interviews. We address members' preparation and career interests entering the Science Squad, their experience during Science Squad and its effect on their educational path, the career-related benefits that they derived from participating, and the influence participation had on their career paths.

We separated the career-related issues from the rest of the evaluation findings for two reasons. First, career paths are complex, and involve participants' incoming career goals, interests, and motivations for participating, in addition to their experiences during the program and their career opportunities and decisions afterwards. We found that, in addition to the coding and domain analysis we conducted for the earlier study, additional methods of analysis were needed to make sense of the rich data set that we had acquired, which are detailed in the full report.

Second, the graduate school experiences and career paths of STEM graduate students are a topic of great national interest at this time, given concerns over the adequacy and diversity of the U.S. STEM workforce. The interest of Science Squad students in teaching is relevant to another major national issue, the quality of U.S. science education and its dependence on the adequacy in both numbers and quality of the science teaching workforce. In the full report, we have attempted to place this program in the context of the research literature on these issues.

Findings

Background and Motivations of Squad Members

Prior to participation, Science Squad members had a long-standing interest in teaching and a good deal of experience doing it. Teaching played a role in their anticipated careers, but in a manner specific to their discipline—“teaching science” rather than just “teaching.” For example, many were interested in becoming faculty and teaching at the undergraduate level, motivated by a love for science and a desire to communicate it. An interest in “giving back” to their community was also important. The availability of funding for Science Squad work and the chance to have a change of pace from the constraints of the research lab were attractive.

The Graduate School Experience

During their Science Squad experience, members encountered a range in degree of support from advisors and other department members. The reasons for advisor and/or departmental support or lack of it focused primarily on the student’s use of time for an activity outside research, faculty views of the value of that activity, and their perceptions of the longer-term career implications for the student. Issues also emerged of the higher value of research than teaching among academic science departments.

Time concerns were raised by both supportive and less supportive advisors—thus time alone was not enough of a concern to explain an advisor’s negative opinion. When the activity was thought to be valuable, members were warned about managing their time, but were generally supported to pursue their work with the Squad. For advisors who were opposed to participation, underlying their concern about time was really a less positive opinion of the *value* of the time spent. Thus, among advisors and others who were opposed, participating in the Science Squad was seen as a distraction from the real work of research, rather than as a useful activity with its own merits for the participant and for society at large. Even members with supportive advisors perceived that, on the whole in their departments, teaching was not valued as highly as research and saw their advisors as exceptions, in supporting their teaching work, to the broader departmental norm.

Thus, while both supportive and less supportive advisors raised the issue of time and progress toward research goals, the real difference in advisors’ reactions lies in the extent to which they valued the activity itself. Also important was the extent to which they accepted and supported their students in developing and pursuing their own career goals. While these two factors were related—an advisor who valued teaching and public communication of science might also more readily support a student’s choice to pursue a career with this emphasis—members also reported as a separate and higher factor their advisor’s support of them as an individual.

On the whole, the picture we compile from the reports of Squad members is one of self-motivated people who felt confident of their own choices despite these choices going against the prevailing norms. Devaluation of their choice by others did not deter them from participating or from feeling positive about their choice to do so. Because theirs was not a choice that would win external approval, members had intrinsic motivations rather than a need for external validation.

Career Benefits of Participation

Members also received direct benefits to their career from their participation in Science Squad. We identified the following categories of career gains:

- Gains of skills and knowledge that improved job performance (mentioned by 14 members);
- Gains of professional resources, including materials, networks, and ideas (6 members); and
- Gains that enhance the job search, including résumé enhancement, interviewing skills, and improved ability to evaluate job opportunities (6 members).

We detailed the totality of gains from participation for members in the previous report. Many of these are also career gains because they were applied to later professional work, whether directly used in a similar job or transferred to new work contexts. Members identified a variety of skills and knowledge gained while serving on the Science Squad that had enhanced their job performance and described how these skills and knowledge applied to their later work. The opportunity while on the Squad to develop their skills and knowledge in a wide variety of classroom settings was seen as important in enabling them to then transfer these gains to new settings in their later work.

Skills were the most common type of transferable gains. Teaching skills were valuable career skills for those who continued in teaching—the majority of our interview sample, as we detail below—but also for some whose work involved explaining complex ideas to general audiences. The process by which members developed teaching skills was also one that enabled them to readily transfer them to new settings. Repeating and refining a presentation under slightly varying conditions enabled members to develop strong, general, teaching skills that could be drawn upon in later teaching work, whether at the K-12 or university level.

It is also important to note that these skills are focused in two areas—teaching skills and communication skills—where previous research has shown that Ph.D. scientists find their graduate preparation lacking, compared to their level of need for these skills in their later work. In this way, participating in programs like the Science Squad may broaden the graduate training of scientists beyond what they obtain in other aspects of their graduate education.

Career Outcomes of Science Squad Members

At the time of the interview, a high fraction (58%) of the participants had committed to a career in education. If those still planning a career in education are included, the fraction rises to 71%. This is well above the national proportion of graduate-educated life scientists, 28%, who cite teaching as their primary work activity.

In addition to their general choice of an education career, members had made choices within their particular career track that emphasized teaching within the specific mix of activities for that profession. For example, of those teaching in higher education, several had deliberately chosen an institution that emphasized teaching over research, or a position where teaching duties were central. Likewise, the K-12 educators in the interview sample had deliberately chosen positions where they felt they could make a difference.

Throughout members' later work, we see a strong commitment to education. However, participation in the Science Squad did not *cause* members to pursue careers emphasizing education. They entered the Squad with a strong existing interest in teaching; many had pre-existing intentions to pursue teaching at either secondary or higher education levels. Nevertheless, it is clear that Squad participation reinforced their interests, gave them skills that

enabled members to pursue these careers, and in other ways amplified the importance of education as an aspect of members' later careers.

Career Influences of Science Squad Participation on Members' Career Paths

We identified two major types of impact that Science Squad participation had on members' career paths. Participating in the Science Squad served to strengthen commitment to and success in a pre-existing career path for some, and helped to clarify, refine, and change a career path for others. These two broad groups constitute 20 members, over 85% of the interview sample—a large group for whom Squad participation was influential in some way.

For a group of members whom we call the “strategists,” Science Squad participation provided the opportunity to further a career path that they had already planned and begun to pursue. These members completed their Ph.D. (or were on track to do so); many also became faculty. Their experiences on the Squad enabled them to develop skills and expertise valued in their future career, to enhance their professional portfolios, and to refine their career choices.

For another group, dubbed the “seekers,” Science Squad helped to clarify a change in career path. Members of this group had a growing sense of dissatisfaction with their previous career plans and used Science Squad as a chance to explore the possibility of a new career, teaching. Compared with the “strategists,” they were more likely to join the Science Squad early in their graduate career and somewhat less likely to complete the Ph.D. as a terminal degree, because their career intentions changed along the way. Their Science Squad participation influenced their career plans by exposing them to new career options, enabling them to refine career choices within a broader field, or enabling them to rule out a career option. In most cases, science education or teaching became a more important element of their careers, although this was not exclusively the case. Aspects of the Squad that enabled clarification of career paths included immersion in teaching, the contrast with their other activities (e.g. graduate research) and the work environment of each, and personal reflection on these experiences.

Gender and the Teaching Profession

Just as Science Squad had greater appeal for graduate students interested in teaching as a career, it also had greater appeal for women than men. Throughout its history the Science Squad program has attracted women participants in numbers that exceed those of women in science overall. Science Squad members hypothesized that the appeal of Science Squad lay in the underrepresented status of women and minority groups in the sciences. Women and members of underrepresented groups face greater discrimination in academe, and Science Squad provided a forum in which women with similar interests could network with each other. Science Squad also represented an alternative to the traditional, research-oriented, scientific path. Members hypothesized that it is more socially acceptable for women in the sciences to become involved with teaching and outreach activities than it is for men because of the traditional view of teaching as “women’s work.” This view of teaching as “women’s work” may also contribute to the devaluing of teaching in many science departments in research universities. Finally, women and members of underrepresented groups appreciated the opportunity to serve as a role model in the community, potentially inspiring young girls and minority students to become interested in science. Participating in the Science Squad, therefore, appealed to women and minorities because it provided an environment where teaching, outreach and mentoring were valued and where they could, at least in a small way, address the inequities in science.

Conclusions

It is evident from our findings, as reported in this and the previous report, that the Science Squad program is successful in many aspects. It provides a variety of benefits both for its student and teacher audiences and for the Squad members themselves. The benefits for Squad members may be particularly salient because these members are a group of science and engineering students with broad interests and a strong community orientation but who are dissatisfied with some aspects of their graduate education. They find in the Squad an opportunity to pursue their interests and develop their skills in education and public outreach, a supportive community, and a rewarding experience that leads to productive careers.

We have enumerated both participants' direct advice and some recommendations from our analysis that may be useful to the program in refining its activities. While this study was conducted as an evaluation of the program itself, we have also placed our findings in the context of national issues of importance. We suggest that this study provides some insights as to the potential of this program as a model for addressing these issues on campus and nationwide. Two aspects are particularly relevant. First, in a climate of increasing emphasis of the role of the research university in contributing to public science literacy, this program may serve as a model for effective outreach coupled with effective graduate education for a selected group. Second, our findings about the career paths and outcomes of the Science Squad members bear on broader issues of the quality and breadth of graduate education for preparing scientists who can be effective in a wide range of future careers.

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We are most grateful to the teachers and former Science Squad members who were generous with their time and thoughtful in their reflections. We thank the members of the Biological Sciences Initiative for their input, particularly Julie Graf for her enthusiasm, interest, and thoughtful comments on this study, Lisa Romero de Mendoza, especially for her help with financial and hiring logistics, and Rachel Cobb for promptly responding to our needs for information. We thank Elizabeth Sheff for her contributions to the interviewing and Carolie Coates for collegial advice at all stages. Elaine Seymour and the members of Ethnography & Evaluation Research are thanked for their interest and input.

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I. Project Overview

This report is the second of two reports 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 & Evaluation Research, also at CU Boulder.

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 that can be adapted 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 during a school year, up to a maximum of four.

Science Squad members typically serve on the Squad instead of working as teaching assistants (TAs) for a standard college course (though they may, and many do, TA undergraduate courses in other years). 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.

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 to interest younger students in science as a college major or career.

A. Evaluation Goals

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 1990. 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?
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- 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. Issues of gender and ethnicity raised in the data were coded like all other issues, but we did not analyze responses for differences in response by members' gender and ethnicity because of the small sample sizes for men and for non-European groups.

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. Sixteen teachers, who were frequent, recent users of the program, were also interviewed.

In the previous report, we drew on both teacher and Squad member interviews to analyze the benefits and costs of the program, the trade-offs of its design, and the processes by which these outcomes arise, to address evaluation questions #1-3 and 5. In this report, we focus on the career-related outcomes of the Squad members (question #4), and thus draw only on the Squad member interviews. We address members' preparation and career interests entering the Science Squad, their experience during Science Squad and its effect on their educational path, the career-related benefits that they derived from participating, and the influence participation had on their career paths.

We separated the career-related issues from the rest of the evaluation findings for two reasons. First, career paths are complex, and involve participants' incoming career goals, interests, and motivations for participating, in addition to their experiences during the program and their career opportunities and decisions afterwards. We found that, in addition to the coding and domain analysis we conducted for the earlier study, additional methods of analysis were needed to make sense of the rich data set that we had acquired.

Second, the graduate school experiences and career paths of STEM graduate students are a topic of great national interest at this time, given concerns over the adequacy and diversity of the U.S. STEM workforce. In addition, the interest of Science Squad students in teaching is relevant to another major national issue, the quality of U.S. science education and its dependence on the adequacy in both numbers and quality of the science teaching workforce. In this report, we have attempted to place this program in the context of the research literature on these issues. The career paths and outcomes of the Science Squad members provide insight not just as evaluation findings for the specific program in which they partook, but as research findings that are of broader interest to the extent that they describe not just this program but a common model for "expert in the school" outreach.

B. Study Methods

The 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. Moreover, a low frequency does not necessarily reduce the importance of an observation—for example, an explanation given by a single individual may be particularly insightful in explaining and relating observations 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.

In addition to the coding and thematic analysis that is described above, and that was the source of most of the findings discussed in this and the previous report, we conducted a second type of analysis of the interview data surrounding participants' career paths, which we refer to as a "life narrative" approach. Though information about their career and educational path was not usually shared by interviewees in a strictly sequential form, we could nonetheless extract this material from the transcript and reconstruct it in a time sequence. From these shortened, reconstructed life narratives, we could discern patterns of career development and in the influence of Science Squad participation on these patterns that were not evident when only the individual events, stages, or decision points of a career trajectory were considered. The method is described more fully in Section VI of the report, where the findings from this approach are discussed.

C. Characteristics of 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 is 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. Among our 24 interviews, twelve had completed their Squad participation one to three years before the interview, eight from four to six years before, and four from seven to ten years before. This spread in the time span of participants meant that the resulting 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, and 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, we interviewed as many of the earlier participants as we could reach. However, because they had been out of contact with the program longer, these participants were also harder to locate for an interview. Moreover, the program supported fewer Squad members in the earlier years. Thus the final sample distribution across time frames of participation is numerically weighted toward more recent participants, but includes solid representation from earlier cohorts as well.

Based on our interviewees' comments, the overall design and goals of the program had changed little over time. A few features had evolved in response to member feedback—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. On the whole, however, the program was remarkably stable in its goals and organization and in the activities and outcomes reported by Squad participants. We were struck by how well participants recalled details of their experience and were able to trace aspects of their current career back to that experience. Indeed, several members 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. We will not report the ethnicity of our interviewees here in order to preserve confidentiality for the small number of non-white interviewees, but the majority (of both interviewees and past members) were of European-American descent. 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 interview sample was drawn, we cannot establish whether this distribution is representative of the Squad participants overall, but it does include the same range of departments as the original roster, with the exception of chemistry. At the time of the interview, all 24 interviewees were still working or studying in science, engineering, or science education or seeking work in these fields.

Most had been graduate students in masters or doctoral programs at the time of participation, and the remainder included mature, advanced undergraduates, recent baccalaureate graduates, and post-doctoral fellows (by their own report of their educational and career status). 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, for simplicity we often refer to the Science Squad members collectively as "graduate students," because this perspective is strong in many of their comments.

II. The Background and Motivations of Science Squad Participants

In our previous report (Laursen, Liston, et al., 2004), we discussed the background of Science Squad members and their motivations for participating in the program. Of the 24 Squad members in our interview sample, a large number had prior teaching experience with school-age students. For some, this included experience in K-12 schools—four held K-12 teaching certificates—while thirteen others described informal teaching experience with students of that age. Experiential education featured strongly in their backgrounds—through teaching hands-on activities such as sports, art, and outdoor and safety skills; through working in youth-serving venues including camps, parks, museums, and after-school and summer programs; and occasionally through their own education, particularly for those with nontraditional schooling.

Twelve members also cited important previous teaching experiences in higher education, primarily as TAs (teaching assistants) in their graduate programs, and many discussed particular influences from working with students who were non-specialists in science. Overall, it is clear that Science Squad members had a strong existing interest in teaching and substantial prior

experience with teaching, particularly in active learning and experiential education. This prior experience may explain their interest in the Science Squad, account for their selection as Squad members, or both. It is clear in any case that the BSI is able to recruit from a strong talent pool. The program director confirmed that the program deliberately seeks to be highly selective in its recruitment, because the quality of the program is so dependent on the quality of Squad members—an opinion shared by the teacher interviewees (Laursen, Liston, et al., 2004).

Members also discussed their motivations for participating in Science Squad. They described both their own experience—what drove them personally to pursue this opportunity—and characterized the motives that they ascribed to their fellow Squad members. We sorted these motivations into broad categories. In descending order of frequency of mention, they are:

- A desire to teach and to share science with others (discussed by 21 members),
- Interest in social justice and educational equity (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, and 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. We discussed these groups of motivations in detail in the previous report, as well as the benefits (and costs) that Squad members reported actually gaining from their participation. The fact that the benefits most strongly resemble their initial motivations suggests that Squad members' prior experiences in teaching gave them realistic expectations of this new experience.

As noted, the two most important motivations for members were their desire to teach and their desire to “give back” to society. These two motives were linked: members saw Science Squad as a chance to serve their communities by supporting education, particularly in under-served schools, exposing students to education and career opportunities in science, and communicating science effectively to nonscientists. The origins of members' interest in teaching went far back, to family and school experiences, and were manifested in a variety of ways. It is clear that the Science Squad experience was not responsible for developing members' interest in teaching, but rather the Squad attracted people with an already strong teaching interest and background, as is evident in examples such as the following quotations.

Oh, I think it's genetic. I come from a family of teachers, my father was a high school teacher for 33 years, many members of my family have taught at various levels, both in public schools and in colleges. So it kind of runs in the family. I had, as an undergrad, held a job where I was working in the city parks... doing education programs for K-12 students, as well as general public, as a volunteer....

I suppose, in the beginning, it was probably in college, which was, “All right, I have all these interests—what do I do with them? What do I major in?” I mean, I'm going back that far. And I had always enjoyed teaching, whether it be outdoor school counseling as a

high school kid, or I taught downhill skiing, I taught swimming, and numerous other stuff, growing up.

Although they had a strong interest and background in teaching, most members did not describe these prior experiences as launching a planned, lifelong career in teaching. They had an interest in teaching, but attended graduate school because they were primarily interested in science. Even if they planned a career in teaching science (at the K-12 or, more often, undergraduate level), they were driven by their interest in and enthusiasm for science and desire to share it, rather than by a more global interest in the development of youth. Thus, rather than as preparation for a career, they described their teaching activities as a chance to share their enthusiasm for science, develop their teaching skills (perhaps as useful to other careers), as a way to combine multiple interests, and as an opportunity to encounter new places and populations. For example, this speaker describes her K-12 teaching work as an opportunity to develop the teaching skills she felt would be needed in her future career as a college faculty member, itself motivated by her interest in the subject.

...I've always actually wanted to teach college or university. And for no other reason other than content matter, basically.... But it always bothered me that college university professors never had to have any teaching education. And, you know, the college that I went to was a good college, but every person there, (laughs) as [in] any kind of schooling, has had the teachers who know their stuff but can't teach. And so I didn't want to be one of those professors.

Another student had sought to apply her science knowledge and experience in different cultures, describing her post-baccalaureate (pre-Science Squad) teaching experience as a self-invented "Teach for America" program. Similar to the participants in that program, which places people as teachers in under-served schools and which targets those who do not have an education degree but who do have an interest in teaching and community service, she had a science degree and wanted to experience classroom teaching—thus she created for herself the opportunity to do so.

