The Catalyst Scholarship Program at Hunter College. A partnership among earth science, physics, computer science and mathematics

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Abstract

The Catalyst Scholarship Program at Hunter College of The City University of New York (CUNY) was established with a four-year award from the National Science Foundation (NSF) to fund scholarships to 40 academically talented but financially disadvantaged students majoring in four disciplines of science, technology, engineering and mathematics (STEM). Scholarships were awarded to students in their junior or senior years majoring in computer science, geosciences, mathematics and physics to create two cohorts of students that spend a total of four semesters in an interdisciplinary community. The program included mentoring of undergraduate students by faculty and graduate students (peer-mentoring), a sequence of three semesters of a one-credit seminar course and opportunities to engage in research activities, research seminars and other enriching academic experiences. The program resulted in increased retention rates relative to institutional averages. This article describes the program, presents an overview of accomplishments and lessons learned, results of an assessment performed at the end of the fourth year of the award and a discussion of the process of establishing the program, from the original plans to its implementation at the institution.

Introduction

Science, technology, engineering and mathematics (STEM) education is a central theme in higher education today. The national need for a science educated labor force has promoted government funding for programs geared to diversifying and increasing the percentages of the workforce engaged in STEM fields. This funding effort offered unique opportunities to members of society traditionally underrepresented in STEM careers. The establishment of scholarship programs at many academic institutions promoted fruitful discussions and research on "best practices" for preparing the next generation of skilled STEM professionals. The impact of this national development was underscored by the 2012 National Science Foundation (NSF) S-STEM Projects Meeting, attended by about 400 people involved in STEM programs, mostly Principal Investigators at academic institutions and other organizations. The report for this meeting can be accessed from http://www.asee.org/Post_Meeting___Program_Final.pdf. This meeting was convened to provide a venue to share experiences, discuss challenges and opportunities encountered when implementing STEM programs, review best practices, successes and challenges, and to explore strategies for the sustainability and institutionalization of S-STEM projects. Overall, the experience from these programs has shown that their success depends strongly on effective and dedicated mentoring strategies (e.g., Koenig, 2009; Wilson, Sanner & McAllister, 2010; Yelamarthi & Mawasha, 2008), having a common academic experience for all students in a cohort (e.g., a seminar-style course), and on the active integration of scholars in research projects and other research opportunities (Yelamarthi & Mawasha, 2010).

The Catalyst Scholarship Program (CSP) at Hunter College of the City University of New York (CUNY) includes all the elements mentioned above and was implemented in specific ways that depended on the realities of the institutional environment. CSP evolved as feedback from the targeted population was received and incorporated. Regular evaluation and assessment led to adjustments that were implemented as the program grew and became better established. In the next section of this paper we present and describe the general structure of CSP and its various components in detail. We follow with a section on the program's overall performance and evaluation. Using results from surveys conducted at the end of the fourth year of the award, we discuss the program's impacts on STEM students and the institution. We conclude this article with a discussion of the dynamic nature of the program, its evolution from its original conception to implementation at the institution, highlighting the lessons learned in the process that might inform new strategies for the future.

Program Background and Description

Institutional Environment

Although scholarship programs share a set of common features, many are characterized by their unique institutional environments, which affect the operations, outcomes and impacts of these programs (Tinto & Pusser, 2006). Hunter College is the largest of 11 senior colleges of the 24-campus City University of New York (CUNY), with a student population of over 20,000. Founded in 1870, it is also one of the oldest public colleges in the country. It is an urban, coeducational, liberal arts institution where a high percent of students are first generation college students. Over 50% of Hunter's students belong to ethnic minority groups. In 2012, the gender ratio at Hunter College was a typical 69% female to 29% male. Seventy-one percent of these students were born outside the United States or have at least one foreign-born parent. Hunter College attracts many students because of its easy access by public transportation but its space limitations forces students to commute elsewhere after class. Hunter provides campus housing for only a small percentage of students. Fifty seven percent are full-time students, and many of those work outside the college. Over one-third of Hunter's students are employed full-time while pursuing a degree. A substantial number of Hunter's students are in financial need defined in terms of the Cost of Attendance and the Estimated Family Contribution. Hunter College's 6-year graduation rate has steadily increased in the past decade reaching nearly 50% in 2014, which when compared to the national average of 58% at public institutions (U.S. Department of Education, 2015), underscores the extent to which our students face financial pressures.

Program Goals and Objectives

CSP was established with the following specific goals: (1) to increase the recruitment, full-time enrollment, and retention of financially needy students in earth and environmental science, computer science, mathematics and physics at Hunter College; (2) to increase retention through individually assigned faculty mentors, individualized academic and career planning, targeted support services and quality instruction; and (3) to establish faculty and peer mentoring programs in STEM departments. The interdisciplinary setup of CSP sought to strengthen collaborations among STEM departments within the college and to open new venues for STEM students (and faculty) to pursue research careers in interdisciplinary and non-traditional disciplines (e. g., bioinformatics, computational geoscience, environmental science). The ultimate objective of CSP is to provide the skills, incentives and directions to put students on track for graduate school and/or successful professional careers, and to increase the skilled labor pool in high demand technical fields.

