# Enhancing the Early Undergraduate Science Experience: Situated Learning in the Scientific Community

Pilar Pazos, Gregory Light, Bernhard Streitwieser,
Penny Hirsch, Denise Drane
Northwestern University[i]

*Over a decade ago, the Boyer Commission advocated that universities develop greater opportunities for first year students to engage in meaningful research experiences. Many undergraduate science programs today continue to emphasize a traditional model of rote learning of core material before students can become involved in more intellectually engaging research activities. The "Science Research Workshop Program" at Northwestern University brings freshmen and sophomores in biology and chemistry into contact with faculty and peer mentors to develop research skills and create a proposal for independent research through summer laboratory work. Pilot data on the program reveal participants' increased scientific interest, clarity of goals, and determination to pursue science careers.*

## Introduction

In 1998, a groundbreaking publication challenged American's research universities to implement innovative ways to strengthen undergraduate education and involve first year students more heavily in research activities with faculty and graduate students. *Reinventing Undergraduate Education: A Blueprint for America's Research Universities*, also known as the Boyer Report after Ernest L. Boyer, the late President of the Carnegie Foundation for the Advancement of Teaching, made a passionate case for America's

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research universities to return to John Dewey's principle of learning "based on discovery guided by mentoring rather than on the transmission of information" (Boyer Commission, 1998, p. 15). The report argued that research universities had the resources to adapt these prescriptions for change, implement the model it was promoting, and take the explicit action steps it laid out to make "research-based learning the standard" (p. 15).With regard to science, technology, engineering and mathematics (STEM) disciplines, the report also coincided with increasing concern at the time over the alarming decline of U.S. science graduation rates.

Among the report's ten recommendations, the first urged that faculty, graduate students, and undergraduates should engage in research activities together and jointly develop the complex thinking and communication skills that a research "adventure of discovery" brings about (p. 16). Above all else, the report stressed that student interest had to be captured early on and then cultivated within a rigorous culture of learning. It pointed out that, ironically, freshman courses were often the least intellectually stimulating at exactly the time when the introduction of new material and the broadening of intellectual horizons was in fact most important (p. 19).Through research opportunities, the Commission argued, critical skills must be established in the freshman year and then developed in subsequent years so graduating seniors would be able to fluidly enter the "zone of transition" later on into graduate education and professional life (p. 17). Studies have shown that in many undergraduate science programs the overwhelming emphasis on rote learning of large amounts of core material can have the unintended consequence of causing greater attrition from the discipline (Seymour and Hewitt, 1997; Kardash and Wallace, 2001). Capturing student interest early on, thus, becomes especially important.

For newly arrived freshmen who begin their studies on a traditional pre-med track, often their first exposure to science education is a series of large lecture hall courses. Most undergraduate courses in chemistry and biology are firmly rooted in the transfer of current knowledge in those areas. Students are expected to acquire the “facts” of the discipline and learn how those “facts” may be understood and applied in problem solving. That trend is even dominant in laboratory-based courses. In one study, Stewart and Lagowski (2003) indicate that most undergraduate chemistry laboratory courses emphasize the verification of concepts taught in the lectures or on the discovery of known concepts. They also suggest that critical, independent, creative thinking is rarely expected or encouraged in undergraduate studies. This emphasis and the large lecture experience can negatively impact students’ commitment to science or science-related careers.

Wendy Katkin has pointed out in her research (2003) that since the publication of the Boyer Commission Report, research universities have responded to its recommendations and made noteworthy efforts to implement many of its suggestions, including more research opportunities for first year students. By now, over half of all research universities have established administrative offices with internal and external funding that supports undergraduate research activities. That development has meant increased faculty mentoring and the accompanying growth in research output by undergraduates. And, programs and organizations that make undergraduate research possible have also steadily grown with time, as have their conferences, journals, and other outlets that disseminate the products of young research scholars (Blanton, 2008; Gonzalez, 2001). Yet, despite these developments, relatively few models currently exist for how young science aspirants can be brought into research activities in their earliest years of undergraduate study. Research by undergraduates remains an activity that is too often pursued by only the best students. Moreover, as has traditionally been the case, the majority of those who have research experiences are still most heavily concentrated in the science and engineering disciplines where laboratory assignments make up part of the general curriculum (Katkin, 2003). Thus, few models of strong early research programs for science students are available for institutions and faculty to emulate (p. 26).