I mean, there was nobody doing that at the time, at least not formally. But it was something I wanted to do personally, so I took the classes and certified and taught for a couple of years... the first year in a rural school, and the second year in an inner-city school, and both cases had large minority and low-income populations in those schools.

Teaching was often seen as a way to combine multiple interests—a line of work that took advantage of diverse interests and enabled one to maintain them, rather than forcing one to narrow one's focus.

And so there was definitely those two interests that I wanted to meld somehow, teaching and sort of the medical side of it.

I had worked in the public school system in Denver quite a bit, prior to coming to graduate school, and so it [Science Squad] just kind of seemed like a perfect fit between, you know, my anthropological research and interests, and my experience with education and particularly with the public schools in the Denver metro area.

Comments like these identify Science Squad members as scientists with a broad set of interests, of which science is one among others.

In a similar vein, six members expressed a desire to get out of their department for a change of scene or to broaden horizons. This included both a desire for a simple change of pace from

research and everyday life in the lab, and deeper, unmet needs for more interaction with people and for a greater sense of value in applying their science to issues in the real world. Comments like this one reflect a view of teaching as a way to broaden horizons beyond the confines of the 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.

We discussed these unmet needs at greater length in the earlier report, and we will also return to the departmental norms and values surrounding these graduate students that provide an environment in which these needs can go unmet. It is interesting to note here, however, that while broad interests obviously suit the Squad members well to their role as science ambassador to the schools, this attribute may also signal a certain lack of alignment with the predominant culture of graduate school. In their breadth of interests, this group may resemble a group described by Preston (2004) in her study of exit from scientific careers—people who leave science because of discontent with the narrowness of science. In her study of attrition from Ph.D. programs, Lovitts (2001) identifies the “at-risk” completers (people who complete the Ph.D. but considered leaving at some point) as having broader interests and a greater degree of social involvement than the “on-track” completers who never considered leaving grad school (Lovitts, 2001; p. 93; see also Ch. 6).

As we discussed in the previous report, pragmatic considerations as well as intrinsic motivations played a role in members’ motivations to participate. Eight members mentioned that the availability of funding for their Squad work was important as an alternative to funding as a research assistant or TA. In no case, however, was funding the only motivation discussed; it was always mentioned in combination with other motivations.

In sum, Science Squad members had a long-standing interest in teaching and a good deal of prior experience of doing it. Teaching played a role in their anticipated careers, but in a manner specific to their discipline—“teaching science” rather than just “teaching.” For example, many were interested in becoming faculty and teaching at the undergraduate level, motivated by a love for science and a desire to communicate it. An interest in “giving back” to their community was also important. The availability of funding for Science Squad work and the chance to have a change of pace from the constraints of the research lab were attractive.

III. Science Squad as a Part of the Graduate School Experience

A. Timing and Duration of Squad Participation

The majority (17) of our 24 interviewees were in graduate school at the time they participated in the Science Squad. The rest participated as a postdoc, as an employee with some prior graduate work, or as an advanced undergraduate or recent baccalaureate. Members with only undergraduate education were rare—most participants, even if not enrolled in a graduate program at the time, had already done some graduate work in science. Thus, like those concurrently enrolled in graduate school, they had first-hand experience of graduate work in science and could comment knowledgeably on issues of departmental culture, advisor support, and so on.

About one quarter of the interviewees participated as late-stage graduate students, in their fourth year or later, while another quarter participated in the second or third year of their Ph.D. work. Because some of the latter students already held a masters degree, they also can be considered at an advanced stage in their graduate work.¹ Including the postdocs and experienced employees, we can classify about two-thirds of the sample as experienced scientists at the time of their Science Squad experience. The remaining third participated at a relatively early stage in their scientific careers.

We will comment further on how the timing of Squad participation related to the career influence from participation, but we can make some generalizations here. The data suggest that graduate students were most likely to participate in Science Squad in the latter part of their graduate career. There are several reasons why this makes sense. With their research projects already established, they were out of the “dependent” phase of research and had become independent in research, able to manage their own research time (Lovitts, 2005). Most were no longer taking classes, giving them the flexibility to spend two days a week in the schools. They were beginning to turn their thoughts to the future—as we shall discuss in more detail below, they were developing career plans and took advantage of the Squad opportunity to bolster their career prospects or to explore possible career paths. This is also consistent with a pattern reported by the program director, who observed that many applicants to the Science Squad tell her that they had been aware of and interested in the opportunity for some years prior to applying, and had waited to apply until the time was right to balance their graduate studies and research with Squad participation (Graf, personal communication).

Science Squad members participated for a variety of time periods. The duration of participation ranged from one to six semesters, and up to four years total for one individual who continued with Science Squad after graduate school as an employee. Most participated for the standard term of a year (two semesters), but one quarter re-joined for one or more additional semesters. In fact, the high rate of repeat participation helps to explain the small number of participants available to interview, despite the fact that the program had been in existence for over ten years. It is also testimony to the rewards of the experience that several members continued for more than a year.

B. Reactions of Research Advisors to Squad Participation

Especially in science, graduate students’ research advisors play a crucial, gatekeeping role in their progress through graduate school and career development (Fox, 2000; Fox, 2003; Lovitts, 2001; Pedersen-Gallegos et al., forthcoming). We expected that the reaction of the research advisor to a student’s choice to participate in the Science Squad might be important in students’ decisions about whether and when to participate. The risks of advisor disapproval might be substantial: loss of research support and mentoring, delays in approval of a thesis or dissertation, or lessened support for job and fellowship applications.

We were also interested in the effect of Science Squad participation on career paths. Advisors’ views of the advantages and disadvantages of participation relative to students’ career aspirations may affect students’ own views or decisions. Based on anecdotal evidence from students who inquire or apply, the BSI staff believed that a negative reaction from an advisor deters some

¹ Whether or not a masters typically precedes the Ph.D. is field-dependent. This group appears to reflect what is probably typical: in biology and the “hard” sciences, participants tend to apply to graduate school intending a Ph.D., while a previous masters (perhaps in another field) is more common in anthropology, engineering, or geography.

graduate students from applying to the Squad. We thus asked every Squad member to comment on the reactions to participation that they experienced from their research advisor and others in their department, and on the level of support they received for their choice to participate.

Of the 24 members interviewed, a total of 21 were working under the supervision of a research advisor at the time they participated, either in graduate school (17) or otherwise working in a research group (4) (e.g. as a postdoc or technician). Of these 21, thirteen described their advisor as generally supportive of their intentions, and eight described their advisor as negative about either their participation in the Science Squad or about the longer-term career consequences of this choice. Below, we discuss in more detail the range in degree of support from advisors and other department members, and their reasons for support or non-support, focusing primarily on the student's use of time for an activity outside research, their views of the value of that activity, and their perceptions of the longer-term career implications for the student. As will be seen in the following discussion, participants' choices were often discussed in a framework that assumed a higher value for research than teaching. This issue, as it pertains to advisor and departmental support, is discussed here, but we also take up this question in a later section of the report.

As noted, the majority of Science Squad members reported their advisor to be supportive of their participation, although they did report a range in the degree of support. The most supportive advisors were described as endorsing the student's career development in whatever direction it was leading. They recognized the student's right to make decisions based on his or her individual career and educational goals and accepted the student's choice to pursue the Science Squad opportunity to further these longer-term goals.

I knew people in my department who were like, "Yeah, sounds really cool, but there's no way I'd be able to do it." Not because they couldn't, like, personally they couldn't do it, but because they wouldn't be allowed to do it, which is kind of a shame. And I suppose that just depends on... what the goals are and who you're working with. And I happened to be fortunate enough to work with somebody who was a little more lenient and flexible with my particular education plan.

These factors—support for the student as an individual, and interest in the student's intellectual and professional development—are the same as those cited as important in the advisor-advisee relationship in Lovitts' (2001) work on graduate degree completion.

Supportive advisors were nonetheless concerned about the time commitment represented by the Squad, and its effect on students' research progress.² Advisors were pro-active in alerting the student to the potential consequences of joining the Science Squad for meeting their short-term goals, particularly their research work.

Well, he said, you know, "Do what you want to do, but you know it's not gonna help you get done any sooner." (laughs) I mean he supports me as a person, fortunately. He's a little different than most of the people in my field. But he said he had concerns about it interfering with my work, and me getting done in a timely manner, you know, my degree taking five years instead of four, or whatever.

Such advice may in fact have helped Squad members become aware of the need to prioritize their time, as the following comment suggests.

² As we have discussed previously, the time commitment was not generally described as greater than the appointment made, but did tend to be greater than a nominally equivalent teaching assistantship in the department.

My advisor, he was great. He didn't say, "Bad idea." I mean, there were a few times, I think, when it really mattered, and he'd say, "I think you need to focus on this research, instead of taking on another responsibility." But for Science Squad he was supportive; I think he wrote me a letter.... So I was lucky. And maybe that just was a good match in terms of picking an advisor, but I know other people get a lot of pressure. Even, you know, to not spend time TAing, or working with the graduate teacher program, or things that CU has that are great resources.

As these two quotations also highlight, members did not take their advisor's support for granted. They often pointed out that they had deliberately chosen an advisor who would support them as an individual. Lovitts (2001) finds that "interest in me as a person" is an important factor in students' satisfaction with their graduate advising—and it may be an especially important asset for someone intending to pursue a teaching-oriented career who is studying in a research-oriented department. Pedersen-Gallegos and coworkers (Pedersen-Gallegos, Smith, and Marshall, forthcoming) have discussed how normative hierarchies of career aspirations within disciplines may impose constraints in a mentoring relationship, especially for those who are not pursuing the career paths considered most prestigious (typically, academic positions at research-oriented institutions).

In addition to viewing students as individuals with the right to make their own decisions about their education and career paths, advisors' support was also attributed to the value that these faculty placed on the teaching and public communication of science. Members felt that their advisors valued the societal benefits of outreach work, understood their student's interest in outreach as a motivation behind their choice to participate, and could weigh its broader merits relative to the short-term costs of participation.

Member: Because I think at heart most of them are teachers and they appreciate the teaching. [Goes on to describe individual faculty and their involvement in various education programs.]

Interviewer: So they were supportive of the pedagogy aspect from the beginning?

Member: Oh absolutely, yeah, there was no question, they were concerned about the time, but they weren't concerned about the value.... I think they would have questioned it if I had done it for a couple more years—they would have said, "Well, you know, what about your career?" but for one year, they were very supportive.

As this quotation highlights, support for participating on the grounds that it was a valuable activity was sometimes predicated on the notion that it would remain a well-defined, short-term commitment rather than an ongoing one. This example also raises the issue of the career implications of participating, which we discuss further below.

Though this was not commonly reported, a few advisors were also cognizant of the benefits of this type of work for the Squad member him- or herself, particularly in developing transferable skills.

I think our advisor thought that it was a really great opportunity. She wanted us to not do it forever, because she could definitely see that it was time, commitment—and it is a big time commitment. But I think she liked, and I know she's encouraged other people to maybe look into doing it, you know, for a year or so, 'cause it is a good way to—she saw that it definitely improved my public speaking skills, and I think she sees it's at least, you know, beneficial for that.

Because some advisors (and, as discussed below, other department members) do value both the broad societal benefits of outreach work and the individual benefits to their students, we suggest that BSI share with its participating departments the evidence of benefits to Squad members, K-12 students, and teachers that this work has already uncovered (Laursen, Liston, et al., 2004). This may help build support for its programs and raise the profile of such work in the departments from which Science Squad members come. Moreover, knowing that their work makes a difference has been shown to be important in motivating scientists participating in outreach to continue (Andrews, et al., 2005).

Some advisors were more qualified in their support. They supported science education and public communication of science in principle, and perhaps even participated in these activities themselves, but felt that the commitment required for the Science Squad might be too great for students at an early career stage. Reaction from these advisors was described as weaker than either active support or active opposition, and included neutrality, interest, and sometimes “puzzlement” over why the student would make this choice. Nonetheless, these advisors too respected their student’s choice, even if they did not entirely understand it.

Interviewer: Sounded like your advisor wasn’t all that excited about you doing it.

Member: Well, I think he was kind of intrigued. He was never negative about it, but I think he wondered why I would be bothered to be driving into Denver, and going in and teaching in a Grade 2 classroom as opposed to being a teaching assistant, and then getting on with my day with other things. And finishing a chapter of my thesis, or my dissertation, and things like that. And he’s very much a high-productivity person. But on the other hand, he does do public lectures, he knew the importance of public education, and saw that as important community service, and, you know, he was respectful that that was my choice—but I think that it was not a choice that he would have made.

From the university point of view, I think my research advisor, who is very much focused on his research and a very productive researcher, was a little baffled why I would want to take time out of my busy schedule to do this as opposed to simply being a TA in the department. Which I guess was perhaps a perceived cost from somewhere within my department. But, in fact, I didn’t personally see it the same way.

As seen in these comments by supportive advisors, time (or specifically, timely completion of research work toward the degree) was a concern. In fact, time was a concern shared by all advisors. But for some advisors, the loss of time to pursue research was a concern that overrode any potential benefits to either the student’s own career development or to society at large. Thus, among advisors who were not supportive, time was the primary issue they raised with their students.

My advisor thought it was nuts! “Why do you wanna...? You’re gonna be here longer, why are you doing that?”

Member: I think he thought it would be a drag on my time, and my job was really to do my lab work and write my thesis. And I saw it as very much in line with my overall preparation, and I don’t think this time detracted from my lab work or writing my thesis.

Interviewer: But it sounds like overall, your advisor had a somewhat negative impression of the Science Squad?

Member: I think he’d have a negative impression of anything that took me outside the engineering building.

However, the fact that time concerns were raised by both supportive and less supportive advisors shows that time alone was not enough of a concern to account for an advisor's negative opinion. As we have seen, when the activity was thought to be valuable, members might be warned about managing their time, but were generally supported to pursue their work with the Squad. Thus, for advisors who were opposed to participation, underlying their stated concern about time was really a less positive opinion of the *value* of the time spent. Even members with supportive advisors perceived that, on the whole, in their departments, teaching was not valued as highly as research. They saw their advisors as exceptions, in supporting their teaching work, to the broader departmental norm. Thus, among advisors and others who were opposed, participating in the Science Squad was seen as a distraction from the real work of research, rather than as a useful activity with its own merits for the participant and for society at large.

...[My friend] was in [another] department, they certainly didn't want him spending his time teaching, they wanted him publishing papers. Most of the faculty in [that department] don't teach, their graduate students teach. They don't value that. ...And I think that would be a general rule for science.

Member: Certainly my advisor wasn't a big fan of supporting teaching, so my last year, when I was pretty much finishing up, I decided, "I'm gonna take charge here," and I decided I was gonna do it, and just do it....

Interviewer: Yeah, good. And when you say your advisor wasn't supportive, [you're] meaning that he didn't think that would be a good idea for you to spend your time that way?

Member: Yeah, because in academic science, teaching high school really doesn't improve your credentials in that society. And so it's distracting... in his words it was distracting me away from my research.

These members' reports about their advisors' and colleagues' attitudes toward different careers in science echo findings from other researchers. Pedersen-Gallegos et al. (forthcoming) report that in their interviews with scientists, there is broad consensus that research is more valued than teaching, with teaching below the undergraduate level particularly devalued. Lovitts (2001; p. 287) notes the example of an advisor who described a "brilliant" student who was teaching high school as a "failure." Likewise, Seymour and Hewitt (1997; pp. 197-201) found that, among science and math undergraduates who had considered a career in teaching, some two-thirds were dissuaded from pursuing this career, in part because they felt that their faculty did not value teaching.

Moreover, when advisors were opposed to Science Squad participation, their concerns centered more on the career path implied by the ambition to join the Science Squad, than on the Science Squad position itself. Because of their emphasis on teaching, Squad members' career goals were, almost by definition, different than those the advisor him- or herself had pursued. Thus many faculty did not share or even understand these goals.

I think my research-oriented professors were... fairly neutral toward it, or not particularly impressed. They were training me to be a researcher and that's what was interesting and... that was pretty much it.

As far as the faculty went, at least in my department... I got the impression from some of them that they felt like it was sort of a side track. It was a way to get away from what you're going to be doing, or what you should be doing.

One member made this point particularly clear. She distinguished her advisor's lack of concern about her Squad participation from his disappointment about the career path in science outreach work that followed—in part as a result of her Squad participation and the self-knowledge she gained therefrom.

Interviewer: Talk about support. How did your advisor feel about your decision to do the Science Squad?

Member: I think that because it wasn't any more time than a regular TAsip, my advisor didn't have a perspective one way or the other.

Interviewer: Didn't care really?

Member: No—I think that, you know, that being said, I think it was probably the consequences of where I ended up after my TAsip with the Science Squad that he probably objected to more than the TAsip itself. (laughs) So...

Interviewer: Yes. Do you think he made a linkage between the two?

Member: Uh, no. No, I think it was more—I mean, I think that again, I mean what I recognize through, partially through my experience, was that I wasn't—I wasn't interested in pursuing an academic career in a university as a tenure-track faculty. And so, you know, subsequent to being in the Science Squad then, I made different choices about—I mean, originally, I had been in the program to get a Ph.D. After being in the Science Squad, I realized I didn't have any interest in finishing a Ph.D. I knew that I liked outreach programming a lot more than I liked academic science, and so that gave me the, uh, kind of, clarity to understand that I needed to finish with a Masters and pursue my interests in a different way. So, you know, again, I don't think that my—it wasn't due to the Science Squad, it was just me recognizing something about myself.

Another member also described this reaction. By identifying oneself as the “Science Squad type,” a graduate student could risk giving the lasting impression that s/he was not a real scientist. Declaring an interest in the Science Squad was, in essence, “coming out” as a science educator rather than as a “real” scientist.

Member: And then at other, other times you just, (laughs) you'd hear people say, oh, you know, “Oh, he's on the Science Squad.” And they'll be like, “Oh, that.”

Interviewer: Is that, is it sort of a geeky, geeky thing to do, or...?

Member: No, it was a—um, trust me, scientists are already geeks. There's no problem there. It had to do with... there seems to be an expectation that if someone is in the sciences, well, dammit, they're gonna continue in the sciences. And if you're in research you are in love with research, you immerse yourself with research, and when you get finished you're going to continue with a post-doc. You know, you're gonna continue to pursue a professorship and blah blah blah. (pause) And I think that by joining the Science Squad, it's almost like making a statement that, “Hey folks, I wanna do this.”

Again, this finding is similar to Seymour and Hewitt's (1997) discovery that science students who did maintain an intention to pursue teaching became covert about their plans, in order not to lose the support of their faculty.