The original design of CSP called for the support of 40 scholarships over a 4-year program, to be given to 20 qualified students for a maximum period of 2 years per student. Ideally this plan would have led to two cohorts of 20 students, 5 from each of the participating departments that would have spent a total of 4 semesters in an interdisciplinary community. We decided to limit the number of scholarships granted to 20 per cohort in order to be able to provide a yearly amount of $6,500. This amount, based on covering the cost of attendance, increased slightly after two years and provided substantial financial assistance to the scholars, thus reducing the extent to which these students needed to seek outside employment. The cost of attending our institution (in-state tuition, not including food, housing and other incidentals) as reported by the Office of Financial Aid was approximately $6,083 per year in 2008 and increased to approximately $8,397 per year in 2012. Reducing the financial burden on students pursuing a degree is critical at our institution, where 65% of students belong to low income households (income less than $35,000 per year) as reported by the 2013 CUNY Task Force on Retention. Choosing a larger scholarship amount is supported by studies that have shown that a combination of substantial financial incentives and academic support services were essential for improving academic standing and raising grades for disadvantaged students, particularly for women and for those in commuter settings (Angrist, Lang, & Oreopoulos, 2009; De Paola, Scoppa, & Nisticò, 2013). A management team led by the Principal Investigator and composed of four additional faculty members in the participating departments administered the program.

To be eligible for a CSP scholarship, U. S. citizenship or legal permanent status was required and students had to demonstrate financial need (determined through the Financial Aid Office) as well as academic achievements commensurable with a minimum cumulative GPA of 3.0 and completion of at least 60 college credits, the equivalent of junior standing at most institutions. Additional eligibility requirements included enrollment as full-time students in one of the participating departments and a formal written agreement to complete all work assignments related to the scholarship, meet regularly with faculty mentors, and participate in program's events. CSP developed a dedicated website where all application materials were available. The establishment of the program was widely advertised within the college and the CUNY community to reach the large population of transfer students. Advertising and recruitment was also accomplished by personal visits to STEM classes and by reaching electronically (with the help of the Admissions Office) all incoming students that had indicated an interest in STEM careers. After all applications were checked for completeness and eligibility, they were made available to all members of the management team for review. The review process was aided by the development of a Review Matrix, where applications were ranked by assessing the demonstrated desire to succeed in STEM classes, information from recommendation letters, academic and personal goals as described in the personal statement, minority status and the student demonstrated financial need. The final selection was determined in a special meeting held by the management team for this purpose.

Program Components

Individual mentoring by faculty and graduate peer-mentors, development and completion of an academic success plan (ASP) and participation in a 1-credit seminar class that became the Catalyst Seminar are the three fundamental components of CSP and are listed in Table 1. The structure of these components and the selection of activities was guided by the aims of designing an engaged learning environment by providing the necessary elements for active involvement of scholars as well as a supportive academic setting, all conditions that are known to contribute to student's success (Smith, Clarke-Douglas & Cox, 2009; Tinto & Pusser, 2006). In addition, CSP encouraged and facilitated optional participation in scholarly activities such as research with Hunter College and the broader CUNY faculty community, internships at New York City's many research and academic, and non-academic, institutions, participation in workshops and seminars and visits to research laboratories in other universities. Mentoring was crucial and mandatory for all students in the program. The ASP and the 1-credit seminar were mandatory for only three out of a total of four semesters of the scholarship. In addition, scholars had to attend a minimum of one major event per semester, referred to as the 'Catalyst Social', such as an 'end of semester' or 'end of year/cycle' celebration attended by of all members associated with CSP.

Individual mentoring by faculty and graduate peer-mentors. An effective mentor is key to accessing academic and professional resources and to providing direct assistance in navigating college culture particularly in a large urban institution characterized by a commuter population (e. g., Budny, Paul & Newborg, 2010; Fifolt & Searby, 2010). Consequently, faculty mentoring and reporting were core to CSP. At the onset of the program, all mentors, faculty and graduate student peer-mentors, participated in the Workshop on Effective Mentoring developed for the CSP and led by Virginia Valian, former director of the Gender Equity Project at Hunter College. Subsequently, the health of the mentoring component was monitored through meetings and other venues of frequent communication between the management team and mentors to discuss experiences and mentoring practices. In addition, data on number of meetings between mentors and scholars were compiled and mentors' reports were reviewed regularly to assess progress and to identify issues as soon as they arose. The members of the management team, themselves mentors in the project, were responsible for overseeing mentoring activities in their respective academic departments. Additional mentors for the scholars were drawn from a group of full-time faculty members in the participating departments who were committed to participate and had an established record of teaching and advising undergraduates. Mentors were paired with scholars according to overlapping academic and research

Mandatory Scholars Commitments
Attend meetings monthly with faculty mentors and 1 – 2 meetings per semester with graduate student peer-mentors. Goal: ***discuss scholarly progress, participation in program's activities, academic aspirations and career goals.***
Enroll in the 1-credit seminar course during semesters 2, 3, and 4 of the award period. Goal: ***community building and interdisciplinary instruction.***
Develop and complete an individual Academic Success Plan (ASP) during semesters 2, 3, and 4 of the award period, rewarded with funds for textbooks. Goal: ***provide an incentive and a formal structure that rewards scholars' commitments to optional activities.***
Optional Scholars Commitments
Participate in additional scholarly activities: research or internships, attend department colloquia, join a science club, prepare posters for presentation at institutional, local and regional meetings, and contribute to research articles. Goal: ***provide opportunities, formal and informal, to gain specific knowledge and skills that better prepare students for graduate school or/and the labor force.***

Table 1. List of Catalyst Scholarship Program main components and the goals they accomplish.

interests and encouraged scholars to engage in a research experience.

Peer mentoring represents another critical mentoring strategy that builds community and de-emphasizes seniority and hierarchy (Wilson, Holmes, Sylvain, Batiste, Johnson, McGuire, Pang, & Warner, 2012). To ensure that incoming students had a strong network of student support, a student peer-mentoring program was established linking graduate students in the participating departments with those entering the program. Scholars were assigned a graduate peer-mentor as their primary peer-mentor contact, with whom they met regularly as individuals and in groups. Peer-mentors provided invaluable feedback to the management team while benefiting from the environment provided by the program. The mentoring component of CSP was formalized by developing templates with guidelines for monthly meeting and by asking faculty and peer-mentors to complete and submit the reports on their meetings.

