State University of New York
Louis Stokes Alliance for Minority Participation: Research on Best Practices

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Abstract This report is the based on a 10-year study of the activities developed under a National Science Foundation (NSF) Louis Stokes Alliance for Minority Participation (LSAMP) grant to a collaborative of institutions from the State University of New York. The goals of LSAMP are to recruit and retain under-represented minority students in the STEM (Science, Technology, Engineering, and Mathematics) disciplines and encourage these students, as appropriate, to apply to and enter graduate programs in the sciences. The study used a logic model, considering resources, activities, and outcomes. The report provides details of major strategies adopted by the alliance and in each area summarizes what the evaluation and research found were best practices leading to success. The areas identified were: local organizational arrangements to administer the grant; undergraduate research; academic support; process skills needed in college; social support and community building; interest in graduate school; and success in graduate school. In each area, the report's conclusions are based on data and analysis obtained from surveys, site visits, interviews, focus groups, and observations of meetings. The study also reviews relevant literature, providing additional documentation for conclusions and recommendations. Student voices are heard in numerous quotes and a comprehensive survey (N = 82) asking about adjustment to and progress in college. The report will be useful to anyone involved with programs that support students in higher education. The best practices contain guidelines for implementation and show the connections between program activities and student success.

Underrepresented Minority Students in Higher Education. The National Science Foundation (NSF) and others have documented the fact that African American, Hispanic, and Native American students are underrepresented in the STEM (Science, Technology, Engineering, and Mathematics) disciplines—with regard to numbers of students in the majors, degrees earned, and entrance into graduate school. The discrepancies become greater, moving up the academic ladder. A report by the Woodrow Wilson National Fellowship Foundation (2005) indicated that, even though African Americans and Hispanics make up 32 percent of U.S. citizens in the normal age range of Ph.D. candidates, only 11 percent of all U. S. citizens earning doctoral degrees are Black or Hispanic. There is general agreement in the academic community and beyond that efforts should be made to remedy the situation. Several reasons can be given for making this

effort (Miller, 1995). First, the productivity of the entire nation depends on the achievements of everyone. Second, civil rights benefits that have been gained will be furthered only if minority students gain the educational background required for their next steps. Finally, the maintenance of a just society requires that minority students achieve at a rate comparable to the population at large.

The big questions, then, are more about strategies than objectives. Most agree that changes should start early, with quality instruction and interventions when children are young. Training and ongoing professional development need to be upgraded for teachers and faculty members at all levels. The best teachers should be rewarded. High quality materials and technology should be employed. A longer school year would undoubtedly help. New methods of teaching and learning should be piloted, tested, and when successful, disseminated. The learning environment needs to include high expectations and an approach to the whole child, with family and caregivers included. We mention these only to review our understanding that the problem is extensive and the solutions complex.

The Louis Stokes Alliance for Minority Participation (LSAMP) has been funded and supported by the NSF because we cannot wait a generation for better prepared students to arrive at colleges. We, as a society, have to do our best for underrepresented minority students of all ages. In a general sense all LSAMP strategies fall under the headings of recruitment and retention. In accepting the grant, institutions, departments, programs, and individuals commit themselves to the task of enrolling more underrepresented minority students in the STEM disciplines, maintaining them as majors, and encouraging them to consider graduate school. But the grant allows latitude, and LSAMP alliances have adopted various strategies in their efforts to achieve the overall goals.

Strategies employed by LSAMP alliances nationally have included:

- Working with admissions offices to improve the recruitment of minority students;
- Strengthening articulation with community colleges to expand the pipeline;
- Sponsoring professional development for faculty;
- Introducing curricular programs that will benefit minority students;
- Working with faculty members who endorse the program's goals;

- Providing academic support through tutoring and workshops;
- Providing social support, advising and mentoring;
- Offering process workshops and courses in freshman orientation, study skills, test preparation, and the like;
- Encouraging and sponsoring undergraduate research, with funds from LSAMP and other programs;
- Providing information and encouragement about graduate school;
- Providing support as students apply for and enter graduate school.

