Chapter 4

The Brandeis Science Posse: Building a Cohort Model Program To Retain Underserved Students in the Sciences

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Retaining minority students or students from under-resourced backgrounds in the science professional pipeline is a challenging problem of national concern. For the past eight years, the Brandeis Science Posse program has recruited and retained students from under-resourced groups in STEM disciplines. In collaboration with the Posse Foundation, we have facilitated the formation of a close-knit, mutually supportive learning community, a "science posse," for eighty students to date from New York City public high schools. The Brandeis Science Posse model includes a two-week pre-collegiate summer immersion program and two years of mentoring by a graduate student majoring in STEM. Additionally, the students provide each other with group support throughout their undergraduate experience. To date, 84% of the Science Posse scholars have graduated with a major in STEM, and they have achieved a 96% overall graduation rate. Assessment has shown that all of the above program elements contribute to engagement and retention in STEM of the Science Posse Scholars.

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Introduction

For some time, the scientific community has recognized the need to increase the number of minority and under-resourced students majoring in the sciences. Within selective institutions of higher education, 55% of White students and 63% of Asian-American students are retained in the sciences, compared to only 38% of underrepresented racial minority students (*1*). Specifically, the number of African-American and Latino students pursuing careers in STEM fields is relatively small in comparison to White or Asian students (*2*). Discussions are ongoing as to why minority students and students with fewer socio-economic resources tend not to study science at the collegiate level and why those who do begin as science majors often do not finish their undergraduate or graduate STEM degree (*3*). One study (*4*) found that although "black students have stronger initial preferences than whites for majoring in the natural sciences, engineering or economics, they are significantly less likely to choose one of these majors for their final major." The authors attributed this phenomenon to the tendency of students with weaker academic preparation to gravitate toward less challenging majors. Their results have led some to suggest that less well-prepared students, particularly minorities, who are interested in the sciences would be better served by attending less competitive institutions (*5*, *6*), a viewpoint that has generated considerable controversy.

Several studies point to a number of factors that may influence minority retention in STEM. These include the development of faculty and peer relationships, the prevalence of faculty guidance and mentoring, cultural or societal influence, self-perception of ability, and overall academic preparation (*7–9*). The academic preparation a student brings when entering the university environment is an extremely important predictor of university success. We have observed that students from under-resourced schools tend to perform significantly lower on university level exams and assignments and may require remediation efforts.

Many programs have been established to help under-resourced students succeed in the sciences. Some offer advanced, intensive laboratory experiences for minority students during their undergraduate education, either during the school year or in intensive summer research programs (reviewed in (*10*)). Others aim to provide students with academic preparation in advance of their undergraduate coursework. Still others make available mentoring networks, long-term career advice, and help with college admissions (*11*). Research has also demonstrated the importance of having a positive peer group in science. Astin and Astin (*12*) found that when a student had a greater number of peers majoring in STEM fields, the student was more likely to be retained in STEM. Similarly, McGee (*13*) found that underrepresented minority students were more likely to be retained in STEM fields when the students had "likeminded friendships." The efficacy of these individual programmatic elements has been analyzed, with most findings suggesting that diverse target groups respond differently to each type of intervention (*14*).

These issues cut across all of the sciences. Chemistry, as the gateway course to medicine as well as to several other STEM disciplines, plays a disproportionate role in STEM retention, or the lack thereof (*15*).

Through a collaboration with the Posse Foundation, we have designed the Science Posse Program to retain urban scholars in STEM disciplines at Brandeis University. This program provides students with a cohort of like-minded scholars from similar communities, a graduate student mentor, a pre-collegiate training program and access to research opportunities.

The Brandeis Science Posse Model

Brandeis University Profile

Brandeis is a private, liberal-arts research university in Waltham, Massachusetts with an entering first-year class of about 850 students. Based on current admissions applications, approximately 45% enter with an intention to pursue a career in the allied health professions and/or in the sciences. However, enrollments in entry level science courses suggest that more than 60% of Brandeis students actually explore such career paths. About 380 students graduate each year with a major in a STEM discipline.