An Academic Success Plan. The main objective of designing and implementing an Academic Success Plan (ASP) was to promote scholar engagement in research and dissemination, activities that have been shown to correlate with an increase in GPA (Fechheimer, Webber, & Kleiber, 2011). An ASP consisted of committing to two activities in addition to the regular semester commitments of attending the Catalyst Social and meeting with mentors. Activities include monthly use of learning centers available at the college, joining and participating in departmental clubs, attending regular departmental seminar series, attending career development workshops and attending local professional meetings relevant to the student's potential research interests. This list was designed to effectively develop a community more oriented towards active and explicit research in STEM. The ASP was envisioned as a venue to involve scholars in preparing posters for presentation at institutional, local and regional research meetings, to offer them the opportunity to contribute to research articles and to aid them in developing communication skills. The ASP sequence, namely commitment to an ASP for each of 3 consecutive semesters, established a path towards engagement in research activities, which our specific environment and student body characteristics demanded. Scholars developed their ASP in close collaboration with their faculty mentors, who helped tailor the plan to suit individual needs and academic interests and were required to report on these activities at group meetings. The program supported this endeavor with a modest amount of funds for textbooks for each semester that scholars committed to an ASP.

The Catalyst Seminar: a three semester sequence of a 1-credit seminar course. All scholars are required to participate in a sequence of three semesters of a 1-credit seminar course, beginning their second semester in the program. The overarching goal of the sequence was to provide a venue for scholars to meet regularly as a cohort and build a sense of community. The specific objective of the sequence was to reinforce the cross-disciplinary and inter-disciplinary nature of many of today's STEM careers and professional opportunities where STEM knowledge is relevant. The expected outcome for the sequence was that students learn how the specific expertise gained in their discipline relates to larger problems whose solutions rely on the expertise in other disciplines. This outcome was assessed by evaluating the required assignment for each semester. The assignments were (1) writing a short essay describing a research area and a specific question within it that warrants investigation, to explicitly describe how the selected research problem could be approached by different disciplines and to identify and invite (by writing a letter) at least one scientist from another academic or research institution who could be a potential collaborator; (2) an interdisciplinary project of small-scope to be carried out by a group of scholars, preferably of different disciplines; and (3) a full-fledge research project (design, development and completion) by a group of scholars from different disciplines, culminating in a presentation of results to the entire community. The approach followed in implementing this component of the program is consistent with studies that have stressed the importance of active learning in STEM education (e. g., Smith, Clarke-Douglas & Cox, 2009).

The Catalyst Seminar met every other week during each semester for two hours each time and was led by a faculty coordinator, typically the CSP program director, who guided and facilitated the activities planned for the semester. The first semester was devoted to interdisciplinary instruction, titled "Exposure and Connections". STEM faculty gave an invited lecture about their research and endeavored to show explicitly how the program's participating disciplines contributed to their work. In conjunction with the lectures, scholars were assigned one pertinent journal article, preferably authored by the presenter, which was discussed by the entire cohort. Graduate peer mentors would typically participate and facilitate the discussion. Topics covered by the series typically included lectures on rip currents, paleoceanography as a nexus of chemistry, climate, math, physics and modeling, optics research applied to medicine, algorithms for 3D modeling as used by computer scientists, sequential on-line detection and classification in 3D Computer Vision and space-time modeling in mathematics and statistics.

The following two semesters of the Catalyst Seminar sequence were devoted to preparing scholars to work as young scientists in a group, and this was accomplished in stages. In both semesters, we used a more active learning approach in which the students take ownership of their learning process through disciplinary and interdisciplinary engagement in a project. Groups of four to five scholars were formed to work on a project, with the requirement that all four disciplines participating in CSP be explicitly represented in each group. The scope of the project and the type of engagement required, however, were different in each of the semesters.

In the second semester the coordinator was in charge of selecting and leading a 'research project' of small scope, which while challenging to scholars in all disciplines was 'safe' enough that answers were readily available. The seminar was built around a common theme based on a journal article in lieu of a textbook. The article selected was "On the Upwelling of Downwelling Currents" by R. P. Matano and E.D. Palma, published in 2008 in the Journal of Physical Oceanography (Volume 38, pp. 2482-2500). Scholars took charge of each section of the article from a disciplinary perspective: earth scientists discussed the basics of ocean circulation, physicists helped set up the governing equations for a moving fluid from basic principles (such as Newton's second law of motion), mathematicians led the way from the general equations to the specific equations used for the problem to be solved and computer scientists were in charge of the computational methods that lead to the final answers.

In the third semester, the final one for the majority of scholars, the role of the coordinator was that of a coach who provided unstructured guidance and facilitated the formation, meetings and discussions of interdisciplinary research teams that assumed complete charge of the entire research enterprise. Scholars were responsible for selecting a research theme of enough interest to all members of a group, finding a specific research topic, crafting the research question, deciding on methodology, selecting the appropriate data to use and of coordinating individual contributions according to different skills. At the end of the term groups prepared a presentation and produced a research report as a short 'journal article'. The seminar included projects in which scholars developed physical experiments such as a study of wind belts to generate energy and building an underwater Remotely Operated Vehicle using a commercial kit. Scholars accessed large data sets from available sources (precipitation data to study pattern of change, seismic data for a study on the environmental impacts of fracking) and handled of these large data sets led by the computer scientists. Scholars also learned about physical mechanisms from current publications, a task led by the physics majors mostly, and learned the basics of data analysis using sophisticated techniques and software such as Matlab, tasks led by mathematics and earth science majors in each group.