SUNY LSAMP Priorities and Participants Members of the SUNY LSAMP alliance on which this study is based include: SUNY Stony Brook, Albany, Binghamton, Buffalo, New Paltz, and Old Westbury. At one time or another the SUNY LSAMP alliance employed most of the strategies listed above. But as time passed, some activities were viewed as more effective or feasible and so resources were allocated in some areas more than others. After a few years, without making formal decisions, there was general agreement on the following list of key activities and priorities. The questions have helped identify best practices that have been uncovered and may help guide others who implement similar activities.

1. Organizational Structures

- How does each site function in terms of personnel, decision making, funding, supervision of services, as well as coordination with the institution and related programs?
- What student records are kept and how are they used?

2. Undergraduate Research

- What are the major benefits of undergraduate research in general and summer research programs in particular?
- How can more students benefit from research, perhaps in a modified form?

***3. Tutoring, Course-related Workshops, and Curriculum Initiatives*.**

- How are tutoring programs administered at SUNY sites? What are the differences? What is LSAMP's role?

- What grade-related and course-related data are available?
- Based on students' experiences and other data what are some essential elements in successful tutoring programs?
- What curriculum initiatives hold special promise for minority students?

4***. Process Workshops and Freshman Success Courses.***

- Why are process skills important and how are they best developed?
- What are the arrangements and content for study skills courses and workshops?

5. Community Building, Advising, Communications, Social Support

- Why is community building important? What activities have been adopted?
- What communications practices, advising, early warning systems, and record-keeping practices are most effective?
- What social support and peer mentoring have been effective?

6. Interest in Graduate School

- What factors create interest and motivate minority students to apply to and enter graduate school?
- What are the challenges in preparing for graduate school?

7. *Success in Graduate School*

- What kinds of support, mentoring, advice, and activities are most needed by minority graduate students?
- What are the best methods for providing the needed support?

Student Experiences and Response to LSAMP We will now discuss the seven areas in detail, presenting and analyzing data. Where possible, we present these data in the wider context of the LSAMP initiative nationally and of related programs. This allows a broader perspective with data and evidence taken from beyond the SUNY LSAMP alliance. We will indicate the sources of data. For each area we will present conclusions about best practices, as well as the strategies used to implement activities and to achieve the objectives in each area. After the body of this report which describes and explains the LSAMP activities and student experiences, we present the results of a comprehensive

survey which provides statistical evidence that the students served by SUNY LSAMP found the program to be important to their progress and performance in college.

Research Plan and Methods In this report, we draw on data obtained during the 10 years preceding the research grant and also on the research activities undertaken with the support of the grant. In summary, these activities included:

- Site visits to participating institutions, with observations of grant-related activities, interviews, focus groups, and meetings;
- Focus group discussions with undergraduate and graduate students;
- Surveys of program administrators;
- Interviews with undergraduates;
- Interviews with program coordinators and faculty;
- An online survey designed to collect data about all aspects of the program;
- Surveys on particular topics, for example: freshman skills courses, transfer students, and summer research students;
- Literature review on topics related to the project, particularly courses and curriculum initiatives with special benefits for minority students.

1. Organizational Structures

The structure of SUNY LSAMP activities, overall and at the individual participating sites, came to the attention of the evaluation after the program had been functioning for several years. The activities on student support that we will discuss in this report address the program goals directly, and so these were of greater interest to the evaluation. But in time we recognized that the structures, allocation of resources, personnel responsibilities and procedures made a big difference in the way program services were delivered and on the effectiveness of these services. We therefore determined that it was important to assess the organizational structures and their effectiveness.

Efficiency While efficiency is not the ultimate goal of any project, it is nevertheless important, and inefficiency is never a virtue. As was mentioned above, the SUNY LSAMP goals overlap with those of several other funded programs active at the participating sites. One program in particular, the College Science & Technology Entry

Program (CSTEP), funded by New York State, maintained structures and processes closely aligned with LSAMP. Studying the relationships between these two and other related programs revealed the following.