A faculty advisor's disappointment in a student's choice to pursue a teaching career might stem from the perceived loss to the field of the talents of a capable student—a compliment to the student, of sorts, though a back-handed one in devaluing their choice to apply these talents to

education rather than research. Disappointment might also be more personal, from simply discovering that a person one is mentoring does not want to be like oneself.

...I kind of felt the whole time that I was in there... that there was sort of a negative—from the perspective of faculty at the school, the fact that I wanted to go into this particular method of teaching, you know, or this level of teaching if you want to call it that, rather than being a TA—kind of, in a way it was viewed as sort of a childish, immature, “Why are you doing this? Because—don't you wanna be like me?” kind of thing. And in some cases it was stated that way, and you hear people ask you at point blank.

In explanation of faculty members' disappointment about their students' career choice, one interviewee pointed out that there is reflected prestige from producing a student who goes on to be a faculty member at a top institution—and thus there is a loss of this prestige if a student pursues a path seen to be of lower status.

I think maybe that faculty have this picture of the Ph.D. student who then gets a tenure-track position, and does a lot of research, and publishes a lot of papers, that everybody knows you were their graduate student, and that, you know, that looks good (laughs) if your graduate student goes on to be a great scientist. And certainly in my field that's, you know, there's a certain amount of prestige that comes from having graduate students who go on to great things. And Science Squad seemed like something of a—maybe a little bit of a distraction.

In a similar vein, Lovitts (2001; p. 281) notes that faculty members asked to describe a successful advisor-advisee relationship focused on the success of the student, “basking in the glow of reflected glory,” rather than the successful relationship that presumably aided the student's development.

Further, members believed, because of the low status of teaching, it was sometimes assumed that those interested in teaching were those not good enough to “make it” in research.

I think there are several professors in [my department] that probably think it's the ones that aren't good enough to make it in science that would do Science Squad.

Member: I don't think it's highly regarded. I mean, I think many of the professors—and many of them are male—I think many of them look down on Science Squad. That would be my impression in biology, anyway.

Interviewer: Why do you think that is?

Member: I think it's the general snottiness you get from professors, I think! (laughs) They look down on high school, they look down on K-12 teachers as not being good as they are, because they're professors. Because I've worked in science for many years. I see the same snottiness with professors as compared to people doing biology in industry. So I think it's a general thing, and the ones that I feel that look down on Science Squad are the ones that I also feel look down on people that research in drug companies. That kind of academic arrogance that I'm not very keen on!

Despite the perceived prevalence of negative views of teaching, advisors often developed a more positive view of the Science Squad as they saw the program in operation and observed its effects on their graduate student. Interviewees reported several examples of changing attitudes. In these cases, support for the individual student leads to greater support for the activity on principle.

Direct experience with the program raises the opinion of its activities and dispels stereotypes that teaching schoolchildren may not require intellectual creativity or deep understanding of science, for example.

I think that my advisor turned around a bit too. I think at first... he was a little bit disappointed that I chose not to pursue an academic research route, but now when I talk to him, he's really genuinely very happy for me... and I think that, you know, his respect for this path has grown too.

There are certain professors who have had more than one grad student who have been Science Squad members, and that [increases] their awareness of this as opportunity for their students to get funding in terms of getting a stipend, but also as a way for them to get teaching experience.... My advisor for instance, I was his first grad student who was on Science Squad... and there had been two more... and with each one, he's increasingly more enthusiastic that that person is on Science Squad.... And I think that's true for other professors that have had multiple people as well.

Thus, while both supportive and less supportive advisors raised the issue of time and progress toward research goals, the real difference in advisors' reactions lies in the extent to which they valued the activity itself. Also important was the extent to which they accepted and supported their students in developing and pursuing their own career goals. While these two factors were related—an advisor who valued teaching and public communication of science himself might also more readily support a student's choice to pursue a career with this emphasis—members also reported as a separate and higher factor their advisor's support of them as an individual.

Member: I know that my advisor thought there were some negative aspects because I wasn't around as much as I would have been had I been just teaching a lab class. But, for myself personally, I loved Science Squad. I thought it was a great experience.

Interviewer: And were there any impacts on you, from your advisor thinking it wasn't a good idea?

Member: I don't think it was that he didn't think it was a good idea. It was just that I think he would have preferred... he would have preferred to have a graduate student that stuck around the lab more often. But I think he also understood pretty well that, you know, *that* was kind of the path that I was starting to choose at that point. That I wasn't gonna go the other route, and continue on and do a Ph.D. and more research.

Again, Lovitts (2001) emphasizes the role of support “for me as a person” in students' satisfaction with their advising relationship—and finds that reports of such support are noticeably more common among students who persist to completion of the Ph.D. versus those who do not. It is interesting to consider how this sampling of advisors' reactions to their students' decision to participate in Science Squad and/or pursue a teaching-oriented career may reflect different approaches to mentoring. While there are several studies that address benefits of mentoring or deficits in mentoring from the graduate students' perspective (Lovitts, 2001; Smith, Pedersen-Gallegos, and Riegle-Crumb, 2002; Pedersen-Gallegos, Smith, and Marshall, forthcoming; and references therein), we have found rather less literature on how advisors view this aspect of their job. However, a few leads are intriguing. Fox (2003) has suggested, for instance, that women faculty view differently from men both their own mentoring role and the type of skills needed by their students to be successful, though her study does not elucidate the differences in practice that may follow from such views. Lovitts (2001) discusses differences in

both attitude and approach among faculty who advise high vs. low numbers of successful Ph.D. completers relative to their departmental norms. In particular, “high producers” were more attentive to students’ intellectual and personal development and made more specific effort to integrate them into both academic and social aspects of the department and the discipline. It would be interesting to know if the reactions of Squad members’ advisors follow any patterns as to either gender or in high vs. low producing patterns, but we do not have sufficient data about the advisors at this time to pursue this question.

C. Reactions from Other Department Members

On the whole, negative responses from advisors were less common than we had anticipated—indeed, the majority of advisors were reported to be supportive. This may be due in part to the deliberate selection of a supportive advisor by these students, knowing that if they had non-normative career interests, they would need a specific type of advisor support. And it should be noted that our sample includes those who did join the Squad, omitting those who may have been deterred by lack of support. However, it is the case that more common than a negative reaction from the advisor was a negative, or at least mixed, reaction from others, both faculty and graduate students, in the department.

My research advisor was supportive of it. I would have to say the department overall, you know, they weren’t supportive. They were like sort of, “Why are you doing this?” And you know, I guess to me it wasn’t any different than how they approached most things that were different than the classic model. It didn’t bother me so much, but they weren’t very—they initially weren’t very supportive of the program.

...and the question would be, “This will do nothing for you in your career, why are you wasting your time?” And I know from other people in the department that there’s people who’ve been interested in Science Squad, that that’s the reception they’ve gotten from their faculty advisor.

Such negative reactions came from peers as well as from faculty, although reactions from faculty may have been more important because they have a greater influence on a student’s progress toward a degree and future career options. Criticism was commonly encountered, though not necessarily widespread: 17 of 24 Squad members reported receiving a negative reaction from someone in their department besides their advisor. However, most members reporting negative reactions from some colleagues also reported positive reactions from others, as in these examples.

I did get some criticism from peers, as well as professors, about committing my time to this instead of doing something that they saw as more professional... but you know, I don’t think that that’s how most people felt. I think that was just a minority.

They think it’s a kooky idea. Don’t wanna have anything to do it, and don’t want it wasting everybody else’s time, and others think it’s some of the most important work we do and support it strongly, so I don’t know....

(continues) I know of at least one graduate student who wanted to do Science Squad whose advisor was very, very, very, very resistant. This is while I was there, so I sat down and talked to him and sent my advisor to talk to him and she did end up doing it. The department has been unwilling, or has at times been unwilling, to include input from BSI into [decision-]making processes even when it affects them.... That said, there were

a handful of really strong supporters who talked in summer institutes and things, and asked me questions about how my Science Squad stuff was going and had a genuine interest in that. It's a mixed bag. And I think it's back to the kooky idea thing....

The risks to Squad members of negative reactions from department members were lower than the risks of negative reactions from advisors, but still non-negligible. As with advisors, time concerns were raised by dissertation committee members, and these had to be managed or defended against by keeping research productivity high.

I think, to a certain extent, they did appreciate the idea that I was going out and getting an interaction with more different kinds of students.... So, it was, you know, "This is a good learning experience for you, it's great that you're doing Science Squad, but don't let it slow you down on writing your dissertation." And that was it. So, you know, I don't think I was ever told, "You shouldn't be doing this," it was just, "Where's your dissertation?" (laughs) "Where's Chapter Four, I want that." (laughs) You know.

Some members worried about repercussions if committee members viewed their Squad participation as a poor choice against other investments of the same time that would have been seen as professionally more meaningful.

Member: There are difficulties—not that, you know, that was just part of the job and it was fine. I don't have any complaints about that, it's just... the only real down side was the reflection of what that meant to my career was mostly nothing, and then beyond that, the time allotment cut into research time.

Interviewer: Right, so personally valuable, but professionally either somewhat meaningless or actively damaging.

Member: Yes. Although, fortunately my advisors, my entire committee was supportive, so there was never an issue on my committee, but easily there could have been. There easily could have been somebody on my committee, who I could have had in the committee and could have been very negative about it.

Another risk was that, by teaching off-campus instead of inside the department, members had reduced visibility in the department, and might not be well recommended for jobs and other opportunities.

I didn't get the time teaching in the department which, you know, if I was going to apply for a job or something at another department, they might say, "Well, Science Squad, why was she wasting her time with that?" So I don't know if that would—um, it's something that just occurred to me, and I would hope that people would see it as an asset, but... I feel like that could come back to haunt me at some point....

...well, I haven't felt this yet in the department, but I was always a little bit worried people would think, "Oh God, she's doing Science Squad again!"

One member reported difficulties in securing the loan of departmental equipment to use in a Science Squad presentation.

Our department chair, I could never get a sense of it. Sometimes she got stingy about lending equipment out to us, which was—I mean, we had spoken to her about it beforehand—but she also worries about details, so that's just her thing.

Not all reactions from the department were negative—positive attitudes were also reported. Just as with advisors' attitudes, positive responses from others were ascribed to the value these colleagues placed on science education and the importance of a scientifically literate public. Such colleagues felt it was useful for someone to be publicizing science in general and giving children a more realistic picture of their own discipline, and appreciative that someone was doing this important work.

It seemed like they appreciated that kids out in the world were getting some botany. It's often (laughs) kinda, of the biological sciences it certainly... isn't the sexy one, it doesn't show up on TV a whole lot, it's not considered especially newsworthy. And so, giving kids a little bit more diverse picture of what biology is about— it's not just medicine—it was something that others seemed to appreciate.

My impression is most scientists are really in favor of it. That's because the more that they can see students getting excited about science, you know, and that—as a career or at least being more scientifically literate, and knowledgeable—is a good thing. And a lot of scientists really—they don't really know what goes on in a high school classroom, to be honest. ...I don't think most scientists really want to be bothered a whole lot with a bunch of zoo-ey high school kids, but they're fine if other people want to. (laughs)

In addition to the mix of reactions among peers and faculty within a department, there were also differences among departments. Some departments, particularly those where grants with research assistantships for graduate students were harder to come by, valued the Science Squad for its financial support for their students. In these cases, the awarding of a Science Squad position was seen as prestigious, and as good news worth sharing with the department, as the quotation below describes. In fact, this member suggests, as a practical way to raise the prestige and visibility of these positions, that BSI send a congratulatory letter or press release to the department.

“We don't have to fund her!” (laughs) ...And my advisor was really supportive. Like, we have a little newsletter that goes out once a week, or maybe once every two weeks, to the department, and she made sure that it was in there that I had been hired by BSI.... She realized that there was an interview process, that we were picked from several people, and so that was kind of nice....

(continues) You know, maybe that would be a suggestion—that a letter to the head of the department that we're funding these people, you know, because we think they're valuable and have valuable things to give to the community. ...In my department, it's a little bit different and so much of our funding has to come [from outside]. And that type of money in the department to support all the graduate students—so anything that we can do to support ourselves was seen as being good.

This may also reflect disciplinary differences, in that departments where research funding was less available are also departments in which research careers are less common—thus teaching may be both a more common career path and a more valued one.

Perhaps the most commonly encountered reaction from departmental colleagues was neither positive or negative, but disinterest. This often stemmed from lack of awareness of the nature of the student's activities, or of the work of the Science Squad more generally. Some speakers

suggested that greater awareness would come from longer exposure to the program within the department.

You know, I think it was pretty variable. I got the impression that people were either involved and really sort of down with it, you know, and kind of interested and excited about it, or else they didn't really know enough about it to really make a decision one way or the other.

I'm not sure they knew exactly what all the BSI was doing.... I may just have a limited perception, but I'm not sure that the BSI was as visible on the CU campus as they might have been. But again I was in [a field that] had only recently been added as one of the sciences represented by the Science Squad, so it might have been different in, you know, some of the biological sciences where they had had grad students for more years—those departments might have had more of an awareness. I think I was very well supported in it, but I'm not sure that I ever discussed it at great length. The departments were very willing to share their materials, however, and I don't think they would have done that if they had not valued the purpose of the Science Squad.

Again, these comments suggest that it might be very valuable for the BSI to share with participating departments the results of this study about the benefits of the program to students, teachers, and Squad members.

D. Coping with Negative Reactions from Advisors and Departments

One reason behind our interest in the reactions of others to Science Squad members is to ascertain whether negative reactions by advisors and others, or even the risk of such, deterred some interested graduate students from applying to or joining the Science Squad. We also wondered whether negative reactions would have consequences for the graduate school success and later career paths of those who did become Squad members. While, as we have reported, negative reactions from some department colleagues were experienced by most members, they seemed to have had relatively little negative impact, or indeed little consequence of any kind that members were aware of. Thus it is difficult to claim that Squad members were in fact marginalized in any meaningful way.

One obvious reason for this finding is that we interviewed Squad alumni—people who did become Squad members, despite whatever negative reactions they encountered, and thus had already overcome any negative reactions. It is possible, as in the second-hand report below, that some graduate students would be deterred by their advisor's reaction (or anticipated reaction) from pursuing this opportunity, but we did not directly interview people in this group.

Interviewer: Do you think that deters some people from checking out the Science Squad who might otherwise like to do it?

Member: ...I think in [my] department it does, because people almost look down on it, 'cause, you know, "It's K-12 science. That's not *real* science." So, I think it does. I think it might, 'cause there is a lack... not much approval from the faculty there.

However, a striking point, and one that comes across in several of the quotations already cited, is the degree to which Squad members were *not* deterred by these negative reactions. As we have noted, many participants were late-stage graduate students or postdocs who had become independent and were planning their careers. Their interest in teaching was long-standing, well-developed, and deeply personal. Feeling confident in their decision to participate and resisting

negative messages from an advisor or others may also have been easier to do in retrospect, at the time of our interview, than it was at the time the decision was made. It is nonetheless noteworthy how common such confidence was.

... [in the] strictest academic sense, I guess there were people that wondered why I was involved with that program as opposed to sticking to the kind of normal path—but that rarely stops me from doing these sorts of things anyway.

Member: He was not particularly supportive of it. Ah, he thought that it would be very time-consuming and would take away from my research hours... but I just indicated to him that I wanted to do it. (laughs) So...

Interviewer: And did that impact you with him, or in terms of departmental resources or anything like that?

Member: Interestingly, I don't recall anything like that. He just mentioned his reservations about it, and I indicated that I was going to go ahead and we left it at that. (laughs) So, and he and I got along quite well and continued to get along, after I was participating in the program.

Members described themselves as feeling sure of their choice to participate despite an initial negative reaction from their advisor or others. They saw intrinsic value in the work and had a personal conviction that this activity was a good fit for them.

Interviewer: And what prompted you to do it anyway? I mean, what changed for you at that point when you said, "Even if this person doesn't value it, I'm gonna do it?"

Member: Well, I feel like I had already... I mean, I had given him enough of my time and I had listened to him enough years that (pause) I owed it to myself to listen to myself at that point.

Some members did report coping strategies that they used to deal with an advisor's opposition. They ignored negative comments or learned not to take such comments personally, and balanced the emotional rewards they gained with the emotional costs of faculty disapproval.

Oh, he was a little passive-aggressive, so he would definitely make comments throughout, that it was a poor choice on my part. But I've kinda learned to let some of what he says just kinda fly. We don't always see eye to eye on everything. And I was getting a lot of gratification from it, so I really didn't let his opinion affect me too much.

Another took pains to ensure, when concerns about the time involvement had been expressed, that her Squad participation did not affect her research productivity.

Member: But I never encountered any sort of problem. I mean nobody ever—other than the comment my advisor made initially—nobody ever spoke to me as if it was a bad idea.... There was just nothing negative that anyone ever said about it. I mean, I think a huge factor was... I think if my research had suffered, I think if I had shown signs of becoming extremely involved in that and in not to seriously pursue my research, then that would've been bad...but since I continued to make good progress toward my degree, it was fine.

Interviewer: But had you actually become more involved at the expense of research, it would not have been fine.

Member: That would not have been fine. I seem to recall that 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 gonna have to make sure I work no more hours than I would work as a teaching assistant."

We noted in the earlier report the high level of professional and personal support that Squad members had received from BSI staff with whom they worked, and the role modeling they saw there of an effective and collegial organization. While no members explicitly made this connection, this additional mentoring from BSI staff may be a factor in members' ability to resist internalizing negative views from others or to respond effectively to them.

On the whole, the picture we compile from the reports of Squad members is one of self-motivated people who felt confident of their own choices despite these choices going against the prevailing norms. Devaluation of their choice by others did not deter them from participating or from feeling positive about their choice to do so. As the following speaker put it, this was not a choice that would win external approval, and therefore one should have intrinsic motivations rather than a need for external validation.

Interviewer: Well, I guess if I had to make a broad generalization, the folks I've talked to who've done it have been fairly, um, independent people who said, "I wanna do this so I'm gonna do it."

Member: ...Yeah. You have to. I think you have to, 'cause certainly if you're doing it to gain approval, it's not gonna happen.

For other students, who may have been interested but did not become Squad members, perhaps advisors' concerns and the low status of K-12 teaching in the culture of academic science did play a role in their choice not to pursue the opportunity. Negative attitudes may deter some qualified students, but at the same time this situation does tend to select for members who are capable of making a choice that is appropriate for themselves and of defending it to others—as this speaker pointed out.

I can certainly tell you that people asked me about it, and they wanted to do it, and in some cases they *did* do it. So, I mean, the interest was there. As far as the concerns or the fears of, you know, repercussions or attitudes towards them (pauses)—I don't know. ...I guess I didn't really hear anybody ever walk up to me and say, "Oh, I'm scared," you know? So I don't think that too many people were. I mean, these are big people. They can deal with some criticism and looks in the hallway. You know, people have to do what they wanna do.