Program Performance and Evaluation

CSP funded 48 scholarships over a period of five years, starting in June 2009 and ending in May 2014. We present below the overall statistics for the entire 5-year period and we note that the assessment of scholars' satisfaction with

Year	Gender	STEM Major	Ethnicity	Race*
1: Ns = 16	*Female* *63% (10)* *Male* *37% (6)*	***Computer Science: 25% (4)*** ***Env. Earth Science: 31% (5)*** ***Mathematics: 19% (3)*** ***Physics: 25% (4)***	***Hispanic 0% (0)*** ***Non-Hispanic 75% (12)*** ***Not Reported 25% (4)***	***White 50% (8)*** ***Asian 31% (5)*** ***Pacific Islander 6% (1)*** ***Not Reported 13% (2)***
2: Ns = 18	*Female* *61% (11)* *Male* *39% (7)*	***Computer Science: 28% (5)*** ***Env. Earth Science: 28% (5)*** ***Mathematics: 22% (4)*** ***Physics: 22% (4)***	***Hispanic 0% (0)*** ***Non-Hispanic 66% (12)*** ***Not Reported 33% (6)***	***White 44% (8)*** ***Asian 28 % (5)*** ***Pacific Islander 6% (1)*** ***Not Reported 22% (4)***
3: Ns = 17	*Female* *65% (11)* *Male* *35% (6)*	***Computer Science: 29% (5)*** ***Env. Earth Science: 29% (5)*** ***Mathematics: 18% (3)*** ***Physics: 24% (4)***	***Hispanic 12% (2)*** ***Non-Hispanic 53% (9)*** ***Not Reported 35% (6)***	***White 35% (6)*** ***Asian 18% (3)*** ***Black 12% (2)*** ***Not Reported 35% (6)***
4: Ns = 21	*Female* *48% (10)* *Male* *52% (11)*	***Computer Science: 33% (7)*** ***Env. Earth Science: 33% (7)*** ***Mathematics: 14% (3)*** ***Physics: 19% (4)***	***Hispanic 14% (3)*** ***Non-Hispanic 43% (9)*** ***Not Reported 43% (9)***	***White 38% (8)*** ***Asian 33% (7)*** ***Black 10% (2)*** ***Not Reported 19% (4)***
5: Ns = 10	*Female* *30% (3)* *Male* *70% (7)*	***Computer Science: 40% (4)*** ***Env. Earth Science: 20% (2)*** ***Mathematics: 0% (0)*** ***Physics: 40% (4)***	***Hispanic 0% (0)*** ***Non-Hispanic 100% (10)*** ***Not Reported 0% (0)***	***White 50% (5)*** ***Asian 50% (5)*** ***Black 0% (0)*** ***Not Reported 0% (0)***
*Race listed as Black may be Black or African American.				

Table 2. Catalyst Scholarship Program demographics for each year, listed according to gender, STEM major (department) ethnicity and race.

the program that follows is based on data limited to the first four years of the program. Table 2 below summarizes the demographics of the program since its establishment. The numbers in the first column in the table correspond to the number of active scholars in the year period indicated in each cell.

Overall 83% (40) of the scholars completed the program with an average GPA of 3.6, 36 of which have graduated from the institution and moved on to STEM careers or joined the labor force. Those that were still at the institution at the time of writing were set to graduate within a semester or two. As a result of their experience with CSP, some scholars delayed graduation to improve their physics and mathematics background and secure their admittance to STEM graduate programs. The Program experienced an attrition rate of 17% (8 scholars) over the 5 years: loss of eligibility (4), personal reasons (1), and health related issues (3). Table 3 below summarizes the overall performance of CSP with relation to the specific program goals of recruiting, retaining and graduating scholars. These data indicate that CSP performed well when compared to similar STEM scholarships and national statistics on STEM retention, graduation and attrition rates (Gilmer, 2007).

Comparing the performance of Catalyst scholars with the CUNY population indicates that the program was effective in retaining and graduating STEM students from the participating departments. At the inception of the program data from the CUNY Office of Institutional Research indicated that the six-year and eight-year graduation rates for the institution were 45% and 48%, respectively. In addition only 64% of all students at the time were retained at the institution until their fourth year. Students typically join CSP after completing an average of three years of study at the institution. Of the 48 scholars who held scholarships at any given time over the duration of our program, a total of 36 have graduated in a timely fashion and have been retained in their initial STEM discipline. This constitutes a 75% graduation rate for the Program, with scholars either graduating within six or eight years from the time they first began their undergraduate course of study.

The largest attrition occurred in the second year of CSP, with four students leaving, and it decreased as we learned how to better implement different measures to improve retention. Attrition dropped to only one student in the third year and to two in the fourth year. Although two students were lost to the program in the fourth year it is also important to note that only one lost eligibility after being put on probation (discussed below) the previous semester when full-time status was not satisfied. The other student had by the end of that year developed a clearer career path that led him to make stronger commitments to another STEM research program.

Part of helping students succeed is giving them a chance to improve when particular circumstances do not allow them to excel. Consequently, CSP included a probation period for scholars not meeting 3.0 GPA for a semester, during which time the scholar had to meet bi-weekly with his/her mentor instead of the required monthly meeting. As the program progressed through its second year, we learned that although, by and large, GPA is a good measure of academic standing, it is not the only one. Our program, our particular institutional setting and our goal of improving retention rates required moni-

	new scholars	total scholars during year	scholars retained	scholars completed (and graduated*)	attrition
Year 1	16	16	13	3 (3)	0
Year 2	5	18	5	9 (1)	4
Year 3	12	17	10	6 (4)	1
Year 4	11	21	7	12 (6)	2
Year 5**	4	10	9	9(8)	1

* Numbers in () correspond to scholars graduating within year period

** Data included in table but not used in present analysis

Table 3. Catalyst Scholarship Program retention, completion and attrition data.