- At two sites, the two programs were supervised by the same coordinator using the same support staff, and in fact the programs were virtually indistinguishable. The students served were almost entirely the same because on these campuses there are not many licensing programs, which would serve CSTEP but not LSAMP students. The result of this connection is that all aspects of support services, special workshops, and social activities could be coordinated— with regard to funding, staffing, promotion, etc. In addition, support staff members were used effectively, maintaining records and contact with students.
- Several sites had different coordinators for LSAMP, CSTEP, and other programs. But these coordinators reported to the same local administrator or the reporting lines converged at a higher administrative level. Resources were therefore shared and activities coordinated. This approach worked well when there was cooperation at all levels. Tutoring services, social events, guest speakers, and other activities were cosponsored and there was very large overlap in the students served. But in our experience it sometimes happened that those responsible were preoccupied with their own programs and coordination was not always a priority.
- At one SUNY LSAMP site the two programs were totally separate, with CSTEP entirely dedicated to students and programs in the nursing school. This arrangement provided clarity and efficiency in services for each program, but there were no shared resources and no synergy.

The above differences represent the coordination of LSAMP primarily with only one program. Similar issues arose in connection with other programs such as EOP, the NSF-sponsored McNair program, the NIH-sponsored undergraduate research initiatives, as well as locally funded activities that provide advising, or academic and social support.

Effectiveness If a program is efficient, it then has the opportunity to be effective. For SUNY LSAMP, there were several important organizational factors related effectiveness. We shall discuss resources, continuity, and the delivery of services.

Resources are the building blocks for a program. They will be discussed in detail throughout this report. At this point it is important to note that resources are always limited. Funding, space, personnel to serve as tutors, student time—these and other resources are finite. Overlapping programs will consequently be more effective if they share resources. Funding, for example, can vary as programs are cut or grants are concluded. If tutoring workshops, or staff are funded from several pooled sources, they will be more secure and effective.

One SUNY LSAMP site effectively brought together services funded by EOP, another government grant, CSTEP, LSAMP, and local funding. Excellent centrally located space under the library was used. The program offered tutoring, academic workshops, advising, as well as special assistance in developing English skills. The program was under one overall director, was able to grow organically according to need and was quite secure financially. Programs at some of the other sites approximated this integration but none provided such a complete structure.

Continuity is the second element required for effectiveness. LSAMP and similar programs are guided by long-term goals; success for a year or two is not good enough. Turnover in personnel, particularly in the area of LSAMP coordinators, was a liability for the program.

A third effectiveness factor is the delivery of services. Turnover in personnel described above at times created a lack of consistency in programs, such as freshman skills courses and tutoring. In addition, the personal contact with students so important in support programs can be lost as coordinators change.

Staffing In addition to the coordination of LSAMP with other programs, there are organizational issues related to the personnel overseeing the program and their other responsibilities. Each site created the position of local PI and coordinator. The PI was an administrator or a faculty member. The coordinators were young people, recently out of college, with good people skills and ambition. In some cases they had other assignments

and responsibilities, in addition to LSAMP. Since the coordinators were paid with grant funds and were responsible for a mix of programs they sometimes looked for more clearly defined and secure positions; and some left their positions to go to graduate school. The SUNY LSAMP sites had an average of three different coordinators during the 10 years that we are reviewing.

The project PI and director at Stony Brook, the lead institution, held alliance-wide meetings, several times a year when funding permitted and less frequently when funds were more limited. These meetings usually lasted for two full days and provided the opportunity to present and share new information about the program, to discuss activities and funding, to strengthen connections, to plan cooperative events, and often to introduce new personnel to the program. These meetings helped create positive feelings about the grant and boost morale.

Institutionalization The National Science Foundation, like other funding agencies, wants funded programs to last. The Foundation looks for sustainability or institutionalization. The structure of the organization plays an important role in this process. A program with a strong administrative structure is not guaranteed to survive, but it is unlikely to last without such a foundation. We can say that solid organizational arrangements are a necessary but not a sufficient condition for institutionalization.