The STEM majors offered at Brandeis include Biology; Biochemistry; Chemistry; Computer Science; Health: Science, Society and Policy (HSSP); Mathematics; Neuroscience and Physics. The largest enrolled STEM major is Biology, with approximately 130 graduates per year. Students are not required to declare majors until the end of their sophomore year; however, most students intending to pursue a degree in a STEM discipline (except for mathematics, physics and computer science) enroll in the general chemistry lecture and laboratory their freshman year.

Similar to many universities, general chemistry, organic chemistry, introductory physics and introductory biology at Brandeis are taught in a large lecture format, with classes ranging in size from 150 to 300 students. Most courses consist of three hours of lecture led by a faculty member and weekly recitations and labs directed by a graduate student or advanced undergraduate teaching assistant. Introductory chemistry is the exception to this, with recitations being led by faculty members. Often, students report feeling detached or removed from the faculty member, interacting primarily with their TA.

History of the Science Posse

Brandeis began a partnership with the Posse foundation to establish the first Science Posse in 2008. In this program, ten high school seniors from New York City schools are admitted each year to Brandeis with full tuition scholarships. The Scholars retain this scholarship whether or not they major in a STEM discipline. The students come to Brandeis as a cohort and are encouraged to rely on one another for emotional and academic support throughout their college career. Although not specifically designed as a minority retention program, the

demographics of the Science Posse students are markedly different than those of the general Brandeis undergraduate population (Table 1). Within the first seven years of Science Posse, 74% of students are classified as racial minorities, compared to 13% in the overall Brandeis population. Additionally 67.5% of students in the Science Posse are need-based federal grant eligible, while this is true of only 21.5% of all Brandeis students; 68.75% of Science Posse Scholars are first-generation compared to 15% for all Brandeis students.

Table 1. Characteristics of Brandeis Science Posse Students as Compared to Traditional Brandeis Students from 2008-2015

Demographic Characteristic	*Science Posse*	*Brandeis Population*
Gender		
Male	46%	43%
Female	54%	57%
Race		
African-American	34%	4%
Asian-American	20%	14.4%
Latino/Hispanic	39%	6.1%
White	4%	49.4%
Native American	0%	0.3%
Unknown	2.5%	12%
Multi-racial	1%	2.3%
Other characteristics		
Average SAT score	1174	1371
Need-based federal grant eligible	67.5%	21.5%
First generation status	68.75%	15%

To be selected for Science Posse, students need to be nominated by their school, a guidance counselor, another scholar, a non-profit organization, etc., based on their academic success, leadership and demonstrated interest in the sciences. The formal selection process, which is coordinated by the Posse Foundation, then takes place over several months. This process emphasizes leadership, communication, and problem solving skills rather than the traditional admissions metrics of standardized test scores, such as the ACT or SAT, or grades.

After being nominated, students are chosen for the scholarship through a three-step process. The Dynamic Assessment Process is a group interview consisting of guided activities that allow trained observers to identify students with outstanding communication and problem-solving skills (*16*). The top 50% of students who participate in the Dynamic Assessment Process are invited to the second step in the admissions process, an individual interview with two members of the Posse staff. At these interviews, students select their top three choices of partner colleges and universities and can express an interest in being in a Science Posse (or in a standard "liberal arts" Posse in which there are no expectations about college major). To be in the Brandeis Science Posse Program, a student must plan to major in Biology, Biochemistry, Chemistry, Math, Computer Science, HSSP, Neuroscience and/or Physics. From these interviews, a finalist group of approximately twenty students is selected. Representatives from Brandeis and the Posse Foundation then conduct another group interview involving a set of structured exercises with the twenty finalists, and the cohort of ten Science Posse Scholars is selected in the middle of December of the students' senior year of high school.

The selection process for Science Posse is quite rigorous. Nonetheless, some of the students who are accepted as Posse Scholars would not be admitted to Brandeis through the regular admissions process because of their relatively low test scores. From 2008 through 2015, the average SAT score for Science Posse Scholars was 1174 compared to 1371 for other Brandeis students. Although there are no racial or ethnic criteria, 34% of the Science Posse Scholars at Brandeis have been African-American, 39% Latino, 20% Asian-American, 4% White, 1% multiracial and 2.5% race or ethnicity unknown. The demographic information for the Science Posse and the entire Brandeis student population is summarized in Table 1. We have selected and sponsored a Science Posse cohort each year since 2008, totaling 80 student scholars to date, 48 of whom have graduated from the university and 31 of whom are currently enrolled.