Total number of Scholars surveyed = 19			
Number of responses = 17; response rate 89.5%			
Status with the CSP; %(#s)		**Major; %(#s)**	
Current Scholar	35.29% (6)	***Computer Science***	***23.5% (4)***
Recent Graduate	0% (0)	***Earth & Environmental Science***	***41.2% (7)***
Completed the Program	47.06% (8)	***Mathematics***	***11.8% (2)***
Did not complete the Program	17.65% (3)	***Physics***	***23.5% (4)***

Table 4. Characteristics of surveyed population.

toring academic performance in a more integral way. As studies have shown, early identification and correction of student problems is critical for student success and overall retention (Gilmer, 2007; Khoury, Jenab, Staub, & Rajai, 2012). Therefore in an attempt to identify and correct poor scholar performance earlier, probationary measures were revised to include considerations about maintaining full-time enrollment status, attending mandatory meetings with mentors, and participating in the Catalyst Seminar and other group activities. This comprehensive approach allowed for earlier detection of issues that would have resulted in a lower GPA at the end of a semester. Scholars were asked to inform the program the reasons for not meeting scholarship requirements and meet with the program director, who then reported the outcome of the meeting to the management team. The scholar was put on probation for the semester in which issues were identified as a warning, and the scholar was monitored more closely during that period. Financial support was not affected at that time but the scholar was informed that failure to show progress towards improving her/his standing with the program would result in a suspension or termination of the scholarship funds.

CSP had eleven students on probation and scholars that took temporary leaves of absence. Only four of these scholars had to leave the program after the probation period, while seven returned which constitutes a 'recovery rate' of roughly 64%. Three of our scholars had to take leaves of absence for a short period. Two of these students returned, completed their tenure with Catalyst successfully and graduated from the institution upon completion of the scholarship. The other student left the institution.

Question No, Weight: 1 through 4	responses % (#s)	Percent favorable
***1.** What is your overall rating of your experience in the Catalyst Scholarship Program?*		
1. Ughh, I hated it	0% (0)	94.1%
2. I only learned a little	5.9% (1)	
3. I learned a lot	47.0% (8)	
4. I learned a lot, I enjoyed myself and I would recommend it to others in STEM fields	47.0% (8)	
N/A	0% (0)	
***2.** How helpful were the mandatory faculty mentor meetings?*		
1. Not helpful, I didn't gain anything from the meeting	0% (0)	93.8%
2. Not helpful but it kept me on track with my academics	6.3% (1)	
3. Moderately helpful	31.3% (5)	
4. Extremely helpful, I gained a lot from speaking with my faculty mentor	62.5% (10)	
N/A	5.9% (1)	
***3.** Did you benefit from the Academic Success Plan (ASP)?*		
1. I've never submitted an ASP, what's that?	14.3% (2)	78.5%
2. No, it was only $100 and not worth the meeting with my faculty mentor to submit it	7.1% (1)	
3. Yes, but the paperwork was annoying	42.9% (6)	
4. Yes, the extra $100 for books was very useful and I enjoyed creating the ASP with my faculty mentor	35.7% (5)	
N/A	17.7% (3)	
***4.** How did you benefit from the Catalyst Seminar series?*		
1. It was a waste of time	0% (0)	84.6%
2. I only learned a little	13.4% (2)	
3. I learned a lot	69.2% (9)	
4. It was extremely enriching	13.4% (2)	
N/A	23.5% (4)	
***5.** Has the interdisciplinary context of Catalyst allowed you to advance in your existing field?*		
1. No, I don't care about the other STEM fields	***0% (0)***	***93.3 %***
2. It helped me a lot, but it is not important to me	***6.7% (1)***	
3. It was extremely helpful	***40.0% (6)***	
4. I gained interest in pursuing more STEM fields	***53.3% (8)***	
N/A	***11.8% (2)***	

Table 5. Questions and results from the Catalyst Scholar Program general satisfaction survey.

Fourth Year Partial Assessment

At the end of the fourth year we compiled data from the active scholars at that time through a series of surveys conducted using SurveyMonkey® services. A large scale assessment will include data collected since the establishment of CSP and it is beyond the scope of the present article. Here we discuss the data collected in the spring of 2013 in some detail. We consider this discussion illustrative of the successes and lessons learned from CSP and a useful contribution to the community interested in STEM education and in possibly establishing similar program in academic setting such as ours.

Assessment of general satisfaction with the CSP. Year four of the program began with 21 scholars, two of which graduated early and joined the labor force in STEM related jobs, therefore the total number of scholars at the time of the surveys was 19 and we received 17 responses. Tables 4 and 5 summarize the characteristics of the surveyed population and the results that reflect scholars' levels of satisfaction with the program. The design of the informal survey allowed for comments to accompany some of the questions, comments that were extremely helpful in providing further insights into scholar's gains from the program.