Scheirer (2005), identifies five important factors influencing sustainability: (1) program flexibility, (2) a champion, (3) fit with the organization's mission, (4) perceived benefits, (5) support from stakeholder organizations. These factors provide a good framework for the discussion of a program's sustainability or institutionalization. How well does SUNY LSAMP reflect these factors?

(1) Flexibility. Implementation of LSAMP activities has been adapted to local circumstances in some ways. Where possible and appropriate the program has been integrated with other programs that have related objectives such as CSTEP, or AGEP. Also, while the overall goals are the same for each site, local circumstances have sometimes created a focus on a particular area—such as community building, tutoring, or research.

(2) A champion. LSAMP is limited in scope and as a result the local directors and coordinators have always had other responsibilities. At some sites, a faculty member

with particular interests in minority students has emerged with a concern for the LSAMP program and students. It would be accurate to say that most of the participating SUNY LSAMP sites have had one or more champions for diversity and minority students and this has included support of LSAMP along with other programs that provide support for minority students.

(3) Fit with the institution's mission. The SUNY sites vary in their commitment to expanding minority enrollments. All include such a commitment among their policies. But this commitment is sometimes in tension with other policies and goals, such as for example increasing SAT scores. Available financial support also varies.

(4) Perceived benefits. This factor is real but subject to interpretation, with large questions: whose perception, and what benefits? There were some on each campus who sincerely believed that LSAMP and similar programs offered substantial benefits to the students served, the institution, and beyond, as described above. But there were others whose focus was on their teaching, research, and attracting the best and brightest students—judged by traditional norms.

(5) Support from stakeholder organizations. This support closely related to the previous factors, but it looks to concrete activities rather that simply to perceptions. Do the administration, admissions office and others actively recruit, provide funding, and support to minority students? Again, this varies considerably at the SUNY sites.

Best Practices The experiences in organizational arrangements of SUNY LSAMP provide several best practices that we can at least tentatively suggest—for our own benefit and for other programs to consider.

1. Efficiency through coordination with other programs. LSAMP and related programs can be successful even though their identities are submerged in a larger on-site program that has a local stamp and can provide consistency over time through coordination and common direction.
2. Effectiveness through shared resources, continuity, and delivery of quality services. Resources are always limited and sharing them is the only way to add value to them, benefiting the students served and the institution. Carefully used and shared resources will help lead to continuity and quality services.

3. Meeting the requirements for institutionalization. Coordination and consolidation of services is consistent with recent literature on the ingredients necessary for institutionalization. In particular, commitment from the administration, is much more likely if programs with common aims work together.

2. Undergraduate Research

It was understood from the outset of SUNY LSAMP that undergraduate research, because of the ways in which students become engaged in science, was to be a significant activity in accomplishing two important LSAMP goals: increased retention of underrepresented minority students in the STEM disciplines, and motivating students to consider graduate school and careers in research.

Studies have identified a number of student benefits derived from undergraduate research. Gafney (2001, 2005) found that students' understanding of science changed dramatically as they went from learning to doing science. They were at first surprised at how often "things don't work out," and how results are unclear. Their relationships with faculty became more informal and collegial. Seymour et al. (2004) found that research increases student motivation and interest in science. Alexander et al. (2000), based on a program that was highly successful in retaining students and moving them to graduate school, identified several essential elements that they hypothesize are necessary for success. Among these are: a minority community with students at various levels in a program that continues for several years, providing a forum for discussions of race and ethnicity as well as science; and projects that allow students to work on real open-ended research under the direction of a concerned research mentor.

In addition to the studies of undergraduate research, there is considerable data on involvement theory showing that undergraduates who are more engaged with their education through curricular and extra-curricular activities (Astin, 1984, Tinto, 1997, Kuh, 2003) are more likely to continue in college and in the STEM disciplines than those who simply go to class and return to their rooms to study (Light, 2001).

Finally Lopatto (2007) finds that undergraduate research provides information and insights useful to research on learning. For example, it may turn out that some students

have the potential to do more challenging work than could have been predicted based on their classroom performance. In general, students doing research learn to appreciate teamwork, beginning with those in their labs or projects, but extending to other researchers and groups doing similar work in remote locations.