## Undergraduate Research as a Beneficial Learning Experience

Benefits stemming from participation in research have been reported at several levels, including cognitive, personal and professional development (Hunter et al, 2006; Lopatto, 2003, 2004). Students who participate in undergraduate research, compared to those who do not, have been found to more likely complete their undergraduate education (Nagda et al., 1998; Ishiyama, 2002), continue on to graduate school (Alexander et al. 2000; Foertsche et al., 2000; Bauer & Bennett, 2003) and express greater interest in science and science-related careers (Fitzsimmons et al., 1990; Zydney et al., 2002). Gains in self-confidence have also been reported as a result of participating in undergraduate research experiences (Ferrari & Jason, 1996; Campbell & Skoog, 2004, Houlden et al., 2004). In an attempt to assess the impact of undergraduate research, previous studies have linked self-efficacy theory to the research training process (Betz, 1986; Phillips & Russell,

1994) and to eventual success in academia. Students who participate in legitimate research experiences have been found to have higher levels of confidence in their research abilities and science skills (Kahn, 2001; Kahn & Scott, 1997; Phillips & Russell, 1994).

Nonetheless, as mentioned above, something that has largely been missing is a program that helps science aspirants develop the tools they need to enter a community of researchers actively doing science; what might be described as helping students learn, negotiate and practice the "language-game" (Wittgenstein, 1968) of scientific research. The term "language game" is meant to highlight the "the fact that the speaking of language is part of an activity, or a form of life" (para. 23) practiced in a shared community. These skills can make the difference between abandoning science or committing to it. Skills associated with the language game of scientific research include how to contact and get into a science laboratory, understand how to structure and write a proposal for early research funding, identify a workable research question, find a mentor, and begin to think the way scientists think. Thus, the key factor that characterizes further progress in the pursuit of science is the development of a deeper understanding of the skills of the scientific language game.

## Doing Science: The Science Research Workshop (SRW) Program

This paper is based on the premise that "doing science" should be an essential part of undergraduate science education and is not the same as learning science in the classroom. It describes a particular initiative, the Science Research Workshop program (SRW), an apprenticeship-style program that was designed to encourage undergraduates to major in science by engaging them in legitimate scientific research during their first two years of study. The guiding philosophy of the SRW program is to create a carefully scaffolded environment to assist students in doing science, albeit at the periphery of the scientific community of practice but transitioning toward the core of that community. "Doing science" does not, of course, simply consist of knowing relevant scientific concepts and the practice of particular science skills and procedures; it is also composed of a complex understanding of the language game—norms, rules, practices and concepts—in which this knowledge and these skills are embedded. As such, the SRW program is designed to help students engage in many of these core skills.

In the sections below, we describe the theoretical frameworks which inform the program, the program goals and structure, and the unique features of the program. Finally we present results from a preliminary assessment of the program's impact on students' experience participating in the program.

## Theoretical Frameworks

The Science Research Workshop (SRW) Program described in this paper draws on three theoretical frameworks, each of which is associated with helping novice learners break through real or perceived barriers and become invested in further advancement within a particular field or discipline: 1) situated learning theory and the community of practice; 2) collaborative learning; and 3) scaffolded instruction

### *1. Situated Learning Theory and "Communities of Practice"*

Brown, Collins, & Duguid (1989) and Lave & Wenger (1991) describe situated learning as a type of learning entrenched in a system of activity or community of practice that is deeply determined by a particular physical and cultural setting (Chaiklin & Lave, 1993; Lave, 1988). Situated learning theory describes communities of practice in terms of concentric levels of expertise in which a practitioner moves from newcomer or novice to expert within a given structure of practice. In this respect, the idea of apprenticeship in "communities of practice" is a central construct for situated learning (McLellan, 1996; Kirshner & Whitson, 1998; Wenger, 1998; Wenger, McDermott, & Snyder, 2002). Lave and Wenger (1991) describe this idea of apprenticeship in terms of a broad conception of learning which they refer to as "legitimate peripheral participation." This concept suggests that newcomers learn the key practices and knowledge of a particular community and/or discipline by participating in legitimate practices of the community, at the periphery to begin with but then increasingly moving toward the innermost levels of the community, represented by the full scope of expert practitioners in the discipline (Lave & Wenger, 1991).