The percentages shown in the Table 5 were computed with respect to the number of respondents that answered each question with any response other than N/A. N/A includes 'no answer' as well as Not Applicable, and this percentage is computed with respect to the total number

#	Weight: 1 through 4	responses % (#s)	Percent favorable
1	*How satisfied are you with your mentoring interactions and overall experience with your mentor?*		
	1. Not satisfied	0% (0)	94.12%
	2. A little satisfied	5.9% (1)	
	3. Satisfied	29.4% (5)	
	4. Extremely satisfied	64.7% (11)	
	N/A	0% (0)	
2	*My faculty mentor showed genuine concern for me and treated me with respect and answered all of my questions.*		
	1. Not at all	0% (0)	100%
	2. Sometimes	0% (0)	
	3. More often than not	23.5% (4)	
	4. Always	76.5% (13)	
	N/A	0% (0)	
3	*My faculty mentor provided guidance about my educational program and advised me on my degree progress.*		
	1. Never	0% (0)	88.24%
	2. Sometimes	11.8% (2)	
	3. More often than not	11.8% (2)	
	4. Always	76.5% (13)	
	N/A	0% (0)	
4	*My faculty mentor provided support and constructive feedback throughout the semester.*		
	1. Never	0% (0)	88.24%
	2. Sometimes	11.8% (2)	
	3. More often than not	23.5% (4)	
	4. Always	64.7% (11)	
	N/A	0% (0)	
5	*My faculty mentor provided information about (any, some or all) internships, graduate school, research opportunities and professional development workshops.*		
	1. Never	0% (0)	88.24 %
	2. Sometimes	11.8% (2)	
	3. More often than not	29.4% (5)	
	4. Always	58.8% (10)	
	N/A	0% (0)	
6	*My faculty mentor was available when I needed him/her and helped minimize my anxieties about school.*		
	1. Never	0% (0)	94.12%
	2. Sometimes	5.9% (1)	
	3. More often than not	29.4% (5)	
	4. Always	64.7% (11)	
	N/A	0% (0)	

Table 6. Questions and results of the Catalyst Scholarship Program survey on mentoring component.

of respondents (17). Percent favorable is computed as the sum of the percentages for positive and extremely positive answers, weights 3 and 4 in the table.

Consistent with the overall level of satisfaction, mentoring, pedagogic and research opportunities offered by the interdisciplinary of CSP proved to be quite successful and received the highest percentages of positive responses. The overall favorable responses for questions 3 and 4 in Table 5 were both lower than expected, namely below the 90% satisfaction scale. However, we note that the broad distribution of responses in question 3 suggests a much lower level of satisfaction for this component than the number reflects. Responses for question 4 were more tightly centered about a favorable response. Question 4 also has the highest number for N/A and this may be the result of scholars not having had enough time in the program to participate in or complete a full cycle of the Catalyst Seminar. The evolution of the Catalyst Seminar and the process of rolling admissions into the program are discussed later in the paper.

The survey included questions (not shown) to ascertain opinions and satisfaction levels with other aspects of the program, such as the impact of the program on future plans, career choices and activities that foster community building. Building a sense of community for a cohort of diverse students is particularly important in a commuter urban environment (Fifolt & Searby, 2010; Kalevitch, Maurer, Badger, Holdan, Iannelli, Sirinterlikci, Semich, & Bernaouer, 2012). Our scholars reflected their appreciation of CSP community building with answers that yielded an overall 87% approval of this aspect of the program. From the outset most of the scholars wanted to pursue careers in STEM fields following graduation, either by planning to go to graduate school or to join the labor force, and participation in the scholarship only strengthened and confirmed their original plans. We did find, however, that for a small but significant percent of scholars (approximately 20%), participation in CSP motivated them to continue on to graduate studies, either in their preselected major or in one of the CSP disciplines.

Assessment of the mentoring component. In addition to having scholars evaluate the overall CSP, we assessed the mentoring component of the program in some detail. The survey and responses are shown in Table 6, with percentages computed as those in Table 5.

The results in Table 6 show that the level of satisfaction with the mentoring component was very high, consistently ranging from 88% to 100%. Studies have investigated and quantified the relation between students' grades, personal motivation and academic success and students' perceptions of faculty connections (Vogt, 2008; Micari & Pazos, 2012; Christe, 2013). Our results are consistent with such studies and led us to infer that one of the most important attributes of our program, providing the largest contribution to scholars' success, is the robust mentoring effort.

As we reviewed the mentoring component every year, we found that some patterns emerged. Faculty mentoring activities during Fall semesters were formalized more frequently than during Spring semesters, with an average of 78% reported during Fall as opposed to only 57% for Spring semesters. As mentors and students became more familiar with each other more informal interactions take place and mentors seem to deem it less necessary to write reports. Fall meetings were geared primarily toward getting to know students' interests and academic trajectories and to specific discussions of plans for the year, with mentors providing advice on best strategies to design appropriate course load. Spring meetings seemed to be primarily geared toward developing an ASP, to focus on discussions of strategies for setting-up research experiences or internships and to provide advice for career development.

Dynamics of Approach and Implementation

The process of design, implementation and establishment of the CSP program was a dynamical one, providing opportunities along the way for learning which practices are most effective. CSP was originally designed to establish two cohorts of 20 scholars (5 scholars for each participating academic discipline) holding scholarships for two years each. In practice, however, as the program was new to the college and we did not start with a full 20 scholars, we settled on an approach of rolling admissions. Every year since 2009 in the spring semester we have been able to advertise and recruit new students while some were graduating. This process led to a mix and overlap of scholars at different levels in the scholarship. This overlap in turn resulted in a far richer experience for both groups with the unanticipated outcomes of more senior scholars serving as informal mentors for the newcomers. This overlap also offered an opportunity for leadership to the more senior scholars in the cohort. The effectiveness of such a learning culture has been documented by Edgcomb, Crowe, Rice, Morris, Wolffe, & McConnaughay (2010). The effectiveness of instruction which includes student leadership opportunities (Varma-Nelson, Cracolice & Gosser, 2004) was demonstrated during the last semester of the Catalyst Seminar when research groups that included recently admitted scholars, completed projects successfully under the guidance of more senior members of the group.