Resources and Activities With this background, we wanted to study the undergraduate research programs and opportunities funded or endorsed by SUNY LSAMP. The sites participating in the SUNY LSAMP alliance brought important resources to undergraduate research. The four-year institutions house high quality facilities with faculty researchers experienced in the theoretical foundations and advanced techniques in the sciences. Stony Brook and Buffalo have achieved notable success in biomedical field; the Albany campus has a state of the art nanotechnology center; and Binghamton makes ongoing contributions in engineering and biology-related research. The climate that welcomes and nourishes undergraduate research is as important as the available resources.

In addition to the physical resources, the SUNY LSAMP institutions bring important mentoring and supervisory resources. With medical and engineering schools, a variety of computer-related programs, and majors in areas such as evolutionary biology, environmental studies, and biomedical engineering, students can undertake research in areas related to their interests and applied to current problems.

There are many opportunities for undergraduate research at the SUNY LSAMP sites. They are sponsored by departments, institution-funded programs, external grants, and various combinations of these. Opportunities for research are available for individuals from high school through post-doctoral positions. We will describe and examine those that are sponsored, all or in part, by LSAMP as well as those that simply enroll LSAMP students.

Summer Programs for Minority Students SUNY LSAMP has partnered with other projects and funding agencies to organize summer research programs at Albany, Binghamton, Buffalo, and New Paltz. At Stony Brook a summer research program has been sponsored by the NSF AGEP (Alliance for Graduate Education and the Professoriate), a sister program to LSAMP. These programs recruit undergraduates who want to become more deeply engaged in science, and are considering graduate school.

Generally there have been between 10 and 20 students in a cohort, with the sessions lasting about 10 weeks. Each student is assigned a research mentor and spends an extended amount of time on individual or team projects that are associated with the research mentor's research concentration. In addition to the research projects, students devote time to refresher, enrichment or bridging courses in science and mathematics, and attend classes on study skills, time management and the like.

Academic Year Programs All of the SUNY LSAMP institutions promote and advise students regarding research opportunities. Funding for these experiences comes from a variety of sources: LSAMP itself, departmental resources, NSF-sponsored REU (Research Experiences for Undergraduates) positions, local industry and labs, NIH (National Institute of Health) and HHMI (Howard Hughes Medical Initiative) programs, and more. These programs overlap and reinforce one another, and in the process offer opportunities for minority students that complement the goals and activities offered by LSAMP.

Outcomes Annual evaluations of the various research programs and activities have yielded important data on how students benefit from the experiences. We have conducted interviews with faculty members and students, surveyed participants, held focus groups, and observed student presentations. We will discuss some of the more significant outcomes, with supporting evidence.

Impact of Research When asked what the summer experience meant to them, one of the first things mentioned by participants in the Albany summer research program was an increase in confidence. One student commented, *The biggest surprise to me was the realization that I can do this. I feel I will be ready to make the transition to the workplace or whatever I have to do next*. Others described in greater detail the lab skills they had acquired. But beyond the skills it was the personal contact that made a very strong impact, as one student noted, *I am working with a graduate student; I see how passionate she is about her work. She has been an inspiration.*

Students found other rewards in research, as noted in the following comment, *For me it was thinking outside the box. It is different from going to classes and taking tests.*

Research gives you the chance to work independently but also in a way that connects with other people in your field.

Another focus group question asked about the benefits gained from preparing a presentation or poster. Students noted that preparing a presentation helps you to see the "big picture," as you study the literature related to a project, but the process also helps you to "narrow down your topic," to something that is doable. Like those in previous interviews and focus groups, these students identified the fact that research differs from classroom learning in that it focuses on questions more than on answers.

Students in a discussion at the University of Buffalo said that the practical, guided experience of preparing posters and critiquing each other's work gave them a good idea of what is needed for a good poster. Several reported their surprise when attending conferences and seeing graduate student posters that were not carefully done.