Such self-assured individuals are perhaps also the best people to serve as spokespersons in their departments for the value of their science education work to their faculty and their peers. As discussed above, the attitudes of individuals and of departments can be changed as they see the value of participation to the presenters and the value of the program to its school audiences. While it is appropriate to raise concerns about the effect of possible marginalization of Squad members on the applicant pool, perhaps a better way to address this problem is to use the Science Squad program as a tool for changing minds, and to supply both the members and their departments with good information and arguments to explain why their work is important.

IV. Career Benefits from Science Squad Participation

In our previous report, we briefly outlined the variety of career-related gains that Squad members reported. We now elaborate on this discussion. We identify the following categories of career gains:

- Gains of skills and knowledge that improved job performance (mentioned by 14 members);
- Gains of professional resources, including materials, networks, and ideas (6 members); and
- Gains that enhance the job search, including résumé enhancement, interviewing skills, and improved ability to evaluate job opportunities (6 members).

It should be noted that the overall level of career gains reported—of all three types—may be reduced by the fact that not all Squad members had yet begun their professional careers. As many as eight Squad members were, at the time of the interview, in positions that were by definition temporary: still in graduate school, in a postdoctoral position, or in positions that they described as interim to further education or career positions. They could anticipate how their gains of skills and knowledge might be useful in their planned careers, but could not report actual examples of such transfer. Nor had they the experience of seeking and holding a professional position that would make them likely to report gains in useful professional resources or of job search benefits.

We will discuss Squad members' career outcomes—the careers in which they drew upon these benefits—in the next section. We will also discuss, separately, the influence of participation on Squad members' career decision-making process—which can be considered another type of gain, though less concrete.

A. Gains of Skills and Knowledge that Improved Job Performance

In our previous report (Laursen, Liston, et al., 2004) we discussed at length the benefits to members from participating in the Science Squad. The broad categories of gains reported were:

- Gains in skills, including teaching skills, communication skills, and management and organizational skills (discussed 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, resume enhancement, and networking (23).

As discussed in that report, many of these gains were also gains that assisted members in their later job performance. These gains are obvious when the same skills and knowledge are directly used in a similar job, but such gains may also support job performance if they are transferable to new work contexts. For example, a gain of teaching skills may be useful to someone who is not a teacher but whose job includes explaining complex ideas to a wide variety of audiences. In the discussion that follows, we discuss the gains that speakers identified as applicable or transferable to their later career setting, and the ways in which these gains aided their job performance.

Skills were the most common type of transferable gains. Teaching skills were valuable career skills for those who continued in teaching—the majority of our interview sample, as we detail below. As discussed in the previous report (Laurson, Liston et al., 2004), the process by which members developed teaching skills was also one that enabled them to readily transfer them to new settings. Repeating and refining a presentation under slightly varying conditions enabled members to develop strong, general, teaching skills that could be drawn upon in later teaching work, whether at the K-12 or university level.

So you really get a chance to hone some teaching techniques. And that's been some skills that I think I've developed well—in all reports I get back from the students on faculty evaluations 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 kind of just try different angles.

So the kinds of things that we were encouraged to do with the Science Squad were to have very active presentations to encourage participation with the students. ...And just that suite of tools, I find very helpful in the university environment as well. For example, coming [here], I have reworked our entire introductory lab program. We have 600 students that come through our introductory science course. ... And they have twelve new labs that they are doing, that have been rewritten since I arrived to be more active-learning types of education experiences. ...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, again, I feel like I have tools that allow me to have the students actively participate in a lecture.

As we discussed previously, these gains in teaching skills were more than just a set of separate skills—they added up to the development of a personal teaching style.

I think I gained a lot of just 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 kind of keep the kids on task and directed and with me. I think I learned a lot of just ways to present different ideas, to try to reach as many kids as possible. So I think it helped me kind of figure out what my teaching style was. I think it shaped what my management style was gonna be.

Communication skills were also often transferable, as the next quotations highlight. Science Squad members who did not teach in their subsequent careers nonetheless emphasized the benefits of learning to give effective presentations to a variety of audiences, especially non-technical ones.

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.

I definitely think it's a gain from Science Squad. I really thought it was important—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. And I really had to fight my advisor on that, he was like, “Oh, nobody'll care.” And 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.

Particularly useful was the ability to adapt a presentation to the needs of different audiences.

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... as you say, use that language so people 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?

Another member whose career continued in science education was able to apply to her later work the approach to curriculum and teacher professional development that she learned and developed as a Squad member.

...probably, more than any other place, I think that I developed the way that I interact with the public... I developed it with the Science Squad. So... and what I mean by that is that 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 you, 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.... I think 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. And it's, I mean, it's helped me a great deal.

In the previous report, we also discussed Squad members' gains in understanding education issues such as student learning, the structure and nature of the educational system, the work of teachers, and classroom diversity. These gains in understanding also sometimes supported members' job performance. For example, this Squad member, an instructor at a community college, was able to apply the increased understanding of diversity that he had gained from the Science Squad to his work teaching a diverse group of college learners. Again, the opportunity to repeatedly practice these skills—in this case, working with a wide array of learners—was seen as building this knowledge in a way that was then applicable to new settings.

...It's a really diverse collection of people there. Diverse educationally, diverse, you know, ethnically, and economically. And so Science Squad was a really nice, sort of, intro for that. Just, you know, just 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. ...Because in Science Squad we'd do, you know, one presentation, you usually have some sort of a standard presentation, and you'd have to kinda figure out how to maybe modify that a little bit, if it wasn't going so well. It did provide me, I think, with experiences that I use currently, you know, to a great extent, teaching at a really diverse community college.

Another described the importance in her current position of understanding that some student behaviors in the classroom may reflect cultural differences rather than their academic performance.

I think I didn't realize the implications of cultural differences in the classroom. ...I never knew how, 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, members identified a variety of skills and knowledge gained while serving on the Science Squad that had enhanced their job performance. They described how these skills and knowledge applied to their later work. The opportunity while on the Squad to develop their skills and knowledge in a wide variety of classroom settings was seen as important in enabling them to then transfer these gains to new settings in their later work.

It is also important to note that these gains are focused in two areas—teaching skills and communication skills—where previous research has shown that Ph.D. scientists find their graduate preparation lacking, compared to their level of need for these skills in their later work (Smith et al., 2002; Pedersen-Gallegos et al., forthcoming). In this way, participating in programs like the Science Squad may broaden the graduate training of scientists beyond what they obtain in other aspects of their graduate education, a point to which we will return later.

B. Gains in Access to Career Resources

Several members gave examples of career resources gained from the Science Squad that they continued to draw on. These included useful materials, models for programs, and professional networks. One member still used some of the teaching materials she had developed, even though she was now teaching at the college level.

I actually got some teaching materials that I still use. You know, they've developed a little bit over the years but, you know, a lot of pieces of it I still incorporate. So it's kind of a tool.

Another hoped to share her teaching materials through a professional publication.

We're gonna try to take some of our lesson plans and experiences from the Science Squad and try to publish them in a teaching journal.

A few gave examples of ways in which they had shared their experience with the Science Squad with the broader science education community. Some thought of the Squad as a model for contributing to new programs at their own institutions.

And actually one of the things that I'm floating with the education department here is using an almost a Science Squad model for some of their early experiences in school.

But also, into the future, I can see where, I mean, I think there's some good potential [here] for some outreach program. And my contribution would be largely based on the types of skills and experiences that I had in Boulder with Science Squad.

Two members mentioned the benefits of career networking. Those who worked in outreach work, either as their full profession or as a sideline, continued to interact with their BSI colleagues. Those working in the region could also borrow materials from the BSI or continue to interact with some of the same programs they had encountered as a Science Squad member.

I have a set of colleagues that are still at University of Colorado, Boulder, that I still collaborate with... and so, you know, the possibility of kind of furthering each of our own efforts, whether that be through grants or through ideas or through, you know, collaboration on workshops, you know. I have a community that has remained with me... since I've been in Science Squad. So I think that's a concrete outcome for myself.

Member: I had experience with those sorts of programs before, but if I was not introduced to those programs here by the Science Squad, I would not be doing those today. So my outreach interest—so going out to the schools, that sort of thing, are due directly to being involved with the Science Squad.

Interviewer: Yeah, yeah. So it really plugged you into a network, and resources.

Member: Exactly.

This transferability of this type of career gain—resources and networks—was necessarily specific to the particular career that an individual pursued, but educators in both higher education and K-12 education and outreach mentioned such benefits.

C. Gains that Enhance the Success of the Job Hunt

In addition to specific, transferable skills, knowledge, and resources that they made use of on the job, some members also reported that participation in the Science Squad had contributed to the success of their job hunt. These members included those applying for faculty positions as well as those seeking K-12 education and outreach positions. As we discussed earlier, concerns about how Squad participation would affect members' careers were often raised by advisors and others colleagues as a potential negative outcome—so it is important to recognize that, to the contrary, members cited their experience as directly helpful in getting the types of professional positions they wanted.

In the teaching-oriented positions for which these members were applying, their Science Squad experience was taken not only as proving their ability to do the work, but as a signal of genuine interest in teaching and commitment to the community—both positive attributes for these positions.

But being able to teach and then (pause) work on my own academics as well, and just having that kind of experience to show, you know, [a] school that I really have a commitment toward education in general and my own education, has helped a lot professionally.

...and I mentioned my involvement in the Hughes program, you know, on my résumé. I talked about that briefly in the interview as one of the outreach things that I had done... ah, and I think that figured favorably in my being hired. ...I just got a positive response from it. I think that people took it to mean that I was interested in... in being part of a community rather than just at a university.... And I think that's how I couched it, that, you know, not only had I done work within the strict confines of jobs that I had held but I had also tried to...use my education in other ways, like to, you know, work with high school students and so on.

Member: [X College] was somewhere that I also had my eye on for quite a long time, because, you know, they have this intensive program in creative teaching. And so... I'm confident that Science Squad actually helped boost my résumé in getting that job, or giving me some experience for that.

Interviewer: Yeah. So why did this kind of experience help with that?

Member: Again, I think it was just sort of demonstrating creativity in teaching, and dedication to teaching. And additionally it was just more experience.

One member gave an example of how her Science Squad experience enabled her to excel in a challenging teaching assignment during her job interview.

I'm supposed to give a bit of credit, I think, [to] the Science Squad, for me even holding this position.... The one thing that I have been told over and over, after my interview, after I joined the faculty [here], was that they were very impressed with my ability to teach at the undergraduate level, to come into—part of my job interview was to go into a lecture hall with 200 students, and I was asked to give a guest lecture on a topic on a topic from their textbook. And it was a topic that I'm very familiar with, so I was very comfortable with the material, but they had said to me—it wasn't until I was well into the lecture, you know—a couple people actually said to me, "You seemed so calm, cool, and collected coming in and speaking to a room of 200 people you've never met."

(continues) I felt good about the lecture that I gave, and obviously it was a successful one, because they offered me the job shortly afterwards. But again, 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. ...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.

Finally, better understanding of the education system made Squad members more savvy as applicants for positions in that system. Again, this member emphasizes how Science Squad experience developed this awareness, through exposure to a wide range of classrooms and schools.

Member: I taught so many 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 of—a real scope of what's out there. I was in a great position to look for a high school teaching job locally.

Interviewer: Yes. Since you had the scoop on so many schools?

Member: No. I knew a lot, I knew better questions to ask. I mean, even if I didn't, even if I didn't do it locally, I knew what—I didn't ask any of the right questions when I got my first job. Umm, and I knew better questions to ask. That actually played out some in my interviews for this position and others that I had.

While several members cited gains in their job hunt, another member did wonder whether others would not value the Science Squad position on a curriculum vitae. In particular, she suggested that there might be a tradeoff in choosing Science Squad over a standard TA position for an undergraduate class, particularly when applying for faculty positions.

Member: I didn't have a TAship in an undergrad class to put on my résumé. Umm, but I got a job anyway. So I don't know if that—I mean, clearly that may have gotten me a different set of interviews, but I think the Science Squad got me the set of interviews I got or at least in part so. I mean, I did give up something to do it.

Interviewer: Meaning the TAsip?

Member: The TAsip, but I think that what I did proved to be more of a—I mean, I thought at the time it would be, and I think it did, prove to be more valuable to me in my career goals. And heck, I don't know, I expect that there's some search committee somewhere that threw out my application because that's what I did, and they don't want kooky people....

The seriousness of this issue depends on how likely it is that member would have only Science Squad teaching experience rather than a combination of Science Squad and standard TAsips, combinations that were evident in the discussion of other interviewees.

Clearly, however, whether or not Science Squad experience was perceived as aiding the job hunt depended on the type of job one sought. For instance, these members gave examples of differences in schools that would affect the relative value of Squad experience as a résumé-builder.

...They certainly didn't want him spending his time teaching, they wanted him publishing papers. ... They don't value that. So I think it depends on the department, and what their, you know, their basic tenets are. ... And I think that would be a general rule for science. But if you wanna go and teach at a small institution, a liberal arts school for example, they're gonna care. That's gonna help your résumé there, you know. A lot of students, some students that I know have left and gone and taught at private schools with their master's or something, and the Hughes Initiative has been really helpful there.

...Doing Science Squad doesn't really particularly help, it didn't really particularly help my résumé. If I had published two papers during that time in that, I would have probably got a better job faster, at a "better," quote unquote, institution, you know what I mean.

Similar to the earlier discussion about the views of advisors and other departmental colleagues of the Science Squad and teaching more generally, these quotations highlight members' perceptions of the lower status of teaching as a profession in academic science departments. We will discuss this issue in more detail in a later section.

In short, the largest category of concrete career benefit was the gains of transferable skills and knowledge that improved members' later job performance. Gains that aided the job search and that provided specific resources were also reported, but by smaller numbers of members.

V. Career Outcomes of Science Squad Members

A. Nature of the Career Information Available in the Data Set

Before we discuss the current careers of former Science Squad members, we must offer the caveat that the information we have about members' current careers is not consistent in timing across the data set. Because we did not interview all members at the same time relative to their Squad participation, we cannot report data in the typical form of outcomes data, e.g. the fraction of participants in this or that career at some specific time after participation. Because each cohort is small, such a study would require a very lengthy longitudinal study to gather sufficient data to draw conclusions.

In particular, we interviewed Squad members from the previous ten years, back to the early days of the program. Our sample is biased slightly toward later participants, both because earlier participants were more difficult to find, and because the program has grown in size—the first Squad cohort had three members; while later cohorts have had up to six. Multi-year participation further reduces the total number of individuals available for interview from some cohorts. Among our 24 interviews, twelve had completed their Squad participation one to three years before the interview, eight from four to six years before, and four from seven to ten years before. Thus members' career stage at the time of the interview was variable. While some members had been in permanent positions for several years, others were still completing their graduate or postgraduate training, or holding jobs that they defined as temporary.

B. Current Careers

Despite this variability, there are some clear patterns in the career outcomes of Science Squad alumni. They were highly trained in science: 19 of the 24 interviewees held or were completing the Ph.D. in a STEM field at the time we spoke; 4 more held or were completing another advanced STEM degree (masters or professional degree). None had left the field—all were working in a STEM-related job, though two were temporarily unemployed at the time we spoke.

A strikingly high proportion of members worked as educators. Of the 24 interviewees, eight were faculty in higher education, five of whom were tenure-track. Six worked with K-12 education, either with students as teachers or tutors, or with teachers and schools as outreach professionals. Seven were still completing their graduate or postdoctoral education; at least three of these were planning to pursue tenure-track positions. Thus a high fraction (58%) of the participants had committed to a career in education. If we include those planning a career in education, the fraction rises to 71%. This is well above the national proportion of masters' and Ph.D.-level life scientists, 28%, who cite teaching as their primary work activity (SESTAT, 1997).

It should also be noted that a sizeable fraction (21% of all interviewees; 29% of those who had completed their education) of Science Squad members did indeed become tenure-track faculty members—comparable to the fraction (32%) among all biological science Ph.D.s who are tenure-track faculty (SDR, 2001). It would appear that the reported fears of faculty and peers that participating in the Science Squad would “derail” a career in academic science were not well founded. However, the type of institution members selected may not be representative of all academic institutions, as we discuss in the next section.

C. The Central Role of Teaching

In addition to their general choice of an education career, members had made choices within their particular career track that emphasized teaching within the specific mix of activities for that profession. For example, of those teaching in higher education, several had deliberately chosen an institution that emphasized teaching over research, or a position where teaching duties were central.

And so my main goal is, or my first focus is the subject matter, and then my second focus is I really enjoy communicating it with people. And so I have decided to take a job that is 60% teaching, and that fits me very well.

I would ideally like to get a tenure-track position at a school that's primarily undergraduate teaching, but where I can do research with my undergraduates, and still do

some publishing. But not, not a Tier 1 research university, where it's a pressure-cooker state, "publish or perish" situation.... Doesn't really fit my personality.

The ideal route would be, you know, a job where I could be teaching undergrads. It's not necessarily important to me to be teaching grad students, so I could see myself at a smaller school.

As we discussed in the section on members' background and motivation, the desire to integrate multiple interests was common. These quotations emphasize this idea through their language about balance and blending.

And that is, a blend of teaching and research, so that the faculty here who have tenure track are evaluated on their teaching first, the research second and then their service, and they're all excellent teachers here. But they do have time to do research and they do get a lot of research done. It's a nice mix.

I chose [this university] because it's not a Tier 1 school, because there was already outreach work going on here, and I think that's important to give back into the community, and because they value that, they value the balance. They value the balance, and the person.

Among members who had become college faculty, many had specialized to some degree in teaching non-science majors. They expressed a particular interest in this group, and through their Science Squad work had developed a talent for teaching them.

I think that it may have influenced my interest in teaching students who are not necessarily science majors. I was hired, for example, in this job I'm in right now, to teach a large non-majors class... which enrolls a lot of students who are taking the class simply to fulfill their science requirement.... And they come in fairly intimidated and unexcited about science and... I still have that enthusiasm to try to get them interested and excited about science, and I still enjoy that, that challenge... and I think being in the Hughes program reinforced that.

And, you know, I teach introductory environmental science now, and ah, it's because I'm good at it. (laughs) At least they've told me that. You know, they want to attract majors, they don't let people who don't have any teaching skills teach this course. (laughs) That's the feedback I've gotten at least... and it's very much inquiry-based and you know, I think the students enjoy it. Even the non-majors.

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 to, I think, partly to the Science Squad as well, is trying to get other non-science oriented people excited about science and understanding science.