Lave and Wenger's conception of learning within a "community of practice" involves interaction among individuals who possess different levels of skill. That interaction will involve "peripheral" participants who have less expertise with individuals who operate closer to the core of the community and who have higher levels of expertise. Learning in the community of practice is, thus, described not only as new knowledge acquisition but also as developing a sense of belongingness and identity that is associated with that particular community (Wenger, 2000; Lave & Wenger, 1991). In essence, situated learning, then, requires *authentic* contexts, activities, and assessments that are coupled with guidance based on expert modeling, situated mentoring, and legitimate peripheral participation. Greeno (1998) indicates that the power of situated learning is derived from the experience of learning to engage in activities and to solve problems as part of a community in the authentic context confronted by the experts and professionals working at the core of such communities. While this type of environment is rarely found in a traditional classroom, it may be found in research settings (laboratories, seminars, talks) where, as Olitsky (2000) notes, science is practiced as a discursive activity that incorporates disciplinary vocabulary and methodology in the process of constructing knowledge. While still rare, curricular reforms promoting such communities of practice at the undergraduate level have begun to surface in recent years (Olitsky, 2007).

### *2. Collaborative Learning in the Sciences*

As suggested above, there is strong evidence that learning is largely a social process in which interaction with others is essential in understanding the discipline and feeling part of the community of practice (Rogoff & Lave, 1984). However, in contrast with actual scientific practice, the prevalent teaching methods in science are largely based on lectures with an emphasis on transmission of information from faculty to student. Those methods have been found to promote a surface approach to learning science and to emphasize learning as an individual activity rather than a social endeavor (Light & Cox, 2001). Such methods are based on the premise of teaching as information transmission by teacher and learning as factual reproduction by the student. These methods contrast substantially with the idea of science learning as consisting of the active construction of knowledge within legitimate socially determined communities of practice engaging with the scientific method.

One of the most prominent innovations aimed at improving U.S. science education over the past several decades has been the introduction of peer-led team learning workshops, or PLTL (Born et al., 2002; Tien et al., 2002; Swarat et al., 2004). In this type of learning, students engage with one another in small groups led by trained peer leaders to discuss and work through difficult problems linked to the content of a particular course (Dreyfus, 2002; Gafney, 2001). PLTL has been shown by numerous studies to encourage greater student engagement while providing a more constructive environment than the anonymous, pressure-laden first year courses. This research has also documented deeper learning gains, greater retention in the discipline, an improved attitude toward STEM disciplines generally, greater self-esteem, and stronger overall academic performance (Bonsangue & Drew, 1995; Cohen, 1994; Dinan & Frydrychowski, 1995; Drane et al., 2005; Freeman, 1995, 1997; Fullilove et al., 1988; Gosser et al., 2001; Springer et al., 1999; Swarat et al., 2004; Tien et al., 2002; Treisman, 1992).

### *3. Scaffolded Instruction*

Scaffolding in learning is another idea that is closely associated with knowledge acquisition in communities of practice. Frances Christie, using a term borrowed from the construction industry, describes scaffolding as the initial guidance that workers receive while constructing a building and the later withdrawal of the guidance as they become prepared to work independently (Christie, 2005). Vygostky (1978) first suggested the use of scaffolding to assist learners in completing tasks within their zone of proximal development and to minimize obstacles that students face. Through scaffolding, learners are assisted by expert individuals to help them accomplish complex tasks that otherwise they could not successfully complete on their own. Quintana et al. (2004) suggest that scaffolding activities are primarily characterized by the following two aspects:

- Investigating and characterizing the cognitive tasks, social interactions, tools and artifacts that constitute the scientific practices in the discipline of science, in particular, chemistry and biology. Scientific practice in these disciplines involves construction of knowledge through participation in research studies.
- Identifying the aspects of the scientific practices in which learners are most likely to encounter obstacles and providing support to overcome those.