In almost all of the focus groups that we have held on research, students have eventually come to the determination that in research "you are doing science," not just "learning it," as is the case in class and even in course-related labs.

Almost all of the students in the different focus groups said they hoped to enter graduate school. When asked about the origin of this interest, they pointed to a number of experiences including research, travel to conferences particularly the AGEP-sponsored Gathering of Science Scholars at Stony Brook, and consultation with their lab mentors or other faculty.

The Demands of Research All of the participants in the Stony Brook Summer Research Institute (2006), funded by AGEP, reported an interest in research as well as an understanding that research requires hard work, teamwork, and a solid theoretical basis. At the conclusion of the program the participants reported that they had learned a great deal about research, that their mentors were important, that research could be frustrating, and that the summer had opened their minds to new ways of thinking.

Each year, the participants reported spending long hours and finding that it is rare to achieve the desired outcomes in the laboratory. They reported that the summer provided not only clearer ideas about research but also helped them clarify their own goals and aspirations with regard to graduate school and research. All reported that the summer met or surpassed their expectations.

Students made a number of insightful observations in response to an item asking whether the summer had been more demanding than they had expected. The following are direct quotes, with minor editing or clarifications. They demonstrate how the experience of research helped students to grow in their understanding of science.

- *Scientists must be able to think in varied ways from understanding concepts to successfully completing experiments, analyzing data, and interpreting results and they must then be able to communicate that information.*
- *This summer demanded a time commitment, intellectual input, and a willingness to change.*
- *Yes, it was indeed more demanding than I expected. I learned that it was not uncommon to go in to the lab early and leave late at night. I now understand that research takes time and patience and it is rare not to encounter problems.*
- *[The summer] changed my understanding of research. I thought it was only lab/bench work. But it is a balance between bench work and literature review.*
- *The research became more demanding as time went on. I believe I'll need to intern again before I develop a basic idea of research.*

Participants also commented that the summer gave them a clearer idea of what the daily life and routine of a scientist is really like. Frequently, these insights are not achieved until graduate school. The students from the Summer Research Institute will be able to make decisions about graduate school based on a realistic understanding of what is involved in research.

The table below shows tabulations for some items on a survey following the 2008 summer program at Stony Brook. These ratings are typical of those obtained during the six years over which the program was evaluated. But they are not always found in student evaluations of summer research programs, generally.

Table 1. Responses following the Summer Research Institute (N = 9)

	% Agree	Mean
I participated in actual, ongoing research.	100	4.89
I gained practical experience in my field.	100	5.0
I contributed to ongoing research at the laboratory.	100	4.78
My academic preparation for my assignment was adequate.	89	4.44

I received sufficient information prior to the program.	100	4.56
Laboratory scientific staff was available to guide or assist me.	100	5.0
The housing facilities provided were sufficient.	89	4.44
The stipend provided was sufficient.	100	4.67
I would recommend this program to other college students.	100	55

Clearly students were well satisfied with the summer program. Interviews and open-ended items revealed that the individual attention, the excitement of research, the opportunity to become deeply engaged in science, and to work with dedicated mentors accounted for the student satisfaction with the program.

Self Understanding as Emerging Scientists LSAMP participants, who were conducting research at SUNY Stony Brook, spoke in interviews and focus groups about how the research experiences brought them to deeper understandings of themselves and the ways of acting and thinking that they needed for research. This kind of reflection also helped them develop the mental and emotional equipment they would need in graduate school. The following are some of the insights that students expressed when asked what it takes to do pursue research.

- *Do something you really like*. It seemed that students gained this appreciation from the research experience and from conversations with their advisors. There was general agreement that to succeed in research—or in any academic pursuit, a student—even an undergraduate—should follow his or her "passion," nurturing and developing a real interest and emotional attachment to the project and field being studied. These students had already recognized an important lesson that will serve them well in graduate school, namely that willpower alone is not enough to keep one involved in research. It is necessary to really enjoy the activity.
- *Be patient, it takes a lot of time and effort*. This has often been the first comment when undergraduates are asked what it takes to be a good researcher. As has been noted, they are surprised at how long experiments take and how often they do not work out.
- *Persistence is important; Just because an experiment works once doesn't mean it will keep working: Sometimes you can do something with the exact same*

conditions and it will refuse to work. This was an incisive comment, and it was followed by an interesting discussion. At least some of these undergraduates had already found that even success in an experimental outcome is not enough. It must be replicable, showing that it was not some fortuitous factor that accounted for the success.