Several also discussed their involvement in outreach as part of their faculty work. One member had volunteered for an environmental education program as a postdoc. Another helped lead a program to recruit minority high school students to his university. Some described future plans rather than current involvement—many of the faculty interviewees were still early in their careers and were understandably watchful of their time constraints.

There's actually a pretty fabulous outreach program going on in this department already.... So, yeah, I plan to become involved, I'm starting to get a little bit involved.

And I'm elated. I mean that's why I'm at this department is because they care about those kind of things.... The student body is pretty diverse, the faculty here care about that, there's opportunity to do the outreach. So I feel like I can do the research that I've come to enjoy, and do the teaching that I really enjoy, and yet, also participate in sort of promoting, you know, science to younger people.

I think at some point down the road I'd like to see a similar type of program, in my department. We do have an outreach program that's, at this point, kind of in its infant stages of development. But, I can see, in a few years, places in which I could contribute more substantially to that. And that would absolutely be drawing on my experience from Science Squad.

Members' statements about their outreach activities echoed the values that they had expressed about their original motivation to participate in the Science Squad and the benefits that they saw provided to students through the Science Squad.

Volunteerism is important to me. And I choose my volunteerism to look like outreach to kids, 'cause that's what I enjoy, and I think it's important. And I think there's a lot of kids out there who don't know what their opportunities are, and I really saw that as a Science Squad member. Most of those students didn't even know what an engineer was, didn't even *know* an engineer, don't have an engineer of any type in their family, and had no concept of that as something that they could become. Let alone a scientist, or biologist, or whatever. And so, it's important for students to have those role models, and to understand that there are opportunities.

The next quotation comes from a faculty member who remained in academe but had, within her faculty career, changed positions from a research-focused, Ph.D.-granting institution to teaching at a more diverse university that emphasized undergraduate teaching.

I mean, I knew that I was definitely interested in teaching, you know, a nice balance between teaching and research... and at [my former institution], you know. they don't really care about undergraduate education. You don't get any credit for good teaching. And in terms of my lab and my students, I was very successful at getting students and funding and all that stuff, but I didn't like the fact that I always had to have a lot of students in order to get research done, you know and so it meant that I became a manager rather than actually being out there doing things. And so, you know, it just got too crazy and you know, that was also a major complaint. And so now at [my new university] I can have a much smaller program. I can work predominantly with undergraduates and that's really where I think, you know, I can make a difference, is at that level.

Like the college educators, the K-12 educators in the interview sample had deliberately chosen positions where they felt they could make a difference. For one member, this meant a choice to teach at the middle school level, where she felt students lost interest in science and thus her skills in teaching science could matter most. Another chose to work in an under-served school.

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.

[My school,] it's the worst performing school in the state when it comes to [standardized test] scores and things like that. It's the school that if you're gonna read about a school

that's got problems and has to experiment on all sorts of different, new techniques and that could be shut down at any day and blah blah blah....

Finally, members who were not working directly in education nonetheless cited the importance of their educational interests as a part of their careers, especially for communicating scientific ideas to non-scientists and for interacting with young people.

A lot of the people I talk with 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 gonna 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, like, normal people....

It has certainly helped solidify my commitment to working with under-served populations and taught me great presentation skills. I truly enjoyed the experience and would highly recommend it to anyone interested in science education or health. (from a member pursuing medical school)

Throughout all of these examples of members' later work, we see a strong commitment to education. As we have discussed, participation in the Science Squad did not *cause* members to pursue careers emphasizing education. They entered the Squad with a strong existing interest in teaching; many had pre-existing intentions to pursue teaching at either secondary or higher education levels. However, it is clear that Squad participation reinforced their interests, gave them skills that enabled members to pursue these careers, and in other ways amplified the importance of education as an aspect of members' later careers. We examine the influence of Science Squad on shaping members' subsequent career paths in the following section.

VI. Influence of Science Squad Participation on Members' Career Paths

A. Methods of Analysis

In addition to drawing on the coding and thematic analysis that forms the basis of the rest of this report, we analyzed the career paths of Science Squad members using a “life narrative” approach. Although information about the development of their educational and career path was not usually shared by the interviewee in a strict sequential order, we were able to reconstruct the sequence of participants' education and career paths—their backgrounds prior to their Science Squad participation, their graduate school or other career situation at the time of participation, and their post-Science Squad career trajectories and career plans. Some participants were still in graduate school or in other non-permanent positions (such as postdocs) while others had held career-track positions for several years, so their status varied. Because we were interested in potential effects of Science Squad participation on career paths, we asked participants about the key decision points in their career paths. For many participants we had fairly detailed accounts of the reasoning behind their career choices and retrospective statements about their career intentions at various times—for example, at the time they entered graduate school, or at the time, later on, when they decided to join the Science Squad.

Having reorganized relevant portions of the interview data into sequential narrative form (and omitted the rest of the data, such as statements about benefits to students), we then divided each narrative into short segments that distinguished key time periods, decision points, and career-

related thoughts, intentions, or behaviors for each individual's narrative. When we aligned these segments across the group of participants according to temporal and thematic commonalities, we were able to discern across the data set some patterns of career development and of the influence of the Science Squad on career development. Essentially, the data were organized as a two-dimensional matrix, with a single, sequenced, life narrative forming a "row" and common time points, decision elements, and career actions identifying the "columns." While in theory we could have coded for some of the same ideas that emerged as column headings (e.g. career intentions upon entry to graduate school), in many cases the significance of these statements did not emerge until we had sequenced and aligned the narratives. Often the patterns did not share common content, but did share a common sequence—for example, members' career choices were not the same, but they did share patterns of change in career choice that emerged from examining the sequence of original career intent, developing dissatisfaction with that intent, Science Squad's influence, and later career development.

An analogy may help: imagine a pile of necklaces that share some beads of the same type—perhaps green, white, and blue beads are seen on every necklace—while other beads are seen on only one or a few necklaces. Thematic coding is like dismantling necklaces to sort the beads into piles of green, white, and blue (while carefully marking the beads to note which necklace they originally came from)—sorting ideas into categories and noticing which ones are common or rare. Our life narrative analysis was akin to looking for patterns in the sequence of beads across the pile of necklaces. Discoveries may emerge from noticing that the sequence green-white-blue is common to several necklaces, that both yellow and pink do not occur together in any necklace, or that white often appears between two dark colors but never next to yellow. The patterns occur in the sequences of ideas, not just in the individual ideas. To use a second analogy that may assist biologists in particular (and perhaps no one else!), the difference is the same as that between a protein analyzer and a protein analyzer. One instrument measures the composition of a protein by the proportion of each of its constituent amino acids, and the other determines the sequence in which the amino acids have joined to form a long protein chain. Both types of analysis are useful, but answer different questions.

Our approach shares with the narrative analysis methods discussed by Riessman (1993) its focus on the stories respondents tell to make sense of their experiences, and a recognition that people construct and interpret past events and actions to "create a plot from disordered experience." Both the content of the story and the manner of telling the story may be important.

How individuals recount their histories—what they emphasize and omit, their stance as protagonists or victims, the relationship the story establishes between teller and audience—all shape what individuals can claim of their own lives. Personal stories are not merely a way of telling someone (or oneself) about one's life; they are the means by which identities may be fashioned. (Rosenwald and Oehberg, 1992, p. 1; cited in Riessman, 1993).

We have used the life narratives to compare both the career outcomes and the "plot lines" of Science Squad members' career paths. In looking for patterns, we drew on both the career path directions that we could extract from the narrative and participants' retrospective explanations of their career and educational choices and the factors—that is, both the events, as we could determine them from the narrative, and participants' explanations of events. We discuss these patterns in detail below. Briefly, we find that, for a majority of our interview sample, the effect of the Science Squad on members' careers can be viewed as falling into one of two major

patterns. For one group of members, Squad participation provides confirmation of an existing career path and enhancement of members' ability to pursue that path successfully. For a second group, the influence of Squad participation is clarification of career path that is part of an overall change in direction, whether identifying a new path, refining a vague career direction into a specific path, or ruling out a path under consideration.

B. Confirmation of an Existing Career Path

Nine of the twenty-four Science Squad members formed a group we called the "strategists." For these members, Science Squad participation *confirmed* a career path that they were already following and enhanced their preparation for that career. These members had entered graduate school with a particular career plan, joined the Science Squad with that career plan still in the forefront, and used the Science Squad experience strategically to reinforce and validate their original plan by building their skills and their resumes.

The majority of this group entered graduate school planning to become a faculty member at an institution where they could combine teaching with research. Their path was a normative path for science Ph.D. students, in that they pursued academic faculty positions, but less traditional in that most placed emphasis on teaching-oriented than research-oriented institutions.

I think I've always been kind of aimed at the liberal arts college university. So... that was right up there at the top of my list.

And so there was definitely those two interests that I wanted to meld somehow, teaching and sort of the medical side of it... And then I just looked at schedule, or different flexibility with schedules, and that led me to, coupled with wanting to pursue the ... advanced knowledge area, content area, led me to, "Okay, you know, I think I wanna teach college/university." The reason I went to graduate school was, basically, in pursuit of the ultimate goal which was to be teaching college/university.... Whether it's [Science Squad] changed my career path, probably not, 'cause I'm probably still gonna continue with, wanting to do the, you know, the college, university or something. They're related independently.

Consistent with their intentions, they were also successful in obtaining such positions. Among the nine, six were either on the tenure track or were still aiming for tenure-track jobs (for instance, while holding temporary academic positions at the time of the interview). A seventh was still pursuing her education and still on track in her plans to seek a tenure-track position. The remaining two among this group had never intended to pursue tenure-track faculty positions. One became a high school teacher, and one held a non-academic, professional position where public communication skills were valuable and regularly used. What they have in common with the others is not their specific career, but the fact that they have a career that matches, in large measure, their planned career prior to Squad participation and used Science Squad in part as a "stepping stone" to that career.

We call this group "strategic" in their approach to the Science Squad because, while their motivations to participate in the Science Squad were no more instrumental or career-focused than any other group, they both anticipated in advance and valued in retrospect the contribution of Science Squad to their career development. Science Squad participation confirmed their existing career plan and enhanced their prospects for seeing it to completion.

...I think the Science Squad got me the set of interviews I got, or at least in part so... but I think that what I did proved to be more of a—I mean, I thought at the time it would be, and I think it did, prove to be more valuable to me in my career goals.

Participation in the Squad strengthened both the teaching component of their résumé that got them in the door for an interview and the interview skills that helped them clinch the job, as well as providing skills that were useful on the job. We have already discussed, in the section on career gains, specific examples of how Squad participation provided these benefits. In each of the following quotations, we see evidence of how Squad members from this “strategic” group not only gained these career benefits, but had the forethought to develop them through their Science Squad experience and anticipated their utility in both obtaining and successfully doing their desired jobs.

I really thought it was important. 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. And I really had to fight my advisor on that, he was like, “Oh, nobody'll care,” and um, 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.

... 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, in inner city, suburban...” And so I thought, ... “This would probably be a neat way to do that, and you know, it'll look good on my résumé to have done some more different things.”

Member: [X College] was somewhere that I also had my eye on for quite a long time, because, you know, they have this intensive program in creative teaching. And so... I'm confident that Science Squad actually helped boost my résumé in getting that job, or giving me some experience for that.

Interviewer: Yeah. So why did this kind of experience help with that?

Member: Again, I think it was just sort of demonstrating creativity in teaching, and dedication to teaching. And additionally it was just more experience.

While these quotations highlight that members anticipated career benefits from participating in Science Squad, we emphasize that in no case were members' motivations strictly instrumental. As discussed earlier, genuine interest in teaching and a desire to “give back” to the community were motivations expressed broadly across the interview sample. What we emphasize here is the strategic thinking of this group: that Science Squad participation supported their career aspirations is not an accidental byproduct, but one of their multiple goals in participating, and a goal largely achieved. As will be seen below, this pattern is distinct from the thinking of others in the group.

Because career considerations weighed into their thinking, this group tended to participate in Science Squad for a year, not longer. The intrinsic rewards of participating were ongoing, but one year was sufficient to provide most of the career benefits they sought, while investment of a second year might yield a diminishing career return. As the following speaker discussed, he weighed his enjoyment of Science Squad against the career implications of continuing to participate for an additional year.

I was in the Science Squad for one year and I could have continued, but I was also—I recognized that there were other... I needed to diversify my teaching portfolio. If I went through my graduate program having taught primarily for the Science Squad, I don't think I would have been able to obtain the job [I have now]. ...[T]hey would have said “Well, okay, he's got all this research, but he's been teaching high school level.” So yeah, I recognize that, that that was a good thing for a year, but that was really about all I should do. Not that that's all I wanted to do, but that's, you know, the career path I was headed down. Those things were not going to be rewarded and they're not rewarded still.

They also participated relatively late in their graduate careers, in the middle to late stages of their Ph.D. work or between the masters and Ph.D. All of the members in this group obtained a Ph.D. as the terminal degree, except for one who had not completed the Ph.D. but was intending to do so. This pattern too is consistent with their use of Science Squad to enhance their career prospects—they joined the Squad when they were far enough along in their graduate work to be confident of finishing, independent enough to do so whether or not their advisor supported them,³ and beginning to plan their search for career-track positions.

On the whole, then, the “strategists” were those who were confirmed and supported in an existing career path. They entered graduate school with a particular career plan and were still pursuing that plan when we spoke with them. Their Science Squad work assisted them in executing that plan, while their other experiences in graduate school (or after) had not drawn them off this path. That is not, however, to say that they never wavered in their career choice. Like any other graduate students, they had moments of doubt.

I certainly went into graduate school knowing that I wanted a job that would let me teach. Not always confident that I was gonna be able to get a faculty position, or that that was really... or that that life was what I wanted—so I certainly had my waffle days where I thought, “Well, I should just go work at some company and just be done with it.”

For one person, Science Squad participation nearly proved the downfall to her career plan, because it provided a more attractive alternative than the slog through graduate school. We discussed in our earlier report the fact that Squad participation provided emotional rewards of feeling that one's work was worthwhile and meaningful, through students' and teachers' positive responses. This speaker felt this strongly in contrast with a difficult period of her graduate work.

I mean, the Ph.D. process is one that in the middle, you can't remember why you started, and you can't see the end, and so quitting seemed like a really good idea. I don't know anyone who's ever not wanted to quit at some point in the process. And Science Squad fueled that for me, because I saw something that I could do that would be very gratifying, that I could do instantaneously.... You could get, you know, a position right away, 'cause there's need there, you know.

In the end, however, this speaker pursued her original intent to finish the Ph.D. and gain a tenure-track faculty position. As we shall discuss in the next section, her experience was not uncommon. For some participants, these rewards outweighed other factors and led to transitions in career plans.

We have grouped these members as having been confirmed in their career plans, but this is not to say that they made no career decisions or transitions after their Science Squad time. Rather,

³ We did not find a correlation between the support of advisors and the career influence groupings.

these decisions and transitions occurred largely in the specifics (e.g. the type of institution at which to seek faculty positions) rather than in the broad type of career path. The following quotations illustrate such decisions—one from a person already in a tenure-track position, and one still in graduate school.

My experience at the Hughes Initiative [former name of the BSI], and, as well as my experience as a Ph.D. and postdoc, made me want to choose an institution that is a balanced teaching and research institution. I am happy, you know, I came to that again at the end of this postdoc, 'cause a lot of the faculty positions that I had interviewed for were not places I wanted to be.

One of things that I'm also thinking about is teaching at a small liberal arts college, and I think... in terms of my credentials, I think I'm fairly competitive. My main problem is that the research I've been doing does not transfer well to a smaller setting, 'cause a lot of those small liberal arts colleges, in terms of the science projects that they want you to bring, are things that undergraduates can do, 'cause there's not a graduate school associated with it, and there's not the same research staff. So I'd have to, I'd actually probably have to change my focus a little bit... I don't know if too many small liberal arts colleges are set up for that kind of research.

These quotations show that the members were still very active in considering their career decisions, but that the nature of these considerations was to refine the details more than to determine the broad strokes. It is also interesting to note that these quotations reflect subtle considerations about career alternatives that, we may speculate, may in part be informed by the greater understanding of teaching and the education system that many participants reported as a benefit of participation.

Finally, our use of the term “strategists” should not be read to mean that these members were single-minded careerists. Other factors besides the job characteristics alone entered into their decisions. Given the large number of women in the interview sample, it is not surprising that dual-career and family issues loom large among these additional factors.

You know... with the baby (laughs), I'm not sure what's gonna happen in the next year or two, but... um, I definitely still want to pursue my Ph.D. and have the option of being a faculty member at a university, teaching and research.

A lot of support from my husband through some of those times, as well, to sit down and talk about really what would the impact be on the family and on him. Where would we move? What would we do? Could he do that? It's a struggle. Female scientist. Little kids. Husbands with jobs. ...I had a big support network there... and academics clearly meant leaving that.

In sum, for a group of nine members, Science Squad participation provided the opportunity to further a career path that they had already planned and begun to pursue. These members completed their Ph.D. (or were on track to do so); many became faculty. Their experiences on the Squad enabled them to develop skills and expertise valued in their future career, to enhance their professional portfolios, and to refine their career choices. While we do not have comparative data with other groups, we might imagine that this may have helped them find a better “fit” in their first position and avoid some of the pitfalls of trying to fit in a position that is not a good match.

C. Clarification of Career Options

For a second group of eleven interviewees, the Science Squad had a more profound effect on their career plans. For this group, participation in the Squad stimulated *clarification* and *change* in career path: it offered a new career option that they had not previously considered, clarified a particular career direction within a broad range, or ruled out a career path that had been under consideration. Because this group often viewed the Squad as an opportunity to explore different career possibilities, we call them the “seekers,” and our choice of this term will become more clear in the following discussion. We will first discuss the broad commonalities among this group of eleven, then look more closely at particular subsets of this group.

1. The “seekers”: Common Elements of Clarification and Change

Like the “strategists,” most members of this group had a career in mind when they entered graduate school. On the whole their plans tended to be less well defined than those of the previous group, though this characteristic alone was not sufficiently distinct to distinguish the groups. Work by Smith and Pedersen-Gallegos and colleagues (Smith et al., 2002; Pedersen-Gallegos et al., forthcoming) shows that uncertainty in career plans is typical of many graduate students.

I don't think I necessarily have as well-developed a plan when I entered graduate school as maybe some of the other students do. Um, my plan has been more of a work in progress!

A more important distinction was that, at the time of their Science Squad participation, they were questioning or reconsidering their initial career plan. Some who had intended a research career were becoming disillusioned with this idea.

It was very clear to me after my ... postdoc that I hated research, but what was completely unclear to me was what I wanted to do instead. And this was a big black hole mystery.