The above three theoretical frameworks characterize the structure and character of the Science Research Workshop (SRW) program. The program is designed to place students one step closer to understanding what it means to be a scientist by providing them with legitimate scientific experiences, removing barriers that prevent them from entering or progressing within the community of practice, and helping them gain access to authentic scientific activities—actual scientific research—within the community of practice in which they are studying and aspire to progress.

## Goals, Structure and Unique Features

### *Program Goals*

To address the problems outlined above, the Science Research Workshop Program grew from a collaboration among educational researchers, faculty in the biological sciences and chemistry, and faculty in communication. The overall goal of the program is to create an experience that resembles what actual scientists do. Specific objectives include the following:

- Motivate and interest students in pursuing science as a research-related career
- Build into students' thinking a richer conception of:
    - The nature of science and its relevance to society
    - The relationship between science and research
- Provide students with an understanding of what it means to be a scientist
- Create a community of students who share an interest in conducting scientific research

The program attempts to demystify scientific endeavors by helping students become immersed in a community language game of scientific practice. In the weekly workshops, faculty and peer facilitators model behavior and communication to help prepare students to enter a research laboratory ready to explore and learn. The structure of the program assists participants to enter the most peripheral regions of scientific research community of practice by engaging them in legitimate "zones of proximal development" (Vygotsky, 1978; Lave & Wenger, 1991) relevant to their science knowledge, experience and expertise. Scaffolding is provided for the participants through mentoring workshop activities that mirror actual practices in the discipline, such as finding a lab, identifying a research question, reading and writing a literature review, and writing a grant proposal.

### *Program Structure*

In the program's initial year, a series of workshops was offered in both Biology and Chemistry over nine consecutive weeks during the winter academic quarter. Each workshop comprised two main parts: the "science café" and a peer-led workshop. The science cafe consisted of a 30-minute discussion in which science faculty with extensive research experience shared motivating stories about science, conducting scientific research, or their experience as one-time undergraduates starting out in research. At the same time, the themes of the science café are arranged to take students through the initial stages of the research process, from contacting a lab to writing a successful undergraduate research proposal. The second part of the workshop is a 90-minute session led by peer facilitators—senior undergraduate students with extensive prior research experience and facilitation skills.

Participants in the program become familiar with the community of practice primarily through the social interaction they have with more advanced individuals who have different ranges of expertise and seniority. Each of type of participant in the program (student, facilitator, faculty) represents a different layer of experience and involvement in the community of practice: the novices in the program are the program participants, the peer facilitators are the experienced mentors, and faculty are the expert modelers. Practitioners comprise individuals with different levels of expertise, ranging from senior undergraduate researchers to faculty working on the cutting edge of research in biology and chemistry. The senior undergraduate mentors are guides for students entering the peripheral novice strata of the community of practice. The faculty members constitute the expert mentors in the program and represent the central strata within the community of practice. The faculty play the key role of constructing knowledge in the field and providing the means for practitioners to move gradually from the periphery to the more central layers of practice. Their role in the program is to help students understand what it means to be a scientist and move through the transition from novice to expert within that community of practice.

While the science cafes expose students to a conversation with scientists about their research and motivations—what makes them interested in science and what for them are the exciting aspects in life as a scientist—the workshop sessions provide the scaffolding for students to find an appropriate research question and develop their own proposal for research in that area. During sessions, students work collaboratively to develop a research proposal, beginning with strategies for how to approach  faculty members and ask for an invitation to conduct research in their labs, and later progressing to how to write a literature review, articulate the research methodology, and structure the argument to compete for funding. Since students have rarely had instruction or experience in proposal writing (Hirsch et al., 2007; Yalvac et al., 2007), annotated examples of successful proposals and other resources to help students with their writing are also made available. Through peer editing sessions, students receive additional help developing their own proposals. By the end of the program, students are expected to submit a formal two-to-three-page proposal that lays out the rationale, support, and plan for conducting independent undergraduate research in a laboratory over the summer or as an independent study project for academic credit.

Following completion of the workshops, student proposals are submitted to a panel of science and education experts at Northwestern who evaluate them for funding. Students whose proposals are successful are invited to carry out their research during an eight week summer period following the program. In this way, participation in the SRW program is structured to provide students early in their undergraduate study with legitimate experiences within the chemistry or biology communities of practice and then receive the financial support and institutional backing to enter the community and begin doing “real science.”