- *Attention to detail is important; you have to record everything you do; it's very important if you change the conditions.* This statement and the following discussion were a natural corollary to the previous discussion. Students had learned that success in the lab or in any experimental situation is not valuable if the researcher does not know how results were achieved. Carefully written lab journals and notes are essential.
- *You should have people review your work*. This is another indication of students' maturing in their understanding of how scientific work proceeds. Most college students accept the fact that they are evaluated by their professors, and this results in a grade. The idea of science as a group enterprise in which those involved review each other's work in order to improve and make progress is an important step in the thinking of an emerging scientist.
- *You need self motivation; it's not like in class where grades are always on your mind.* This is a corollary to the above insight. What was meant by "self" motivation was intrinsic motivation as opposed to dependence on external rewards. The MARC (Minority Access to Research Careers, an NIH-sponsored program) students recognized that even good grades produce only limited satisfaction, and that once a student knows the material well enough to earn an A, there is not much more to do. But in research there is always more to do, and so "self" motivation is of the utmost importance.

Teamwork in Research Based on popular images, undergraduates frequently think of research as an isolated activity. A NSF-funded summer program at SUNY Stony Brook provides research experiences for students transitioning from community colleges to four-year institutions. This program places students in teams and the following insights into team research were obtained from interviews with each team at the end of the

summer. Some of these are underrepresented minority students who transferred to Stony Brook and became part of the LSAMP program.

- *Division of Tasks* In almost every group interviewed, students said that working alone they could not have accomplished all that was required in their project. This included review of the background literature, experimental processes, data analysis, and preparation of posters.
- *Different Perspectives* Through their projects, students came to accept the fact that their own views, analysis, or ideas for next steps were not the only possibilities and perhaps not the best. They learned to listen to one another and to appreciate the value of other insights. This is an educational outcome rarely achieved in class, lecture, and textbook-based education.
- *Personal Growth* A natural corollary to the appreciation of different points of view, mentioned by students, was the fact that they learned to analyze their own thinking more carefully and to make suggestions mindful of the direction the project was taking. This self-adjusting mechanism indicated a new level of scientific maturity. One student commented, “You have to be patient, and realize it is not about you. Knowing what everyone else thinks is important.”
- *How Science Works* When asked, students quickly agreed that progress in science is always, in their thinking, the product of teamwork. They were quick to mention famous teams, even adding the names of individuals not as well known as their partners in historic discoveries.
- *Future Teamwork* Several students commented that the teamwork learned this summer and in four-year college research would be useful to them in the future, in science, industry, or business in which teamwork is now the norm. This realization is not uncommon but it is interesting and important that college students take it seriously and see themselves preparing for professional lives that will include teamwork.

Mentors Success in undergraduate research depends on the research mentor. Generally mentors are selected or volunteer and they expect to be working with students for whom research is new, and who will need guidance, direction, and support. In interviews,

surveys, and focus groups we have found that the majority, probably 90% overall, of students are pleased with their mentors. They begin to work with faculty and relate to them in new ways—in a more informal and collegial manner. Students frequently describe their mentors in very positive terms—the best, always available, helps when I need it.

Interviews (Gafney, 2005) have uncovered two fundamental differences in mentoring. In the first, students are closely supervised and their work is checked at each step. Under the second style, students are allowed more freedom—to make mistakes, review their own work, repeat experiments, and design changes in experiments—all to some degree on their own.

There is often a match between the closer style of supervision and students who are novices in the lab, and between more independent approaches to mentoring and more advanced students. Ideally, a mentor shifts to more open style as a student progresses and becomes more responsible. This is appropriate, but not universal. Some mentors adopt close supervision as their general style; others are more open and less directive. Differences sometimes depend on the mentor's personality, availability, and previous experiences, as much as on the needs of the student. One advanced research student reported as follows.