Member: I really liked the Science Squad—I enjoyed it a lot. And you know, I think I realized in some ways how unhappy I was in my graduate program by doing the Science Squad. I realized that I could do something that was work and have fun doing it and really be excited about it and have a passion for what I was doing that I had sort of lost in the midst of doing my Ph.D. research....

Interviewer: And what had you gone into graduate school—or what were you thinking about career, before you started with the Science Squad?

Member: Oh, I was definitely thinking that I was going to be a professor. Um, you know, I don't think I'd narrowed it down as to whether I wanted to be [at] a research institution or whether a liberal arts institution, but, you know, I definitely had this image of myself being a professor.

For these members, Science Squad participation was an important influence in prompting further revision of their career plan or development of a new plan altogether. This came about because the Squad provided a low-risk opportunity to explore teaching as a new career possibility, without completely or permanently abandoning the track that had originally brought them to graduate school. This opportunity to explore was timely, because they were already questioning or reconsidering their careers. In the following quotations, the language of opportunity—of

exploration and testing, of trying on a career possibility for size—is prominent, as it is in other observations from this group.

So, you know, I still was reluctant to give up the research academic track, so I decided ... that I would basically take a year ... and do the Science Squad... and spend the rest of my time looking at what opportunities were out there. And by the end of that year, I realized that I was actually very happy doing outreach work, and that I was okay with giving up the academic research path and devoting myself to a different career path instead.

I had a teaching assistant.... I was teaching just the most general freshman biology lab, and that was first time I had ever taught was those labs, and I really enjoyed it. And so, I kind of 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, you know, possibly thinking about going down that path and so I thought Science Squad would be a really good opportunity to, you know, let me figure out if that's something that I wanted to do or not—be in the public school classrooms.

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, and see if it was really an avenue worth pursuing....

The combined pattern of dissatisfaction, or the beginnings of it, with their previous career plan, and the use of the Science Squad as a chance to explore another possibility, is what prompts us to label this group the “seekers.”

Among the eleven in this group, seven were in relatively early stages of their graduate work (or had not commenced it at all). Dissatisfaction may arise at different times during the educational path, but for these members, questioning of their career plans tended to arise earlier in their path, leading them to take action to explore other options before committing more time to the degree. For the “strategic” group, these questions did not arise (or at least did not predominate), so Science Squad could be pursued at a time that was more convenient in other ways. Members in this group were also much less likely than the strategists to complete a Ph.D. as their terminal degree—again, consistent with the notion that once they had discovered that a research career was not for them, they were more likely to adjust their plans if the Ph.D. was not needed to pursue their new career goals.

These quotations show as well the variation among individuals in the extent to which they had already turned away from their original career plans when they began to work with the Science Squad. Some were only beginning to explore alternatives, while others had clearly rejected their original idea and were actively looking for something else. Their reasons for leaving their original career plan included a mix of “pushes” away from research and “pulls” toward teaching, as well as other pushes and pulls such as geographic and family considerations. The following quotation illustrates a mix of pushes and pulls that were active at the same time.

I just found that I really liked working with the public as much as I liked working with college students, but that there was, that I just, you know, I started to do it on many different levels in my spare time and so, so you know, when this opportunity came up, it

just seemed to fit with what I was already doing. Plus, you know, as a sideline, even though I'm really interested in research science, I began to discover that really wasn't—I knew that wasn't going to ultimately be my career. I wasn't planning on continuing on in academia as a professor. I wasn't planning to continue on as a researcher *per se*. I really liked the topics that I was studying, but it wasn't compelling enough to be my lifelong career, and so I was kind of more drawn to working with the Science Squad, because it just fit with my goals, and also my abilities.

Another person had thought deeply about why a career in research, her original intention, was not a good fit, based on extensive research experience. At the time of her Science Squad experience, then, she had already decided not to pursue research, but she had had much less experience of teaching to draw on in deciding whether a teaching career would be a good fit. Here she discussed her well-defined reasons for leaving research, then her questions about a teaching career that she hoped the Science Squad experience could help to answer.

These aren't in any particular order. They'll be in the order they pop into my mind. And a lot of them were equally contributing. But, there's a lot of ... a personality mismatch. In that, when you do bench work a lot of the experiments don't work, and I need a lot of positive reinforcement. So that was very mismatched. I was *so* discouraged and took it on myself a lot, that the experiments didn't work. ... So I would try to compensate by trying harder and then I would fail more and I would get more depressed. So, you need a kind of person who can move on from, "Oh, this isn't me, the experiment just didn't work and I'm just gonna have to try something else and..." It was, I would just take it all on. You also sort of need to be a competitive salesman to sell your grants and your project. You know, when you go to meetings, you have to sell your idea is better than other people's and when you write your grant it's why this idea is best and I'm not so competitive. I like much more working in a more collaborative nature. Um, it wasn't a good match at all, from that standpoint, either. I'm also really a people person, and although you get contact with other lab members, you don't see an immediate, direct impact. You might invent a vaccine and save a million lives, but that would be 50 years from now if you're lucky. And so that wasn't really working for me, either.

(continues) 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. But it was certainly an option from my experiences.

In contrast with the ample experience of research that she used as a basis for evaluating the match of her own strengths, interests, and temperament to those she saw as necessary to succeed in research, she had much less information about teaching, and her questions were broader.

In addition to pushes away from research and pulls toward teaching, family and personal reasons entered the mix as well.

And from a personal standpoint I wanted a job where I only worked 40 hours a week. I wanted my weekends and I wanted to be able to go to part-time if I had a kid, and, which I very much wanted to do. ... I also wanted to pick where I was going to live, and you're damn lucky if you get to pick where you want to live when you're a researcher. More, you have to go where they need that research specialty. So I had a lot of personal reasons too. I wasn't willing to sacrifice a family and a living location.

In addition to a chance to explore teaching-related career possibilities by immersing oneself in teaching, the Science Squad experience also provided a framework for reflecting on one's aptitudes and preferences.

I mean, what I recognized through, partially through my experience was that I wasn't interested in pursuing an academic career in a university, as a tenure-track faculty. And so that, you know, subsequent to being in the Science Squad then, then I made different choices about—I mean originally, I had been in the program to get a Ph.D. After being in the Science Squad, I realized I didn't have any interest in finishing a Ph.D. I knew that I liked outreach programming a lot more than I liked academic science, and so that gave me the, ah, kind of clarity to understand that I needed to finish with a Masters and pursue my interests in a different way. So, you know, again, I don't think that my—it wasn't due to the Science Squad, it was just me recognizing something about myself.

This speaker claims that the Science Squad did not influence her choice, and yet it is clear from her preceding commentary that it did. What she means, we argue, is that it was not a simple cause-and-effect process. The wheels were already in motion for a career change, through dissatisfaction with the academic science career that was on offer in her research department. Science Squad did not initiate this change in career path, but working with the Squad provided a contrast with her research activities and put into relief the differences in the work activities and environment that provided the evidence she needed to sort out her preferences. Other experiences might have catalyzed this same process of self-reflection equally well—but it seems clear that Science Squad did so for this person.

In sum, what the “seekers” have in common is a sense of growing dissatisfaction with their previous career plans and their use of Science Squad as a chance to explore the possibility of a career in teaching. Compared with the “strategists,” they were more likely to join the Science Squad early in their graduate career and somewhat slightly less likely to complete the Ph.D. as a terminal degree, because their career intentions change along the way. Our research group has seen this strategy of trying a career on for size in a previous research study of undergraduate research apprenticeships in the sciences, in which undergraduate science majors pursue summer research as a chance to try out research either as a potential career or as a taste of the graduate school experience (Seymour, Hunter, Laursen, and DeAntoni, 2004).

2. Positive Clarification: Discovery of New Career Options

Among this group of eleven members for whom career options were clarified, seven found their participation in Science Squad to clarify their career options in a positive way, by adding a new option. In general, Science Squad participation added teaching to the mix in a much more substantial role than it had played in their earlier plans. Some members were drawn into new career paths. For example, four now worked in professional outreach roles.

So I think that I had already started along this path before entering the Science Squad, but once in the Science Squad I knew that this was really what I wanted to do for my career. And so everything that I've done since then has been a real—you know, I've really concentrated [on] finding those opportunities that would allow me to continue to do what I'm doing and eventually lead to a position where I could be directing my own program, which is where I am now, so... I think it really crystallized.

For most of these, professional work in science education was a career path they had not recognized as a possibility until coming into contact with the BSI staff as Science Squad members.

Interviewer: And had you, did you know that such positions existed before you did the Science Squad? I mean did you know that was an option when you were in grad school?

Member: I had no idea. I had no idea. You know, I knew [a BSI staff member]... I knew that she had this position and that she was over in the building next door, that she did something, but I really didn't know what she did or what it involved, or you know whether it was temporary or long-term or what the deal was.

...I don't think I even initially saw it as a possible career option. ... I guess over time it started to dawn on me that ... a job of this sort ... might be okay. It sort of slowly grew on me that, "Oh, designing stuff could be fun, and maybe I wouldn't have to spend hours working out the details."

In fact, even among Squad members who were not in this group and did not go into outreach work, the discovery that there were trained scientists who made a living as professional science educators was a common, but new, insight gained from working with the BSI staff.

So that was an eye-opening thing, that it's not all just research, or you know, wet-lab kind of experiment stuff, that there is a whole social science field, and the different age levels too, and education levels to make that transition, so that was good to see that that type of job existed and worked.

...it was nice to see how other Ph.D.s were able to fulfill their science and their other needs by pursuing, by being with the BSI, for example.

Member: This time next year I'm gonna be on the job market again, and I was sort of stretching my mind, and thinking about, you know, various alternatives. ...So, so things like that, you know, come to mind. And it is nice to see that there are people who are doing good work, and seem to be, I think, using their Ph.D.s well, and kind of working a slightly alternative venue within the university system. I also know the people who work at CIRES, with their kind of outreach education program. And that also seems kind of like a neat possibility.

Interviewer: Yeah... so that's a little thing in the back of your mind?

Member: Yeah, yeah. And I wouldn't say... and I'd say probably that before that time, I hadn't thought about it so much. I certainly was introduced to it by everyone who worked with the Science Squad.

A fifth person in this subgroup of seven had no prior interest in a teaching career before starting graduate school but became a K-12 teacher. She discovered her desire to teach during her Science Squad experience, and drew on it to determine the student age group that she most preferred to work with.

I would say in the first two months I decided that I definitely wanted to get in the classroom. So (A), it helped me make that decision. And then... 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. I guess that was my—that was the age group that I really liked. I liked all of them, but particularly like the middle school kids.

The final two of the seven were still in graduate school, but were now strongly considering either teaching at the college level or outreach work as new career possibilities that had not previously been under serious consideration. They had not necessarily rejected research to the extent that some of the others had, but had added teaching to their set of potential career options when it had not previously been important. We place them in this group with those who did pursue a new career because they testified that these new career options had been added to their list after exposure during the Science Squad experience.

But actually the Science Squad has also, um, started my interest in education and science education in [a] K-12 outreach program—so doing something like BSI, it's another place. It's something that I think about quite a bit also. Yeah.

I had no clue! (laughs) I have never heard of that, at all. But yeah I definitely, now that I've seen it, I'm like, "Yeah, that's a really good option for down the road."

Thus, for seven members, the Science Squad experience influenced their careers by opening new career options that they then pursued. We group these members both by their career outcomes—the change in career path that they pursued—and their own testimony about how the Science Squad work had opened their eyes to this path and given them the opportunity to try it out. Although their initial degree of uncertainty, dissatisfaction, or rejection of their previous career plans varied, they used Science Squad to explore a new possibility and found within a new career option that gave a better fit. For those who had not yet entered a career, new possibilities were under consideration. We nickname this group the “discoverers.”

3. *Negative Clarification: Ruling Out Career Options*

Of the group of eleven, four had found the Science Squad experience clarifying in a negative sense—each ruled out a career option (in fact, the same option, K-12 classroom teaching) as a career path. The term “negative” is used here not to indicate that they felt negative about teaching or their Squad experience, nor that this was a negative outcome personally. Rather, we distinguish this subgroup from the “discoverers” because their decision was to rule out a career option rather than to add a new one. This is still a useful clarification of career possibilities and thus a positive outcome for the individual.

Like the “discoverers,” members in this group had used their Squad experience in part to test their interest in teaching—but the outcome was different, as they had discovered it was not a good fit. While ruling out classroom teaching was the principal career decision taken, these quotations also show how other career ideas might emerge—for one person, outreach work with teachers, and for another, teaching higher education.

And after seeing the high school situation, (laughs) I give those people a lot of credit but I couldn't do it again. *But*—working with teachers is a better level for me. So yes, in that way it definitely told me I didn't want to *be* in the high school classroom, consistently, again.

Member: I do think that I decided that I don't ever wanted to teach those levels. It helped me decide that I don't have any interest in being a middle school or high school teacher. Which I don't think is a problem, but it's something that I had kind of contemplated prior to being a member of Science Squad, and had spent enough time, in the course of Science Squad, even though you're never in one place for any length of time. But seeing such a variety of students and teaching styles and that kind of thing, it

just—you know, I really did decide that it's not something that I am particularly well suited for or interested in.

Interviewer: Yes. So it's, ah, it clarified that for you.

Member: Yeah. It really helped me make that decision, which I think is great, because it is something that I had been thinking about prior to that. But it also made me much more comfortable with teaching in general, and so more interested in, maybe, teaching maybe at the college level, which is something that I hadn't given as much thought to before. So it actually, you know, made me much more comfortable getting up in front of a classroom of students.

It should be noted as well that this clarification was “great” for the member, even though it was a negative clarification that ruled out a career path previously considered.

Like the subgroup who found new career options, both “pushes” away from some careers and “pulls” toward other careers were evident in the reasoning of the members about their career decisions, as were additional factors such as work-life balance.

Member: ...given the choice, I think I prefer, and I think I'm more suited to, and I prefer research to teaching. My frustration with research is really when it's part-time, that it's hard to do enough. Umm... but meanwhile it seems to work, and while I feel like I can contribute something even part-time, I think I will stick to research, but it has been quite a hard decision.

Interviewer: Yeah, yeah. It sounds challenging. A lot of different factors to balance.

Member: Yeah, yeah... and I enjoy, really honestly, really I enjoy both, and they're both very different, and they both have good things and bad things, so....

We discussed in the previous report (Laursen, Liston, et al., 2004) how one of the costs of participation for many Squad members was discouragement at the magnitude and difficulty of the task of improving science education, given the sometimes-grim realities of school settings and resources. The following dialogue illustrates how exposure to the realities of the school experience could lead someone to decide that a career in K-12 teaching was not for him or her.

Member: It killed any aspirations I had of teaching high school. I mean, you know, the Science Squad experience wasn't bad, but you know, it did give me some insight into the public school system, at least in Denver. And it just was not very appealing. I mean, I don't really see how high school teachers deal with it on a day-to-day basis. Ah, you know, there weren't enough resources... there were language issues in most of the schools we were in, and ... as graduate students we weren't equipped to deal with a lot of the challenges that we faced. I mean, it wasn't like we could just show up and teach something. We were also expected to keep the classroom under control. Sometimes students had problems on that given day and we had to deal with those. It was just, (laughs) it was beyond... beyond what I expected.

Interviewer: Yeah, so it was an eye-opening exposure. ...And did you know that then? I mean did, by the end of that year did you know you weren't going to pursue a high school teaching career?

Member: Yeah, pretty much. (laughs) I mean, my father was in education, so you know, I was pretty familiar with what goes on at that level, K-12, and umm, I was just hoping to get some big city experience and see what it was like in a school district that was diverse ... but you know, even each school had different problems, and it just wasn't very...

inspiring. I was overwhelmed more than... inspired so I decided, well... it's probably not for me at this point in my career.

If the intent of the program is to recruit to the teaching profession, this might be viewed as a negative outcome for the Squad—a talented scientist deciding not to teach—but it is a positive outcome for the individual, who has then not pursued a career that would be a poor fit. Having the opportunity to test out this potential career settles the matter and allows the individual to pursue other options.

Moreover, this can also be seen as a positive outcome for the profession. Attrition from K-12 teaching is high in the early years of teaching. For example, in Texas alone, 30% of new science and math teachers leave by the end of two years, and half by the end of five years (SBEC, 1998, cited in CoBabe, 2002). Nationally, the statistics are nearly as grim (Ingersoll, 2000, cited in CoBabe, 2002). It can be argued that a realistic exposure to teaching, and a rational decision to teach or not teach based on this exposure, results in a better investment of public (or philanthropic) funds than is training a teacher who then does not serve for more than a couple of years. Finally, the experience did not necessarily turn members off entirely to teaching, but served to strengthen their interest in teaching in other settings (e.g. undergraduate teaching), as some of the quotations above make evident.

4. Science Squad as a Program for Science Teacher Recruitment

We have raised the issue of recruitment of science teachers from the ranks of Science Squad members. Overall, we cannot disentangle the effectiveness of Science Squad as a program for drawing people into and preparing them for teaching careers from the already-strong interest the Squad members had in teaching. However, if we consider the “seekers” as a group who had *not* originally planned to teach or do outreach, but had subsequently become open to these career possibilities, then the Squad experience was effective in converting seven of 11 these people into professional science educators, whether in the classroom or in outreach organizations that support the classroom. Thus, though teacher recruitment is not a primary goal of the Science Squad program, it seems fair to consider whether the program might in fact serve as an experiential form of science teacher recruitment.

We have already emphasized the crucial role of field experience—repeated practice in the classroom—in developing members’ teaching skills and providing them new insights into the educational system. When we compare our findings about the benefits of participation for Squad members and the processes by which these benefits arise (Laursen, Liston, et al., 2004) to the literature on field experiences in teacher preparation, it is evident that Science Squad does share some of the properties of effective field experiences (Wilson, Floden, and Ferrini-Mundy, 2001, and references therein). Members’ activities are focused and well-organized and provide substantial teaching experience beyond the mechanical aspects. Members can closely observe students and teachers in a classroom setting, from which they report learning “survival skills” and gaining better understanding of students and their learning, consistent with what research shows to be specific gains from field work not gained from course work. Working with multiple teachers provides multiple models of teaching and thus may avoid some of the problems that at times arise from one-on-one relationships between a teacher and student teacher, such as the student too closely following the practice of the supervising teacher, which may not fully reflect best practices. One large-scale study has shown that year-long “internship” experiences—of which Science Squad might be considered a variation—lead to greater teacher satisfaction,

higher retention, and better teaching skills than does a shorter, more traditional, student teaching preparation (Andrew, 1990, cited in Wilson, Floden, and Ferrini-Mundy, 2001).

We raise teacher preparation as a comparison because all of the “seekers” were using the Science Squad in part as a chance to explore career possibilities in teaching. In their interviews, the language of exploration was very evident.