Elements of the Science Posse Program

All Science Posse students receive a four-year full tuition scholarship. The Posse Program contains several mandatory elements, each of which has been found to contribute to scholar success and retention (*17*). Upon accepting their nomination to Posse, the scholars agree to participate in each of the activities summarized in Table 2.

Once selected, the Science Posse Scholars participate in a number of individual and group activities focused on exposure to the culture of college and college level science before they enroll at Brandeis. The students attend an eight-month pre-collegiate training program at the Posse Foundation. They meet together for weekly sessions that include three science workshops led by Brandeis staff and other activities run by Posse staff, such as a discussion of race, an activity about religious beliefs, and a Myers-Briggs personality test. Most of these workshops emphasize problem solving and the building of relationships between the scholars to facilitate the cohort mentality.

Table 2. Activities Associated with the Brandeis Science Posse Program

Event	*Time of Year*	*Time Commitment*	*Mandatory or Optional*
Weekly Pre-Collegiate Training (PCT) with Posse staff emphasizing leadership and communication skills	January through August of the Scholars' senior year of high school	2 hours per week	Mandatory
Three STEM workshops within PCT are devoted to science, 1 chemistry, 1 biology and 1 math	1 workshop per month in February, March and April	2 hours for each workshop	Mandatory
Summer Science Immersion Program	July	12 days	Mandatory
Weekly group meetings of the scholars, emphasizing leadership skills and the transition to college	September through May for the first two years of college	2 hours per week	Mandatory
Individual meetings with the Science Posse mentor	September through May for the first two years of college	1 hour every other week	Mandatory
Research lab experience	September through May	Varies	Optional

The students also participate in a twelve-day Summer Science Immersion Program in late June/early July on the Brandeis campus. The program emphasizes exposure to college-level work in the sciences. It does not provide science remediation. In the Summer Science Immersion Program, Posse Scholars have their first experience with the intensity of college level science, the grading curve that is used, feelings of competition, scientific communication and issues with time management. Because of the diversity of intended STEM majors in the incoming cohort, the summer immersion exposes the students to short courses and laboratories in biology, chemistry, computer science and physics. Additionally, students learn about the many academic resources on campus, including the Writing Center, Library and Technology Services, science faculty and tutoring services, in the context of a research project whose results they present at a final poster session attended by many members of the Brandeis science community. Many science retention programs focus on providing students with a greater understanding of scientific concepts. The Science Posse Summer Immersion Program differs from most other models in this respect. It can be viewed rather as socializing students into the sciences.

Once Science Posse Scholars are enrolled as full-time students at Brandeis, they continue to meet as a cohort under the guidance of a mentor for their first two years of college. Prior research has found that having a mentor in the sciences can positively impact retention in STEM, and the effects of mentoring

can be even more significant for African-American and Latina/o students than for White students (*18*). The mentor meets weekly with the cohort as a group as well as individually with each scholar every other week to discuss personal development. Little if any time is spent on science remediation, and the group meetings are not used as formalized study groups. Almost all mentors for the Brandeis Science Posse program have been graduate students pursuing PhDs in various STEM disciplines, including Biophysics, Neuroscience, Chemistry, and Molecular and Cellular Biology. The mentor of the Class of 2015 cohort was a postdoctoral associate in Neuroscience. All mentors participate in mentor training provided by the Posse Foundation and are given regular guidance and support by Brandeis faculty and staff. Although only two of the eight mentors have been racial minorities, the Science Posse mentors are typically from under-resourced or first-generation backgrounds.

In addition to meetings with their mentor, Science Posse Scholars are given the opportunity to work in a faculty member's research lab. Like mentoring, participating in a research lab has been found to positively impact retention in STEM (*19*, *20*). Any interested Science Posse student is offered a paid position in a research lab on campus. STEM faculty work closely with the mentors to appropriately match the students to research opportunities that reflect student interest and will provide appropriate guidance and support. In a typical year, five to seven members of each ten scholar cohort participate in laboratory research during their first and/or second year of college. Historically, about half of these students have continued working in these labs through graduation. Students are encouraged and provided resources to present their research at both on- and off-campus STEM conferences to facilitate further networking opportunities.