Our dedicated mentoring faculty has made it possible to guide scholars through the program while identifying issues of concern about scholars' performance and progress. We assessed the performance of the mentoring component regularly using annual statistics of mentors' reports, surveys conducted among scholars (discussed in the previous section) and surveys conducted among mentors (not included here). The lessons learned through these ongoing assessments were used to revise our mentoring practices from year to year. For example, after our first year we learned that the number of meetings required initially was too high and we reduced it to only one meeting per month. From mentor's feedback we also learned that a lack of a formal report did not necessarily indicate a lack of meetings, as informal encounters were more frequent than reported. The review of the responses to the survey of all mentors confirmed that they felt positively about the semester long/year long improvement in the academic progress of the scholars and attributed part of that progress to their mentoring.

Mentoring also takes place in many informal settings and quantifying the influence of these activities is more elusive. Many of the program's faculty mentors participated in one or more of the Catalyst Seminar sessions and nearly all participated in the end-of-semester activities and presentations, all providing opportunities for mentoring. After the first year, peer-mentor meetings were also conducted in more informal settings such as cafes in the area, resulting in a significant improvement to mentoring. Students were more ready for candid discussions of general issues and future plans and many of them were able to receive practical advice concerning courses, time management and academic careers. Peer mentors frequently encountered scholars informally in their respective departments and used these opportunities to share their own research, experiences with graduate school applications, and other items that pertain to graduate life. A more comprehensive approach to monitoring the mentoring component than simply relying on formal written reports is therefore, necessary for an accurate assessment of the performance of this component.

As discussed earlier, the level of satisfaction with the Academic Success Plan (ASP) component of the program was surprisingly low (see Table 5). This outcome motivated careful consideration of the usefulness of the ASP as a main component of the program. Based on what we learned during the first two years of CSP, we restructured ASP's activities explicitly into four semesters, progressively increasing student's involvement in the program as well as in research opportunities. The improved guidance was beneficial in helping students select activities according to their level in the scholarship, but it did not result in the expected level of improvement of the perceived usefulness of this component. From a survey conducted with the first cohort of Catalyst scholars a 'theme' emerged: scholars were eager to acquire research experience, skills and cross-disciplinary guidance from the start – "even during our first year, put us into groups and give us projects", was one of the recurrent comments added to their answers. Consequently, research conducted in conjunction with the Catalyst Seminar was added as one of the activities to fulfill the ASP. Although this adjustment led to more benefits for scholars and they felt less pressured to find 'alternative' research experiences, the fourth year survey results have led us to conclude that the activities to satisfy an ASP should be integrated into the overall operation of the program, without a need for an additional formal requirement.

The Catalyst Seminar was originally planned around the idea of 1-credit seminar style course with the objective of having bi-weekly meetings of scholars with faculty presenting ongoing research and possibly with some meetings dedicated to outside invited speakers. The seminar was developed and conducted with this tentative structure in an ad hoc manner resulting in an experience that has provided an innovative approach to combining the cohort building and research elements necessary for a successful STEM enrichment program. As scholars became vested in the program, their sense of ownership of potential activities available to them grew and their feedback and expectations shaped the final structure of the seminar away from a passive venue to listen to scientists and toward a space of active learning to become a scientist. It has been documented that research experience in the undergraduate years encourages students to think of themselves as scientists (e.g., Seymour, Hunter, Laursen, & Deantoni, 2004; Hunter, Laursen, & Seymour, 2007; Russell, Hancock & McCullough, 2007) and aids students in solidifying career plans in the sciences (Kinkead, 2003; Lopatto, 2004). In addition, Hurtado, Han, Saenz, Espinosa, Cabrera, & Cerna (2007) report that research is a positive predictor of a sense of 'belonging' for underrepresented minority students. Our preliminary assessment concluded that at our institution the Catalyst Seminar supported these finding and effectively combined academic instruction, research training and community support and cohesion.

CSP has supported a large number of talented, financially disadvantaged students through degree completion and assisted them with transitions to the work force and graduate programs. The program provided a model of interdisciplinary administration, instruction and research within the institution: all aspects of the program, particularly enrichment activities and research and instruction were conducted in an interdisciplinary manner. In addition, the program's success derived from the engaging of a cohort in effective ways by requiring a regular active involvement of faculty and scholars (an ASP, the Catalyst Seminar, a minimum of meetings with mentors, mandatory attendance to 'social events') all of which were closely monitored.

Disclaimer: Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

Acknowledgements

We are grateful for the contributions of all faculty mentors. We want to acknowledge Dr. Virginia Teller for her unwavering support of CSP activities, her guidance throughout the years, her dedication to mentoring scholars and in particular, for her support and mentoring of the first author. In addition, we would like to acknowledge Dr. Randye Rutberg for her able coordination of the Fall 2010 semester of the Catalyst Seminar and for suggesting the format of the term project. The authors would like to acknowledge the assistance of Ms. Chelsea Gross with all matters related to the surveys used in this study. The manuscript was partially written at the GAIN 2013 Workshop funded by NSF Award Numbers 0620087 to Suzanne O'Connell and 0620101 to Mary Anne Holmes.

References

Angrist, J., Lang, D., & Oreopoulos, P. (2009). Incentives and Services for College Achievement: Evidence from a Randomized Trial. *American Economic Journal: Applied Economics, 1*(1), 136-163.

Budny, D., Paul, C.A., & Newborg, B.B. (2010). Impact of Peer Mentoring on Freshmen Engineering Students. *Journal of STEM Education: Innovations and Research, 11*(5), 9-24.

Christe, B. (2013). The Importance of Faculty-Student Connections in STEM Disciplines: A Literature Review. *Journal of STEM Education: Innovations and Research, 14*(3), 22-26.

De Paola M., Scoppa V., & Nisticò R., (2012). Monetary incentives and student achievement in a depressed labor market: results from a randomized experiment. *Journal of Human Capital, 6*(1), 56 - 85.