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’ve been pursuing research and finding it very frustrating not being able—either working part-time and not being able to do enough, or not wanting to work full-time. 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.

Participants were already disillusioned to some degree with their previous career plans, so when the opportunity arose to participate in the Science Squad, they seized upon it as a low-risk chance to engage in a realistic, intensive, teaching experience and thus to explore teaching as a potential career path. Like the strategic group discussed earlier, “seekers” were already interested in teaching and showed an aptitude for it, but they were also led to participate in Science Squad because it offered a chance to investigate a possible teaching career in a temporary way that also supported their ongoing graduate work and did not require a teaching certificate.

In sum, the primary career outcomes of Science Squad participation for this group were career *clarification* and *change*. Interviewees in this group were beginning to reject or revise the career plan with which they had entered graduate school, and their Science Squad participation influenced their career plans by exposing them to new career options, enabling them to refine career choices within a broader field, or enabling them to rule out a career option. In most cases, science education or teaching became a more important element of their careers, although this was not exclusively the case. Aspects of the Squad that enabled clarification of career paths included immersion in teaching, the contrast with their other activities (e.g. graduate research) and the work environment of each, and personal reflection on these experiences.

D. Concluding Statements on Career Influences

We find that the effect of the Science Squad on members’ careers can be viewed as falling into one of two major patterns—confirmation of an existing career path and enhancement of members’ ability to pursue that path successfully, and clarification of career paths that is part of an overall change in direction, whether identifying a new path, refining a vague career direction into a specific path, or ruling out a path under consideration. These two broad groups constitute 20 members, over 85% of the interview sample—a large group for whom Squad participation was influential in some way. We have previously observed a similar distinction between confirmation and clarification of career paths in our work on undergraduate research students (Seymour, Hunter, Laursen, and DeAntoni, 2004).

It is also interesting to compare the two groups we identify to previous work by Smith, Pedersen-Gallegos, and colleagues (Smith et al., 2002; Pedersen-Gallegos et al., forthcoming). They found that many science graduate students do not have clear career goals, but believe this situation to be normal and even beneficial, by not distracting them from the real work of completing their graduate training. They have faith in their disciplines and programs to prepare

them well, and expect their career plans to “work themselves out.” For those for whom things did not work out so well, and who faced greater challenges establishing their careers, receiving good career advising and setting clear goals were more important. This group seems to resemble our second group, the “seekers”—those who were dissatisfied with the most visible career options and who used Science Squad in part to help solve the problem of inadequate career information.

Our “strategic” group includes the Squad members with more traditional career aspirations. However, distinct from the expectations discussed by Pedersen-Gallegos et al. that “things will work out,” these individuals do not take a passive “wait and see” strategy. Instead, they are taking matters in hand to prepare themselves for the teaching aspects of their intended careers. This may reflect differences in the select group we studied versus the more general population in the other study. And, although the academic careers pursued by many of the “strategists” were more traditional than the K-12 teaching and outreach positions pursued by many of the “seekers,” the strategists were still not entirely conforming to the academic norm, because they chose teaching-oriented faculty positions.

Finally, we did not have sufficient evidence to place the remaining four interviewees in either of these categories. While there was evidence of career-related benefits—for example, networking and enhancement of teaching skills used in their current careers—there was no clear evidence in their own testimony that Squad participation had fostered their career development in a previously defined direction or altered their career path toward a new direction. In some cases, members’ level of interest in research had changed during graduate school, but their interest in teaching had not changed and remained high. For others, career options were still very much up in the air.

I’m gonna play it by ear. There’s definitely a part of me that would like to be, to stay in academia and get a professor position. Unfortunately, I think that some of my personality... I’m not very assertive with my superiors which... and I’m not very good with networking, so that path seems a little daunting at times, ‘cause there’s certainly a strong aspect of that in academia. And I’m sure I could do it, but I’m not sure I’m prepared to pay the price. So I’m always considering alternatives to that.

There is no reason to expect that every individual’s career path will be influenced by participating in this program—in fact, it may be remarkable that so many were. However, there may be a relationship between this high degree of career influence on Squad members, and the high representation of women on the Squad. We have described both “strategists” and “seekers” who both, though in different ways, took active advantage of the Science Squad program to improve their career prospects, whether through enhancing their qualifications or finding an alternative career path that was a better fit. In the next section, we discuss the relationship between gender and the teaching profession, and examine some reasons why women in particular may take this approach.

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VII. Gender and Teaching: Why are More Women on the Science Squad?

Throughout its history, the Science Squad program has attracted women participants in proportions that exceed those of women in science overall. Our interview sample, mostly

graduate students, comprised 83% women, while recent national samples of Ph.D. graduates average near 35% across the sciences (Ripley, 2005). A few members were also from underrepresented ethnic groups; although they are few in number, their representation on the Squad nonetheless exceeds the minuscule proportion of these groups in the sciences as a whole.⁴ Because the Science Squad program deliberately aimed to provide role models for underrepresented youth, it is not merely coincidental that more women were not only interested in applying for Science Squad but were also selected to participate. However, the high representation of women is a nonetheless striking feature of this program, which we discussed with each member in our interviews. In this section, we report members' theories about the representation of women on the Science Squad and relate them to the existing literature on women's participation in science and education.

Science Squad members cited multiple reasons for the appeal of the program to members of underrepresented groups, including women and ethnic minorities. As we have discussed, members most often mentioned personal reasons for joining Science Squad, such as an interest in teaching, career exploration, or a desire to take a break from research. However, when asked in the abstract, "Why are more women in the Science Squad?" they often referred to concerns about larger social and cultural factors. In other words, members had many theories as to why the Science Squad attracted more women than did the sciences in general. These theories were often the same as the sociological and cultural factors for women's scarcity in the sciences suggested by the existing research literature, yet members rarely reported these broader factors as the personal reasons that they themselves joined the Science Squad. In the experience of our research group, this quite typical—even when interviewees are aware of the broader cultural context of their experiences, they often do not internalize these phenomena or interpret them as applicable to themselves.

Science Squad members hypothesized that the appeal of Science Squad lay in the underrepresented status of women and minority groups in the sciences. Women and members of underrepresented groups face greater discrimination in academe, and Science Squad provided a forum in which women with similar interests could network with each other. Science Squad also represented an alternative to the traditional, research-oriented, scientific path. Members hypothesized that it is more socially acceptable for women in the sciences to become involved with teaching and outreach activities than it is for men because of the traditional view of teaching as "women's work." This view of teaching as "women's work" may also contribute to the devaluing of teaching in many science departments in research universities. Finally, women and members of underrepresented groups appreciated the opportunity to serve as a role model in the community, potentially inspiring young girls and minority students to become interested in science. Science Squad, therefore, appealed to women and minorities because it provided an environment where teaching, outreach and mentoring were valued and where they could, at least in a small way, address the inequities in science. We discuss these issues in more detail below.

A. Discrimination in Academia

One of the primary reasons that participation in the Science Squad appealed to women, in particular, was the perception of gender discrimination in academia. The emphasis of Science

⁴ In the sciences and engineering, these underrepresented groups include primarily African-American, Latino/a, Native American/Native Alaskan, and Pacific Islander. Asian-Americans are not considered in many national databases to be underrepresented in the STEM fields.

Squad on teaching and outreach represented an alternative path for women who were dissatisfied with the male domination of their fields. As noted previously, some members felt “pushed out” of research and thus out of the traditional scientific career path. Science Squad, then, became an outlet for some women who were struggling with gender barriers in their graduate programs and questioning the traditional scientific career paths. Six out of 24 members hypothesized that gender discrimination and male domination of scientific disciplines were one of the reasons that the Science Squad attracted more women than men. It is interesting to note, though, that the women interviewees most often referred to discrimination in academia in general terms and did not refer to their own departments as discriminatory or hostile. Nevertheless, some women thought that they were more likely to feel unwelcome in the traditional academic environment and, consequently, were more open to pursuing alternative paths.

Fox (2001) reported that women and men have qualitatively different experiences of graduate education in the sciences, with women reporting less satisfaction with their graduate programs. For instance, women were less likely to report that they were respected and taken seriously by faculty. They also felt less comfortable speaking in research group meetings. A female Science Squad member echoed this sentiment.

I think for 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. It's interesting, I think a lot of women feel as undergraduates that there really aren't any barriers to being a woman in science. Everything's fine. 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.

Moreover, some women were not simply “pushed out” of the traditional path, but purposefully chose to participate in the Science Squad as a mechanism to address gender inequities in science. These women viewed the program as a means to address their concerns about the male domination of science and the traditional view of a scientist as a researcher in a laboratory. These women wanted to expand the notion of what it means to be a scientist by bringing more diversity to their disciplines and by successfully balancing professional responsibilities with family and outside interests.

...Very few men actually perceive that there's a problem or feel that it's their responsibility to do anything about it... and I think women having gone through the system recognize that there's a problem and that unless we change the existing system it's gonna continue to be a problem.... I mean, men could go on doing what they do because they control things, it's perfectly fine, and I think for women and minorities to feel included and feel like they can make a contribution to the status quo it has to change... and so it's naturally gonna be those people who are pushing the change.

Women are now receiving undergraduate science and engineering degrees in higher numbers than men (Ripley, 2005). However, as of 2000, one-third of doctorates in the sciences were awarded to women, and women occupied 29% of science and engineering faculty positions in U.S. higher educational institutions. This gender disparity was magnified at the top 50 research institutions, as only 15% of faculty positions in science and engineering were occupied by women (Ripley, 2005). The larger number of women in higher education institutions overall as

compared to the top 50 research institutions lends support to the contention that some women are choosing teaching-oriented over research-oriented faculty positions. However, the real reasons behind this disparity will not be known without further research. The existing research shows that the factors are complex but may have to do with a greater desire by women to achieve a balance between career and outside interests (Goldin, 2004; Stone and Lovejoy, 2004; Jacobs, 2004).

Science Squad members also reflected on factors that draw women to teaching over research. Some members sought to expand the stereotypical roles fulfilled by scientists—to show that scientists also have lives outside of their work including families and other personal interests or hobbies. Some members wanted to re-define conceptions of scientists to incorporate activities such as teaching or raising a family. Not only did members see teaching as an important application of their scientific knowledge, they also viewed it as opportunity to find more balance in their work life. Some members thought that they could more effectively balance work and family through a teaching career than a research career.

For women in academia too, there's still lots of stereotypes there. And I see colleagues who are trying to balance wanting to have a family and wanting to have a life outside of their job.... I don't think we're ever really gonna get over some of the challenges that come from... being an academic. *But*, to me, it seems like the more women that are doing it, and the more diverse backgrounds that are coming into it, the more acceptable various things are gonna be.

But I think that in general, my colleagues... the women Ph.D.s are the ones who wanna find a job that has a balance of teaching and research, and that may have to do with wanting a balance in their lives in general, families and so on.

While many studies have explored the reasons that women leave undergraduate science programs (Sandler, Silverberg, and Hall, 1996; Seymour and Hewitt, 1997), few studies have explored attrition of women from graduate science programs—although it is known that women graduate students overall are more likely than men to fail to complete graduate school (Lovitts, 2001; p. 2), and that there are both differences in their reasons for leaving and differences in their experiences in graduate school that may contribute (Lovitts, 2001). While none of the Science Squad members dropped out of their graduate programs, many expressed dissatisfaction with research and academe in general and instead chose to explore non-traditional career options. Some decided to finish a master's degree rather than the Ph.D., although (as noted in the previous section) these were few. Social climate may play an important role in retention of graduate students, particularly women (Conefrey, 2000; Rosser and Zieseniss, 2000; Lovitts, 2001). A lack of “critical mass” of women faculty and students in a department also leads to dissatisfaction and potential attrition of female graduate students (Dresselhaus, et al., 1995; Meinholdt and Murray, 1999). The subordinate status of women in some departments and in the sciences in general grants them little power to effect structural and cultural change. As a result, departmental culture based on male norms and values of individualism and competition can be perpetuated (Ferreira, 2003).

It is interesting to consider whether women's perceptions of the difficulties of building an academic career in science are related to our findings about the high degree of influence of Science Squad participation on career paths and our categorization of members as “strategists” or “seekers.” If women perceive that they need an extra leg up in their career to overcome

cumulative disadvantage in a male-dominated field, they may be motivated to participate in a program that they see as helping them achieve their professional goals—that is, to behave as “strategists”. Those women who do feel “pushed out” may be motivated to pursue opportunities to explore career alternatives—to behave as “seekers.” Thus women graduate students may be more likely than men to take an activist role in shaping their own careers—in contrast with the high proportion of graduate students who expect their career options to “work themselves out” in due time, as reported by Smith, Pedersen-Gallegos, and colleagues (Smith, et al., 2002; Pedersen-Gallegos, Smith, et al., forthcoming). Women science and engineering students may not be able to afford to take such a passive approach to their careers.

In sum, the literature suggests many factors, such as a lack of “critical mass,” lack of female role models, and an unwelcoming masculine culture in science, that may combine to push women away from research and academic positions. These concerns were also echoed by some Science Squad members, who viewed academe as unwelcoming and sought careers that would allow for greater flexibility, balance, and opportunity to interact with the community and with other women scientists with similar interests and concerns.

B. The Need for a Network of Women Scientists

In contrast to the situation in many of their home departments, women and ethnic minorities were not underrepresented on the Science Squad. The Science Squad created an opportunity for these individuals to network and “find a voice.” Women Squad members expressed the need for a place in which they could connect with others with similar interests and receive support within the university setting. Some male members also noted that the Squad provided a professional network for underrepresented groups to mentor and assist one another. Science Squad provided a forum in which women and minority members with a strong interest in teaching and outreach could establish a supportive sense of community. It is interesting to note that although seven members described the Science Squad as a place where women scientists could network, only two of them discussed personally using the Squad in this manner. Instead, they spoke in more abstract, theoretical terms, saying that women in academia need a place to network and Science Squad could provide such a forum. The following quotations are representative of members who spoke of the Squad as an opportunity for underrepresented groups to network.

I think that part of it is that we are a underrepresented group in science, and it's finding our voice. And for me, in that group, aside from the professional development with respect to learning and teaching, it was also about getting support from other women in science, and the way that we do science, and the way that we do our lives, which is different than the way men do. I mean that's just the way it is. So part of it might be that, trying to seek other people who are like-minded, and who care about the same things....

...There's a certain amount of networking that goes on amongst the science department, people in various departments, and I think because women are underrepresented in the sciences, I think they tend to network with one another. And specifically, my advisor knows other women in the sciences because they're, female, they're faculty members, and I think there's a certain sort of looking out for female graduate students. ...I think that networking has gone on, sort of, on campus, and so that perhaps to a certain extent there's this network of women that's already sort of exists amongst faculty and graduate students.

C. The Opportunity to Serve as a Role Model

Many women were also attracted to the Science Squad as a means to serve as a role model for other young women who may be interested in science. While this was not the primary motivation for joining the Squad for most members, women and ethnic minority members were still very conscious of their responsibility as potential role models. Twelve out of twenty-four members mentioned that the opportunity to serve as a role model was an important aspect of their Science Squad experience. The desire to be a role model in science was also connected to the desire to alter stereotypical views of scientists discussed previously.

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 think I went into the program feeling like that was an important thing.... I thought 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....

My impression was that one of the targets is to get women and minorities interested in science. And so, what's a better way than to show a female scientist who's successful in science go out there and, and teach these women or, and minorities about science and try and get 'em interested in it. So, that's maybe one of the reasons.

It should be noted as well that Squad members were selected in part for the congruence of their views to this goal of the program as a whole—so this high interest in being a role model is not surprising (Graf, personal communication).

Perhaps because it is more tangible and concrete, Science Squad members discussed the opportunity to serve as a role model in more personal terms than they discussed the appeal of Science Squad to women in general. Being a role model was a concrete benefit to the school students that was experienced by many Science Squad members, and was also emotionally rewarding for the members themselves (Laursen, Liston, et al., 2004). The direct, personal discussion of serving as a role model stands in contrast to many members' abstract, theoretical discussion of gender discrimination and male domination in the sciences.

D. Gender Differences in Experiences, Interests, and Careers

Several members also cited basic gender differences as part of the reason that more women are involved in the Science Squad. These members stated that women are more concerned with giving back to the community than men and are also more interested in professional development opportunities in teaching. Women may be more likely to gain satisfaction from classroom interaction and addressing community needs than from research or publishing papers. Eight members described gender differences as one of the reasons that women are more attracted to teaching and outreach programs. While the core of this argument is that “women and men are different” and have dissimilar interests and needs, the argument is not grounded in biological differences. Rather, most members saw gender differences as rooted in social and cultural variables.

But I think it's just a different—we get different things from different experiences. Like I get more benefit from making a connection with a class, having a good day in a classroom, than I do from publishing a paper. My male counterparts are not that way in general, *in general*.

I think in general, having worked for a number of years with men and women, as far as education goes and really making a difference and kind of being attuned to social needs and changes and stuff like that, I think women just care a lot more... than men. It's not to say they're not effective in the classroom, but you tend to see women being more proactive in terms of going after professional development opportunities, and going to workshops and that kinda stuff—you don't see as many men.

Interviewer: We've noticed, if we look over the historical records for all the Science Squad members, about three quarters of you are women. Why do you think that is?

Member: 'Cause we're more sensitive. I think that we're probably a little more empathetic and we maybe a little, I mean I'm just *totally* stereotyping, but I suspect that women are, not less goal-driven, but more—I don't know how to say it, but we want to explore a broader spectrum of what it means to succeed.

Science Squad members' perceptions of gender differences in experiences, interests, and career outcomes are supported in the literature. Female undergraduate science students, for instance, valued interpersonal work more than high status and high pay. In contrast, male undergraduate science students placed more value on high status and high-paying careers (Morgan, Isaac and Sansone, 2001). Women undergraduates in computer sciences report similar differences in women's interests and values as explaining the dearth of women in this field (Pedersen-Gallegos, Laursen, et al., 2004). Teaching is not only interpersonal work; it also is a low-status, low-pay career in comparison to other scientific careers.

Although men and women in the sciences have reported similar frustrations with research, such as competition for funding, significantly more women have cited lack of communication with peers, the publication review process, and tenure process as frustrating aspects of research in the academy (Luzzadder-Beach and Macfarlane, 2000). Further, male graduate students in the sciences preferred academic careers in research universities while female graduate students preferred academic careers in teaching at colleges or universities (Fox and Stephan, 2001). These differences were particularly pronounced in the fields of chemistry, microbiology, and computer science. Women in the sciences, then, may be more attracted to interpersonal work and place a higher value on teaching and communication than their male peers. These findings are also supported in this study through the reports of Squad members that they valued giving back to the community and the interpersonal interactions within teaching, and their career interests in teaching at a small college than a large research university. These factors may also contribute to the higher number of women on the Science Squad than in science overall.