### *Unique Features*

The unique features of the SRW Program are described here in terms of how they facilitate learning within a community of practice, and how they are informed by the theoretical learning frameworks discussed above. These features are designed to scaffold student learning through the provision of legitimate or “real” science experiences situated in collaborative settings. They include: *the timing of the program in the undergraduate curriculum,* attracting students early in their freshman and sophomore years before they have declared a major; *building a community of like-minded early scientists,* through small group, peer facilitation to assist students to acquire the language and identity associated with a legitimate community of practice; a*dvanced peer and faculty role* *modeling,* providing personalized stories and concrete models of the experience of scientific discovery with peers engaged in real research to experts contributing to international scientific advancement; s*pecific and carefully targeted skills for young scientists*, through the provision of scaffolded tools to support them throughout the process of developing a research proposal; *writing an* a*ctual science research proposal*, which structure the program activities and, in competition for grant funding, constitute doing legitimate science.

## Assessing the Impact of the SRW Program

Because a broad ranging assessment of the Science Research Workshop Program has been undertaken and data from the larger study are being prepared for dissemination, this paper shares only those findings related to students' assessment of the program impact on their interest in further science research and future career plans. The research team used a mixed methods sequential design—a quantitative phase followed by qualitative phase—to gain a better understanding of the impact of the program on participants (Ivankova, et. al., 2006; Creswell et al., 2003). All 18 students participated in the program evaluation survey: 6 from the Chemistry workshop and 12 from the two Biology workshops. Individual interviews were also conducted with a convenience-derived subgroup of 14 of the participants from both disciplinary groups.

We first analyzed the quantitative data and then used those findings to construct the questions for the qualitative interviews which probed further areas to refine and explain the initial results. The main question guiding our study of students' interest in further science research and career plans were: 1) What is the program’s impact on the student’s interest in doing science research; 2) What is the program’s impact on the student’s understanding of research as a potential career and on his or her future career plans in science?; and 3) How effective were specific aspects of the program on students’ research skill development?

## Survey Findings

### *1) Student Perceptions of Impact*

The items used to assess student impact of the program on doing research and future career plans were adapted from the Survey of Undergraduate Research Experiences (SURE) (Lopatto, 2004). Participants self-reported their level of agreement with a series of statements using a 5-point Likert rating scale from “strongly disagree” to strongly agree.” These statements fell into three categories: (a) doing research in science—did the program help get them more contact time with professors, or give them an advantage in securing research funding; (b) research in science as potential career—did the program helped the participant know what it was like to be a researcher, and if graduate school or a career in science was for them; and (c) those related to future career plans—did they think the program would actually help them get into graduate school, get a job in science and/or get into medical school.

The results (see figure 1 below) suggest that the items on which students’ scores were highest were those concerned with the aspects of doing scientific research. The mean score for these items was above 4 on a 5-point scale. This is not, perhaps, surprising given that these items align most closely with the program areas that were given the most attention and training—learning how to secure grant funding and coming into more direct contact with faculty. There were also gains in student perceptions that the program helped them become more knowledgeable about what a research career in the sciences entails and whether it and the training for it, through graduate school, would be a career they would be interested in pursuing. The mean score for this category was 3.7. Finally, with the exception of preparation for medical school, there was some positive agreement by the students that participating in the SRW program would be useful for getting the training for a research career in the sciences through graduate school, and also help them attain a job in the sciences or in medicine. The mean score for this category was 3.3.

**Insert Figure 1 here**

*2) Change in Student Research Plans (pre- and post-program)*

As part of the assessment of changes in student future plans with respect to doing research, we employed a survey to collect data on the students' plans for post-graduate education before and after participating in the program. Table 4 (below) shows students' intended career plans before and after the program. Before participating in the program, 61% (N=11) of the students indicated an interest in pursuing medical school compared to 44% (N=8) after the program. The change in these numbers corresponds to a group of three students whose initial plans had been to go to medical school solely in order to become physicians, but, post the program had changed their plans to include research in their career plans through an MD/PhD program. The initial number of students (N=6) that had planned to get a PhD in science before the program remained unchanged. While these numbers are small, this represents an increase of 43% in the number students (10 as opposed to 7) interested in pursuing science research post the program.