Research Design

In order to determine which elements of the program were most closely correlated with student retention in the sciences and student perception of these elements, both a quantitative and qualitative analysis was conducted. The quantitative analysis used data that was collected through a science survey given to students in selected introductory and mid-level science classes. Then the data was matched with student records data which provided demographic information about who was completing the survey and allowed for comparison of different groups of students. The science survey data provided an understanding of students' attitudes and experience in the sciences. The students' record data

The qualitative analysis was conducted with data from 87 student interviews, including 38 Science Posse Scholars, 24 students from backgrounds similar to the Scholars (Underrepresented Students) and 25 students from well-resourced backgrouds. All students who participated in this study were enrolled at Brandeis between January 2012 and May 2013. Table 3 shows the demographics of the three comparison groups. For the purposes of this paper, only results from the Science Posse Scholars are discussed.

Table 3. Overview of the Comparison Groups for Qualitative Research

Comparison Group 1: 38 Brandeis Science Posse Scholars	• Students who were Science Posse Scholars • 90% were first-generation college students and/or low-income • 9 white or Asian-American students, 29 racial minority students • First-years, sophomores, juniors, and seniors • Students entered college with the intention to major in biology, biochemistry, chemistry, neuroscience or HSSP and who attempted at least one semester of sciences intended for these majors (Science Posse students who leave the sciences are still part of the program and participate in all program activities)
Comparison Group 2: 24 Brandeis Students from Backgrounds Similar to Science Posse Scholars (Underrepresented Students)	• Students not in Posse (Science or Liberal Arts) • 100% were either first-generation college students and/or Pell grant recipients • 10 white or Asian-American students, 14 racial minority students • First-years, sophomores, juniors, and seniors • Students entered college with the intention to major in biology, biochemistry, chemistry, neuroscience, or HSSP and who attempted at least one semester of sciences intended for these majors
Comparison Group 3: 25 Brandeis Students from Well Resourced Families	• Students not in Posse (Science or Liberal Arts) • Students from families with adjusted gross incomes of $80,000 or more (one-third of these students were not receiving need-based financial aid) • Students had at least one parent with a bachelor's degree (most students had one parent with a graduate degree, approximately half came from families in which both parents had graduate degrees) • 21 white or Asian-American students, 4 racial minority students • First-years, sophomores, juniors, and seniors • Students entered college with the intention to major in biology, biochemistry, chemistry, neuroscience or HSSP and who attempted at least one semester of sciences intended for these majors

Student Outcomes

At Brandeis, the rates at which students declared majors in STEM fields vary enormously by racial comparison group. These same types of variations have been found in previous research that examined which students declared a major and/or graduated with a major in a STEM discipline at selective colleges and universities (*1*). The observed university-wide major declaration rates demonstrate that a significant number of students of all races who are interested in STEM decide not to declare a STEM major. In contrast, 86% of Science Posse Scholars declared a major in a STEM discipline.

From the Science survey, we learned that the experiences of Science Posse Scholars were very different from the experiences of other students. Science Posse Scholars were much more likely to identify with the statement "I worry I am not as academically strong as other students," with an average 4.16 for Science Posse Scholars and of 3.52 for other students ($p<.0001$) with a 1-5 scale with a score of 5 indicating strongly agree and a score of 1 indicating strongly disagree. Similarly, Science Posse Scholars (4.84) were more likely to feel that "Science in college is harder than science in high school" compared to other students (4.32) ($p<.0001$). Science Posse Scholars (4.26) compared to other students (3.34) were much more likely to agree with the statement "I have to study harder than others in order to earn good grades in science" ($p<.01$). In contrast, Science Posse Scholars (3.87) in comparison to their peers (3.69) were more likely to agree with the statement "I enjoy working out new ways of solving problems ($p<.05$). This finding is important, as it could be interpreted that Science Posse Scholars' enjoyment of problem solving may help to offset some of the academic challenges that they face. These responses demonstrate that Science Posse Scholars have struggled with feelings of academic inferiority, which according to previous research should have resulted in their being less likely to continue with the study of STEM disciplines (*21*).