E. Social Stigma of “Alternative” Paths

Although the gender distribution of the Science Squad members did not mirror that in the sciences at large, many participants noted that it is more reflective of the gender distribution in the teaching profession, particularly at the K-12 level. Traditionally, teaching and outreach have been female-dominated fields just as science has been male-dominated. Many Science Squad alumni noted that the participation of women in the Squad fulfilled these traditional gender roles. Consequently, it is more acceptable for women in the sciences to pursue non-traditional careers such as teaching and outreach because these areas have historically been viewed as women's work. On the other hand, there may be greater stigma for men to be involved with a program such as Science Squad because there is more pressure for men to fulfill the traditional view of a scientist that emphasizes research and/or an academic career path. While it may still be

considered “non-traditional” for a woman to be a scientist, it is more traditional for a woman scientist to teach than to pursue a career in research. Ten members noted that the distribution of women on the Science Squad is more representative of the gender distribution in teaching as opposed to that in other scientific careers.

I think that looking at a group of teachers in general, one might find that there are more female teachers... but that out of all of the teachers, that there's probably a higher concentration of males in the sciences or math, rather than history or language arts, so I think that teaching has been associated with nursing as one of those women's careers and that that still sort of has a little bit of a social stigma for males.

I mean, we're looking at a cross-section of a small population [Science Squad] that is, maybe representative of a larger population issue.... And I think for various reasons education and teaching are still looked upon as a woman's career. So part of that I think is underlying.

One woman noted that women may be more interested in participating in the Science Squad because there are higher percentages of women in the teaching field than in the sciences in general. Women, then, may be attracted to scientific organizations that already have more women members.

I'm not sure what percentage of teachers are men or women, but it wouldn't surprise me if it's similar percentages [to those on the Science Squad], because it seems to me there's far more women teachers than men teachers anyway. So I'm wondering if that percentage of BSI actually corresponds to the number of women and men that go into teaching as a profession anyway. And so that would figure, that maybe more women are interested.

The demographics of the Squad members fit with the gender distribution of scientific outreach programs in higher education in general. A recent study found that women scientists participated in outreach at a higher rate than male scientists (Andrews, Weaver, Hanley, et al., 2005). Moreover, graduate students, particularly those in the last two years of their program, were more likely to engage in outreach than faculty members. Likewise, Science Squad members were disproportionately women in the final years of their graduate programs.

F. Teaching as Undervalued in the Academy

As many Science Squad members pointed out, teaching has traditionally been viewed as women's work. Teaching has also traditionally been undervalued in the academy, as research has assumed a higher-status position. As women in science have often been shown to be more attracted to teaching over other types of science careers, their choice of profession can also serve to cement their subordinate role in some science departments. Nevertheless, Squad members demonstrated a firm interest in and commitment to teaching.

As we have discussed, members, for the most part, joined the Squad with a prior, strong interest in teaching. Almost all were also currently in teaching positions or considering teaching positions in higher education as a possible career option at the time of their interviews. Several were attracted to the Science Squad as a professional development opportunity, because they were dissatisfied with the low emphasis on preparation for teaching in their departments. Other members were discouraged by the hierarchy of values they perceived in the tenure system, particularly at research universities, where research productivity is rewarded over teaching and

outreach activities. Despite the lack of emphasis on teaching in their departments and the risk of negative reactions from research-oriented peers and faculty, Squad members displayed a strong dedication to teaching as a career and placed high value on it. While, as mentioned previously, no members actually reported experiencing negative outcomes within their department from their participation in the Squad, they nonetheless perceived that teaching was undervalued in the academy. We discuss in this section how members' interest in teaching brought this perception into focus. This discussion expands upon our earlier discussion of the reactions of advisors and other departmental colleagues to members' interest in participating in the Science Squad.

1. Prior and Current Interest in Teaching

As noted, most members had an interest in teaching before joining the Science Squad. While some had a less strong background in teaching prior to participation, they used the program as a way to explore a new career or gain more experience with teaching. Members also sustained their commitment to teaching after leaving the Squad by choosing teaching or outreach-oriented careers. For instance, many Squad alumni held teaching positions at the time of their interviews. Five members held tenure-track faculty positions, three were non-tenure-track faculty, six held or had recently held teaching-oriented or outreach positions (e.g. K-12 teacher, educational program coordinator), and four were considering higher education as a future career path. Teaching, then, is a strong theme throughout the experiences and career paths of almost all members despite the fact that it is often undervalued in university science departments.

2. Dissatisfaction with Teaching Preparation in Graduate School

Some members were dissatisfied with the amount of training that they had received, and with the low emphasis placed on preparation for teaching, in their graduate programs. These members specifically sought out better preparation for their teaching roles. Some members used the Squad as a way to gain valuable skills and training that they would use in their future careers, even though they also had other teaching experiences during their graduate programs. Three members specifically utilized the program as a way to enhance their teaching preparation in a way that they did not otherwise receive in graduate school.

But it always bothered me that college university professors never had to have any teaching education. And the college that I went to was a good college, but as any kind of schooling, it had the teachers who know their stuff but can't teach. And, so I didn't wanna be one of those teachers, professors.

I'm kind of always kind of shocked, and I have been ever since I was an undergraduate, and thinking of maybe going to grad school someday, at how little focus there is on teaching. And the majority of graduate students, at least doctoral students, are expected to go on and teach after they get their Ph.D.

And I've always been kinda 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.

While many members participated in the Squad as a way to enhance their teaching skills, these three members specifically mentioned that adequate teacher preparation was not available in their graduate programs. The Science Squad fulfilled an unmet need for these graduate students.

3. Tenure System and Teaching

Teaching and outreach are often undervalued, particularly at research-focused institutions such as the host institution of this program. The tenure and promotion system at Research 1 institutions does not generally reward teaching and community outreach. Instead, the emphasis rests on research productivity. Many Science Squad members were cognizant of the tension between research and teaching at the university and in higher education in general. Even though teaching is undervalued in many research-oriented graduate programs, Science Squad members did not necessarily agree with the tenure system that valued research over teaching. Again, without referring to their specific departments, six members discussed the low status of teaching and outreach within research institutions and the tenure and promotion system in general.

So I would say, yes, people have been affected by outreach, but there's a huge long way to go and I don't know... it's tied into university politics and the university money, and shortage of money. And this is a Research 1 institution. Research is the bottom line.

I recognize that [Science Squad] was a good thing for a year, but that was really about all I should do. Not that that's all I wanted to do, but that's the career path I was headed down. Those things were not going to be rewarded and they're not rewarded still. I mean, there's no real reward for giving presentations at local groups or being a science fair judge, or taking time to do those activities, within the tenure-track system of most colleges and universities.

At the big universities, at the research universities, their emphasis and their evaluation of faculty members and the like is primarily based on our research and publication. So, I would say there were some people probably at CU Boulder who think it's an unnecessary program, and I would just respectfully disagree with them.

As noted previously, some members purposefully chose to participate in Science Squad for the teaching and outreach experience despite the lack of rewards within the university system.

4. Higher Value Placed on Teaching by Science Squad Members

Science Squad members in general placed a higher value on teaching than they perceived among many of their peers and faculty members in their departments. Even though some faced potential criticism from their advisors and peers, members sought out the opportunity to be more involved with teaching and outreach to underrepresented communities. In this sense, the program fulfilled an unmet need for teaching- and community-oriented graduate students in the sciences who were not able to pursue their interests through their graduate program requirements.

I think it tends to draw people who... one of the things I see in people who are interested in the Science Squad is, one, people who are really interested in teaching and who are not getting the kind of teaching experiences they enjoy having as graduate students.

I'm trying to think back through the folks that I worked with and the folks that I knew that did it after me.... 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.

...[members are] I think, obviously people that have a commitment to education above and beyond just their own field of study. So people who do things that, education and outreach and K-12 education in particular, are very important.

As discussed previously, Science Squad members were interested in teaching for intrinsic reasons and discussed external motivations such as funding less often as reasons for joining the Squad. This issue is particularly salient given the fact that teaching is often undervalued within research university science departments. As one member noted, Squad members were “looking for something” more than just research.

The majority of the students who, I think 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.

Squad members actively sought a community-oriented teaching experience as a contrast to their graduate school research. Some members were drawn to participate in the Science Squad as a way to “take a break” from research.

...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 kinda refresh them and re-motivate them.

Despite the fact that many members specifically sought a teaching position because they highly valued teaching, some still felt a tension between teaching and research. A few members initially struggled with the ramifications of a decision not to pursue an academic career. Even though they felt pushed away from research, these members found it difficult to let go of research as a career goal. Some had concerns about the lower status granted teaching as compared to research.

I did have some issues with leaving research, and going on a one-way street towards teaching, and not being able to go back. And it wasn't as prestigious of a job, you could never make as much money, you would never be world-renowned, whatever.

Other members struggled with the wider perception in academe that scientists who teach and conduct outreach are “not competent” or are “lesser” scientists who can’t “do” science. This perception can be a barrier to the pursuit of teaching and outreach activities, particularly for Squad members who also enjoy and value research.

But sort of the perception is that... people are only in science education or outreach if they can't do the science. So that's the first thing people would say. It's maybe one of the reasons why I haven't gone totally in that direction. I like to do research. I think I could make more of an impact doing science education or outreach but... I'm not ready to go that route yet.

Nevertheless, for the most part, Science Squad members actively pursued teaching or outreach-oriented careers upon completion of their graduate programs. They did not perceive the devaluing of teaching in research-oriented institutions as a hindrance to their participation in Science Squad or later pursuit of a teaching-oriented career.

Gender and the tension between teaching and research within academe are related to larger issues of status and power within higher education. Teaching has traditionally been viewed as

“women’s work,” while scientific research has historically been viewed as the domain of men. Research-oriented institutions often emphasize research productivity and publications over teaching for hiring and promotion purposes. Thus a career path in research is more highly valued than a career path in teaching at many Research 1 institutions. Despite the potential negative ramifications of pursuing teaching and outreach opportunities during graduate school, participation in Science Squad held more appeal for women than men. Further, participation in the Squad had no reported negative ramifications for any participants—in fact it often served as a stepping stone to a teaching-oriented career.

Women members hypothesized that the Science Squad provided a venue for women scientists to build a network, serve as role models, pursue alternative career paths, and broaden conceptions of what it means to “do” science. While members acknowledged larger social and cultural variables that affect women in science, they seldom explicitly stated that they joined the Squad for those reasons. Instead, for many members, the program addressed several unmet needs during their graduate education, such as adequate preparation for teaching, development of career-relevant skills that are often lacking in graduate preparation (Smith, Pedersen-Gallegos, and Riegle-Crumb, 2002); and an opportunity to explore alternative career paths and to serve as a role model for young women interested in science.

VII. Summary and Recommendations

In this and the previous report (Laursen, Liston, et al., 2004), we have described the profound benefits—both immediate and longer-term, in skills, knowledge, emotional satisfaction, and professional development—for the members who participate in the Science Squad. The corresponding costs of participation are low, including the long-term career influences of participation. We have also described the benefits to K-12 students and teachers who are the recipients of the program, and have noted the strong correspondence between teachers’ reports and those of the Squad members themselves. We have discussed the tradeoffs of the design of the Science Squad as a short-term intervention that reaches many classrooms, with a focus on under-served and high-minority school populations, rather than as a deeper, more systemic intervention with a much smaller scope. Members enumerate powerful arguments for the effectiveness of this design, both for program recipients but also for the Squad members, whose skills and understanding are developed by the diversity of schools and students that they encounter and by the opportunity to practice and refine their presentations in a variety of settings. From this evidence, we have suggested the Science Squad may be viewed primarily as a program of professional development for science and engineering graduate students with interests in teaching and public communication of science that may not otherwise be fulfilled in their home departments, with very strong, secondary benefits for the K-12 students and teachers who are its audience.

We have also placed the findings of this study in the context of current national concerns—concern over the quality of science education for building science literacy among citizens and developing the scientific workforce, over teacher preparation, and over the effectiveness of graduate education as preparation for the wide range of careers that highly trained scientists may undertake. We summarize here our advice (including that of participants) to the program and to the university, drawn from this study—both recommendations for the program itself and questions for future research that are raised by this study.

A. Recommendations for the Program

- The program is clearly effective in many ways. It serves multiple audiences and brings university resources to bear on issues of local and national importance. We recommend that it be viewed as a priority for continued funding. Indeed, given the increasing importance of education and outreach in the competition for federal research funding, now may be an appropriate time to consider the expansion of the program into other departments or in alliance with other initiatives, such as the existing GK-12 programs on campus.
- Teachers called for expansion along other dimensions: to provide repeat availability of favorite topics central to the curriculum, so that they could reliably include these sessions in their yearly program; to include more offerings suitable to elementary science; and to recruit more minority presenters as role models for children. We note that the implementation of 5th-grade state-wide assessments in science in 2006 provides a timely opportunity to consider the BSI's program offerings for elementary teachers, as a whole.
- Few problems with the program structure were identified. The foremost of these, raised by both teachers and members, was the difficulty of scheduling. We suggest that the program consider development of a web-based scheduling system to facilitate this process. It is possible that the current university web calendar system (such as the online meeting room scheduler at <http://webevent.colorado.edu/>) could be adapted to fill this function.
- In our previous report, we discussed the importance of the teacher in facilitating and building on the Science Squad presentation as a way to maximize the educational value of the program. Clear communication with teachers about their role should be continued and enhanced where possible. Given the current emphasis in K-12 education on “research-based practice,” it may be helpful to include evidence from this study about the importance of this role when communicating with teachers.
- On the whole, Science Squad members felt their training for their classroom role was effective. The quality and availability of individual coaching was praised (it appeared as well that most members were self-starters who needed relatively little guidance to get underway). A few members, however, felt they would have benefited from more collegial preparation and dialogue about their presentations as they developed them. Members suggested forms such as a retreat, prior to the school year, while members are developing their presentations, that would provide both professional development and informal work time and feedback from peers, or an ongoing series of sessions in which members practiced their presentations on each other. This would also help develop greater esprit de corps (an aspect that was not strongly reported in either the positive or the negative sense). One member suggested that the opportunity to “shadow” a current Squad member would be helpful. It may also be valuable to formalize the training materials used already to share as a model for other programs. Mixed views on the utility of group meetings suggest that the agenda for these continue to be carefully developed.
- A repeated call from Squad members, and a need that is clear from the various attitudes that they encounter in their departments, is for greater publicity for the program and its effectiveness. Indeed, the present study can be a tool for this, as it formally documents the benefits of the program to students, teachers, and members. Diverse methods should be considered to inform audiences including past and present Science Squad members and applicants, faculty and graduate students in members' home departments, department chairs

and university administrators. Methods may include web-based dissemination, development of short digests or brochures, presentations by the evaluators, BSI staff, and Squad members, and articles for both peer-reviewed professional journals and newsletters that more directly reach practitioners. The evaluation team does expect to prepare several research articles and welcomes the collaboration and advice of the BSI staff on these.

- Coupled with advertising the benefits to participants, the program can also help to raise the profile of the program and its members, and outreach in general, by sending a congratulatory letter to the department chair and advisor (with the student's permission) upon selection. This might include a short blurb on the program that is suitable for a "press release" to the department newsletter or web site. Squad members themselves may be the best voices to communicate within their own departments—perhaps they can make a presentation or give a mini-workshop in their departments—but the program director and staff should also take a role in informing the departments.

B. Recommendations for Further Investigation

- The present study has been quite detailed in its exploration of the views of two key groups of informants, teachers who invite the Science Squad to their classroom and the Science Squad presenters themselves. We have covered a broad range of anticipated and unanticipated issues, and we see few aspects of the program itself that can be fruitful subjects of further study.
- We raised the question in this report of the possible relationship between an advisor's support for the member's participation in the Science Squad and Barbara Lovitts' findings about the differing approaches of high and low producers of successful Ph.D. students. Because supportive advisors were also reported to be interested in their advisees' intellectual and professional development as individuals, we propose that they are more likely to match Lovitts' high-producer group who also had this characteristic. If data identifying the Squad members' graduate advisors were available, we could examine this relationship to see if it holds up among the current sample, which is a more specialized group than Lovitts' broad sample but one for whom this support may be especially crucial, because of their non-normative career ambitions.
- To examine benefits to K-12 students, we have relied on second-hand reports from their teachers and the Squad members, and have not gathered first-hand reports from students who participate in a Science Squad program. Students were omitted from the study design not because their views were unimportant, but because the short-term nature of the intervention with K-12 students makes it difficult to gather data that would measure any meaningful and lasting changes among students from participating in a Science Squad program. Our findings to some extent confirm this concern—the benefits of the program are not primarily learning of new concepts but rather changes in attitudes and beliefs, and it is difficult to accurately probe these changes immediately following (or pre and post) the program intervention. Such changes among middle school students have been difficult to detect even through a much more profound curricular intervention (C. Coates, personal communication).

These caveats still apply, particularly because the ramifications of the benefits we do report—such as increased interest and enthusiasm in science, changes in views of science and scientists—are so long-term in their consequences. That is, increased interest in science is perhaps a good outcome, but is not the ultimate goal of the program. The secondary

outcomes of increased interest—e.g. students choosing higher education or a career in science, or acting as more informed citizens as adults—are important and sought as outcomes, but are also very difficult to measure. Nonetheless, our identification of the specific types of benefits to students provides clues as to the type of investigations and classroom instruments that might be developed to further document these benefits. Likewise, documentation of the benefits to teachers should make it possible to refine the teacher report form to continue to document, in a less labor-intensive way, the outcomes for teachers and those they observe for students.

- In examining this particular program in detail, we have uncovered some interesting issues with broader implications, surrounding the views about outreach and teaching encountered by Squad members in their home departments. This raises the possibility of examining campus and departmental culture to identify factors that promote and inhibit the development of effective outreach activities at a research university.

Given the wide spectrum of attitudes of advisors and other department members toward this program, we are particularly interested in further exploring faculty and graduate student attitudes toward outreach, including student participation in outreach, and toward teaching in general, among both outreach participants and non-participants. These issues are particularly pertinent at this time, given the current climate of increased emphasis on outreach from research funders such as NSF and NASA. Despite this recent emphasis, this study has demonstrated that many departments grant higher status to research productivity over teaching and outreach activities. A further exploration of faculty and graduate student attitudes towards outreach could provide a more in-depth understanding of the nature and sources of these attitudes, examine the impact of departmental culture on graduate student attitudes toward outreach, especially as they shape the behavior of these future professionals, identify factors that support or inhibit the development of outreach activities at this institution, and suggest opportunities for cultural and institutional change that may foster such work. These research questions have both local and national significance.

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