**Insert Table 1 here**

### *3) Perceived Impact of Program on Research Skill Development*

In addition to assessing the students' overall satisfaction with the program, we also assessed the impact of specific aspects of the program on the development of the students' research skills. Participants were asked to self-report their level of satisfaction with respect to both s*kills regarding particular program aspects*—including, support for finding a lab; developing interviewing skills; learning how to write a CV, and learning how to write a proposal—and *satisfaction with the program*, including the science cafes and the program overall.

Participants in the program rated each of these aspects using a 5 point Likert scale with a range from "very dissatisfied" to "very satisfied." Figure 2 (below) shows the average ratings along with the 95% confidence interval for each of the items. Except for the development of CVs, students reported high levels of satisfaction with those aspects of the program devoted to developing specific research skills.  In addition the students reported a high degree of satisfaction with both the science café and the program overall.

**Insert Figure 2 here**

### Interview Findings

The above findings were supported and enriched by the qualitative data collected through the individual interviews with participants. Data related to understanding the impact of the program on students' perceptions of doing further research and refining their career aspirations found that students overall indicated an increase in interest in science study generally and more clarity with regard to how to incorporate research into future career plans in particular. Students repeatedly highlighted specific skills they gained that they attributed to helping them become more confident to pursue science research.

> [The program taught me] how to clearly state my research question, cite references, how to use *Endnote*, go through example CVs. I still need to develop better proposal writing skills. (Student SP in Chemistry)
>
> I got better at emailing professors and introducing myself to them. The program helps you figure out what you actually want. I ended up in the right lab in terms of my future interests but I couldn't have known that before…. I always knew I wanted to go into research and the summer lab will confirm that for me…but the workshop led me to the lab. (Student RS in Biology)
>
> [The program] got us to talk about having lab experiences and gave us more confidence in the research process, that you learn and make mistakes. The facilitator prompted me to ask more questions and not wait for help but to go out and do it. (Student SC in Chemistry)

Students also attributed their increased confidence to the advice they received from faculty and peer mentors, and the scaffolded guidelines that directed them through the step-by-step process of securing a summer lab placement, analyzing scientific writing, and constructing a proposal for funding.

> We learned how to think through a proposal, which is necessary for any scientist. To do a lit review, to apply for big-time funded research, and to understand how these skills are applied to move into the world of science. (Student RL in Biology)
>
> For many students, this program gave them a more concrete path. Seeing abstracts, learning about other areas of research, meeting contacts, all of these things present various options and give direction and guidance and explain options. (Student AA in Biology)

> [I gained the] ability to discriminate what areas of science study interest me. I will declare in Bio and would have anyway [but I gained a] greater interest in Neurobiology. Seeing their websites and meeting with professors really helped. I will be in a lab this fall [and this program] fine tuned my interests. (Student MH in Biology)

Finally, many students said that the program helped them gain a clearer sense of direction for the next steps to take to advance their success in science study. One student captured the sentiments of many:

> This program gave me lots of direction. I was better prepared for opportunities. I might have felt before that research is inaccessible to me, big-time labs were out of my league, but that's underestimating your potential. You can learn to focus your knowledge and do something with that and do successful research. Knowing that is important. You can start early even if as a freshman you don't know everything in the field yet.

## Conclusion

The Science Research Workshop Program was created out of the basic conviction that students who come into their undergraduate studies initially interested in a career in the sciences may not persist toward the major because they lack what might be thought of as sufficient “insider information”—or what we referred to earlier as the “language-game”—to know what  steps are involved and how to overcome perceived barriers. As with much of the scholarship that demonstrates how undergraduate research experiences can impact students in a variety of ways, we believe the data collected from this initial pilot study provide support for the efficacy of early intervention. Of the 18 students who completed the program, 11 submitted completed proposals and all eventually secured competitive funding from either Northwestern’s Weinberg College of Arts and Sciences, the Program in Biological Studies, the Searle Center for Teaching Excellence, or the National Science Foundation’s Research Experiences for Undergraduates (REU)

Program. All 11 of these students also went on to pursue work in a science laboratory during the summer following the program.