Additionally, our Science Posse program helped students feel better connected to campus resources and assistance. When comparing perception statements from our Science Posse and non-Posse cohorts, we found that Science Posse Scholars' responses revealed stronger campus relationships. The Science Posse Scholars (3.87) more strongly agreed with the statement that "I have a science faculty member who is a role model for me" compared to the response of other students (3.17). Science Posse Scholars also benefit from the peer support that the program provides. The Scholars (3.81) were far more likely to agree with the statement "My peers encourage me to stay in science" compared to other students (3.14). Finally, Science Posse Scholars indicated fewer feelings of isolation from upper class students. Science Posse Scholars (2.29) compared to other students (2.43) were less likely to agree with the statement "In my first year, there were *no* upper-class students I could turn to for advice" which reinforced the qualitative findings in this study that older Science Posse Scholars provided guidance for younger Science Posse Scholars. These findings demonstrate the important guidance and support that faculty and peers provide to Science Posse Scholars, which contribute to the program's effectiveness at retaining Scholars in STEM.

In the qualitative data, our Science Posse students commented that three specific elements of the Science Posse program were important to their success as STEM majors. They noted that the cohort, the mentor and the summer immersion program were valuable and helped them thrive. Representative quotes from student interviews are given below.

On the cohort:

"Anyone in the Posse would be there if I needed them. They're my family. But you don't always love your family. I do love them all, just in very

different ways. But I think there isn't a single person who wouldn't be there [for me], because there's an inherent obligation that we feel. And – I mean I guess I should only speak for myself but – I feel obligated to be there for all [of them]– because they're my people."

On the mentor:

[My mentor] is kind of like my mom away from home. She's that person. I always look forward to our one-on-ones. The fact that she was going for her PhD was a huge inspiration. She's just always - she offered tough love so to speak. Like, I know that I could talk to her about anything. But she'd always be open and honest with me in terms of what she thought about whatever it is that I was going through….I love her to pieces.

On the Summer Immersion Program:

It was hard. I did not expect so much work, but it was – I feel that it was really helpful. Like, just knowing how, like, labs are so much different than the lab that I was accustomed to back in high school and, like, seeing all this technology was also amazing. But, I mean, all the work that we got that whole – those two weeks, it was just – it was hell. It was just that – it was so different from high school, … it was just, like, all right now you have a lot of work to do, here it is. And it was just hard. But I managed, so that was, like okay now I think I know what college is going to be like if this is [the summer immersion]."

Overall Student Outcomes

The primary goal of the Brandeis Science Posse program was to retain underserved students in the sciences. We found that 84% of our science posse students persisted in STEM in the first five graduating cohorts.

Although graduating with a STEM major is an important element of the program, the Science Posse initiative also seeks to increase the number of historically underserved individuals in the STEM work force. An analysis of the first three years of graduating cohorts reveals that, of the 29 graduates, approximately 20% are either currently applying to or attending medical school or MD/PhD programs, approximately 38% enrolled in or are applying to masters programs in science-related disciplines, and another 24% are working in STEM or health-related careers. The fact that 82% of students graduating from the Science Posse program stay in the science workforce suggests that this program provides students with a significant amount of career direction. We will continue longitudinal assessment of those scholars who leave the sciences to determine what factors may be leading to these decisions.

The Posse program has had a major impact at Brandeis, well beyond the number of students in Posse (Table 4), with the mean number of URM science graduates more than doubling from the five years immediately before the first STEM Posse graduates (15.8 in 2007-2011) to the first four years of program

graduates (33.5 in 2012-2015). Note that the mean number of URM Posse graduates in the latter years was only 6.5, accounting for less than 40% of the increase in URM STEM graduates. Although the overall increase in URM students could be coincidental, it seems likely that the presence of the Science Posse on campus has encouraged other minority students to persist in STEM as well. Anecdotally, the success of the Science Posse has been accompanied by higher expectations for the success of URMs in the sciences on the part of faculty and students (both majority and minority).