Edgcomb, M.R., Crowe, H.A., Rice, J.D., Morris, S., Wolffe, R.J., & McConnaughay, K.D. (2010). Peer and Near-Peer Mentoring: Enhancing Learning in Summer Research Programs. *Council on Undergraduate Research Quarterly, 31*(2), 18-25.

Fechheimer, M., Webber, K., & Kleiber, P. B. (2011). How Well Do Undergraduate Research Programs Promote Engagement and Success of Students? *CBE – Life Sciences Education, 10*, 156-163.

Fifolt, M., & Searby, L. (2010). Mentoring in Cooperative Education and Internships: Preparing Proteges for STEM Professions. *Journal of STEM Education: Innovations and Research, 11*(1), 17-26.

Gilmer, C.T. (2007). An Understanding of the Improved Grades, Retention and Graduation Rates of STEM Majors at the Academic Investment in Math and Science (AIMS) Program of Boling Green State University (BGSU). *Journal of STEM Education: Innovations and Research, 8*(1), 11-21.

Hunter, A., Laursen, S. L., Seymour, E. (2007). Becoming a scientist: The role of undergraduate research in students' cognitive, personal, and professional development. *Science Education, 9*1(1), 36-74.

Hurtado, S., Han, J. C., Saenz, V. B., Espinosa, L. L., Cabrera, N. L., & Cerna, O.S. (2007). Predicting transition and adjustment to college: Minority biomedical and behavioral science students' first year of college. *Research in Higher Education, 48*(7), 841–887.

Kalevitch, M., Maurer, C., Badger, P., Holdan, G., Iannelli, J., Sirinterlikci, A., Semich, G., & Bernaouer, J. (2012), Building a Community of Scholars: One University's Story of Students Engaged in Learning Science, Mathematics, and Engineering Through a NSF S-STEM Grant. *Journal of STEM Education: Innovations and Research, 13*(4), 34-42.

Khoury, S., Jenab, K., Staub, D., & Rajai, M. (2012). Using database technology to improve STEM student retention: A total quality management approach to early alert and intervention. *Management Science Letters, 2*, 647-654.

Kinkead, J. (2003). Learning through inquiry: An overview of undergraduate research. *New Directions for Teaching and Learning, 93*, 5–17.

Koenig, R. (2009). Minority retention rates in science are sore spots for most universities, *Science, 324*, 1386-1387.

Lopatto, D. (2004). Survey of undergraduate research experiences (SURE): First Findings. *Cell Biology Education, 3*(4), 270–277.

Micari, M., & Pazos, P. (2012). Connecting to the professor: Impact of the student–faculty relationship in a highly challenging course. *College Teaching, 60*(2), 41-47. doi:10.1080/87567555.2011.627576

National Science Foundation. (2012). 2012 NSF S-STEM Projects Meeting Report, October 14-16. Retrieved from http://www.asee.org/Post_Meeting___Program_Final.pdf.

Russell, S. H., Hancock, M. P., & McCullough, J. (2007). Benefits of Undergraduate Research Experiences. *Science, 316*, 548–549.

Seymour, E., Hunter, A., Laursen, S. L., & Deantoni, T. (2004). Establishing the benefits of research experiences for undergraduates in the sciences: First findings from a three-year study. *Science Education, 88*(4), 493–594.

Smith, K. A., Douglas, T. C., & Cox, M. F. (2009). Supportive teaching and learning strategies in STEM education. *New Directions for Teaching and Learning, 2009*, 19–32.

Tinto, V., & Pusser, B. (2006). Moving from theory to action: building a model of institutional action for student success. National Center for Education Statistics. National Postsecondary Education Cooperative (NPEC) commissioned paper, retrieved from http://nces.ed.gov/npec/papers.asp.

U.S. Department of Education, National Center for Education Statistics (2015). *The Condition of Education 2013* (NCES 2013-037), Institutional Retention and Graduation Rates for Undergraduate Students.

Varma-Nelson, P.; Cracolice, M.; Gosser, D. K. Peer-Led Team Learning: A Student–Faculty Partnership for Transforming the Learning Environment. In *Invention and Impact: Building Excellence in Undergraduate Science, Technology, Engineering, and Mathematics (STEM) Education*, Proceedings of Conference Sponsored by the NSF Division of Undergraduate Education and in Collaboration with the AAAS Education and Human Resources Programs, April 16–18, 2004, Crystal City, VA; American Association for the Advancement of Science: Washington, DC, 2004; Successful Pedagogies, pp 43-48.

Vogt, C. M. (2008). Faculty as a critical juncture in student retention and performance in engineering programs. *Journal of Engineering Education, 97*(1), 27-36.

Wilson, A., Sanner, S., & McAllister, L. (2010). An evaluation study of a mentoring program to increase the diversity of the nursing workforce. *Journal of Cultural Diversity, 17*, 144-150.

Wilson, Z. S., Holmes, L., Sylvain, M. R., Batiste, L., Johnson, M., McGuire, S. Y., Pang S.S., & Warner, I. M. (2012). Hierarchical mentoring: a transformative strategy for improving diversity and retention in undergraduate stem disciplines. *Journal of Science Education and Technology, 21*(1), 148-156.

Yelamarthi, K., & Mawasha, P. R. (2008). A pre-engineering program for under-represented, low - income and/or first generation college students to pursue higher education, *Journal of STEM Education: Innovations and Research, 9*, 5-15.

Yelamarthi K., & Mawasha P. R. (2010). A Scholarship Model for Student Recruitment and Retention in STEM Disciplines, *Journal of STEM Education: Innovations and Research, 11*(5), 64-70.

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