We believe the Science Research Workshop Program portrayed in this discussion serves as one example within the current literature on challenges facing undergraduate science study of a unique initiative that holds promise for the future. Our program provides preliminary evidence of the Boyer Commission Report's contention years ago—that when undergraduates are given opportunities to participate in carefully mentored, legitimate, and independent research opportunities, their experience can go far in motivating them to pursue additional study  in rigorous and intellectually challenging environments and in helping them see how that study can be meaningful and eventually highly rewarding.

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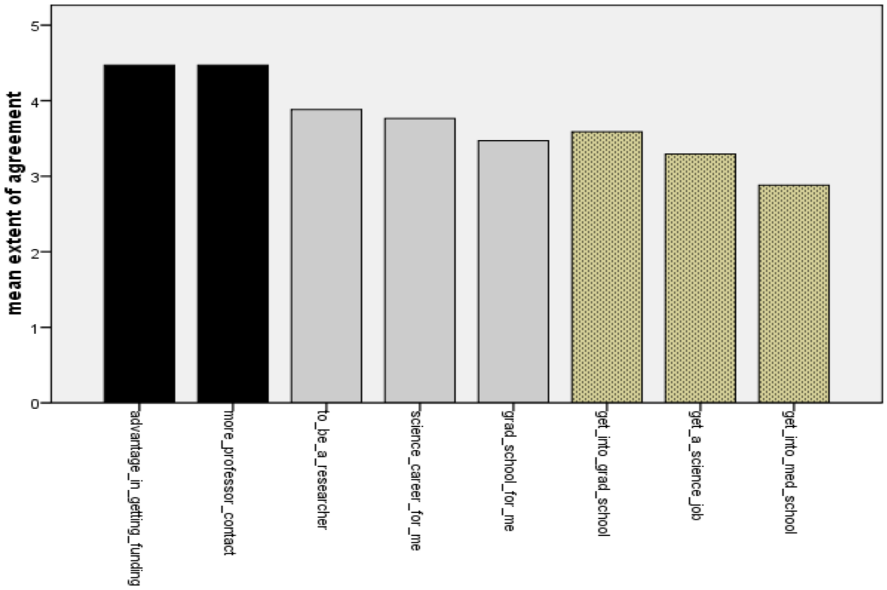

Figure 1. Mean levels of agreement on doing research and research career aspirations

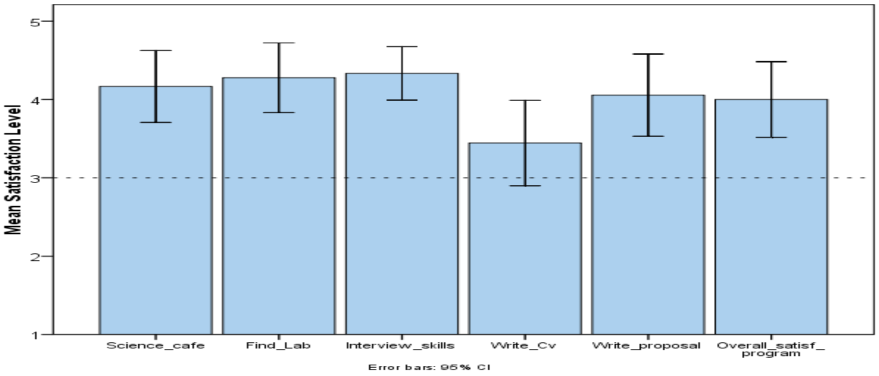

Figure 2. Mean levels of satisfaction with the program

Table 1. Plans for post-undergraduate education before and after the program

| | **Before Program** | | **After Program** | |
|---|---|---|---|---|
| | **Frequency** | **%** | **Frequency** | **%** |
| M.D. | 11 | 61.1% | 8 | 44.4% |
| M.D.-Ph.D./research | 1 | 5.6% | 4 | 22.3% |
| Ph.D. Science | 6 | 33.3% | 6 | 33.3% |
| **Total** | **18** | **100%** | **18** | **100%** |

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