Table 4. Total Number of URM Students Graduating with a STEM Major at Brandeis

Major	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
Biochemistry	1	0	0	1	1	0	2	1	0
Biology	4	2	5	10	10	13	6	11	12
Chemistry	0	0	0	1	2	2	4	0	6
Computer Science	0	0	0	1	0	1	3	1	0
Health: Science, Society and Policy	6	6	1	5	12	11	11	10	18
Mathematics	1	2	0	0	1	3	2	0	0
Neuroscience	0	3	0	0	1	6	1	2	2
Physics	1	1	0	1	0	1	2	1	2
Total	13	14	6	19	27	37	31	26	40

Individual success stories abound. Science Posse Scholars have graduated Phi Beta Kappa and *summa cum laude*, have been chosen as the commencement speaker, have been admitted to prestigious M.D. and Ph.D. programs, and have won multiple Fulbright awards.

Implications of the Science Posse Model

The Science Posse has succeeded at Brandeis in its intended outcome to retain urban underserved scholars in the sciences. Among the first four Brandeis cohorts, 74% of whom were underrepresented minorities and 78% first generation, the graduation rate has been 96%, with 84% completing a STEM major. The program has since been adopted by nine other institutions across the country, including four small private liberal arts colleges, two women's colleges and three large public research universities. These elite schools are observing similar rates of graduation and retention in STEM. These results would appear to provide a counterexample to a recent study (6) of minority students in STEM at several California institutions, which concluded that "less-prepared minority students at top-ranked campuses would have higher science graduation

rates had they attended lower-ranked campuses. Better matching of science students to universities by preparation and providing information about students' prospects in different major-university combinations could increase minority science graduation." Our study suggests that these students can succeed at our most competitive institutions *if* they are provided with appropriate programmatic opportunities.

Although the Posse program has succeeded in increasing the graduation rates of underrepresented and under-resourced students in the sciences, there remain significant disparities between the persistence rates of well-resourced and under-resourced students in STEM. We still face the problem that first-generation students, in particular, leave science in the freshman or sophomore years at rates significantly higher than those from families with a history of university education.

Despite its demonstrated success, the STEM Posse model has limited scalability. The fact that it has been adopted by a set of elite institutions, diverse though they may be in their makeup, is no accident. The Posse Foundation, our partner in developing the program, has a rigid requirement that all students in the program be awarded full-tuition scholarships. This constraint precludes the participation of many institutions with limited resources and restricts the ability of even a wealthy university to expand the program beyond the typical size of ten students per year. A second major limitation is that the pre-collegiate training component of the program requires that all members of a cohort come from one of the ten cities in which the Posse Foundation is established.

To combat the aforementioned limitations of the Science Posse Program, we have developed a scalable pilot science retention program based on many elements of the Posse program. The Brandeis Galaxy Project serves under-resourced students who have already been accepted to Brandeis through the traditional admissions process and who have received their need-based financial aid packages. The program's key components are a non-credit online summer immersion program and a graduate student or postdoctoral mentor once the participants arrive on campus.

The online summer immersion allows the students to meet virtually as a cohort. This is particularly important, as participants are from around the country, unlike Science Posse Scholars who are from the same city. Additionally, the on-line immersion requires students to complete several STEM assignments at home directed at improving their scientific literacy skills. The summer program culminates with an on-campus poster session that introduces them to STEM faculty and staff. The Brandeis Galaxy Project mentors meet with the students biweekly on-campus. The mentors facilitate discussions, provide access to campus resources and attend social outings with the students to help them feel more at home at Brandeis.

Initial results from the Brandeis Galaxy Program indicate success. While we have only two semesters of data involving 16 students, student participants were less likely to drop introductory science courses with 100% enrolling in science courses their second semster. Fifteen of the 16 students have continued pursuing science into their sophomore year. While it is too early to compare the academic progress of Brandeis Galaxy Program participants with Science Posse Scholars,

we feel optimistic that Galaxy may offer another way to support under-resourced students interested in studying STEM disciplines. If this model is effective, it offers a scalable approach to STEM retention that can be implemented by a wide range of colleges and universites.

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