> *My mentor is very methodical and overprotective; he doesn't give you much room to think; doesn't think with you. You get the impression that he doesn't listen. But he is always available. He likes you to be there, to put in a great deal of time. I don't mind that, but sometimes it helps me to go to the library to think. I am more relaxed when he is not in the lab.*

Another student, an undergraduate new to research, commented on the pros and cons of a less structured mentor.

> *Unlike other mentors whom I know, this one doesn't say do this and do that, and if this happens then you do that; he wants you to think on your own. You come up with an idea and he will say, 'Well I don't know, try it and see what happens.' Even if he knows it's not going to work, he wants you to go and find out for yourself. So you learn the process; and*

sometimes an idea that you might have forces you to learn some techniques. And even if you don't get your expected results you learn a lot."

Students are very reflective about their needs and the mentoring relationship. They are not overly critical but seem able to take the good with the bad. Mentors should be mindful of student needs as they adopt and adapt a mentoring style.

Data on Persistence in STEM, Graduate School and Research We have some quantitative data on the graduate education of students who participated in research programs. At SUNY Stony Brook, over a period of 10 years, 85 undergraduates undertook research as participants in the NIH-sponsored MARC program. This program shares LSAMP's objectives and serves the same students. In many cases, students are referred to the MARC program by the LSAMP coordinator. So most but not necessarily all would qualify as underrepresented minority students. A total of 85% (72) of the students who engaged in research as undergraduates in this program, which generally engages students for two years, have or are striving for advanced degrees in science or medicine. The following table shows the data.

Table 2. Graduate Programs Attended by Stony Brook MARC Students (85%)

Program	Completed	Currently enrolled	Applying
Ph.D. or M.D./Ph.D.	8	15	
M. S.	13	9	
M.D./DDS	9	10	
All programs			8

It is impossible to sort out the various factors that lead a student to enter graduate school. But the emphasis placed on undergraduate research as a desirable experience, and the extensive data we have ourselves generated in how students' understanding, motivation, and confidence in science develop through research tell us that there is a strong connection between students doing research and attending to graduate school.

In summary we have found that undergraduate research provides the following benefits to students:

- Doing science: for an extended time; learning that things go wrong; then the excitement of discovery;
- New relationships with faculty: informal and collegial;
- Entry into the scientific community: through background study; trips to conferences, collaboration beyond the lab;
- Developing communications skills: poster, oral, and written;
- Experiencing teamwork in research: in the lab, and beyond;
- Greater clarity regarding graduate school: this is what it is like.

Best Practices Based on the data collected in connection with the SUNY LSAMP research project and reported above, we can abstract the following as essential components to a strong undergraduate research program

1. Research Mentors. Undergraduates experiences in research are influenced by their mentors more than by any other factor. It is essential, therefore that research mentors be selected with great care and that they be sensitive to the needs of undergraduates, providing the appropriate levels of direction and personal support.
2. Communications. Undergraduate researchers need direction and practice in making oral and poster presentations, and in discussing their progress.
3. Teamwork in Research. The lesson that teamwork is central to research is often illuminating to students, dispelling the idea that research is an isolated and lonely activity.
4. Appropriate Projects. Students doing research always comment on what it means to do science rather than simply learn it. But interviews and surveys have determined that the experience works only if research projects are appropriately selected so that students have the opportunity to use their initiative within a supportive environment. If the individual projects are to routine or too difficult, students will not benefit to the degree they should.
5. Project Director. Most undergraduate research is undertaken within the structure of a program, and the directors of such programs are critically important. Although the research mentors guide and support students in a variety of ways,

an overall director is important to insure that the mentors are indeed looking out for the best interests of the student researchers, and to create a friendly environment in which students can support one another.

6. The Scientific Community. The directors with mentors also provide an overall structure in which students are introduced to the scientific network and community, and that they receive appropriate guidance in preparing presentations and in applying to graduate school.

3. Academic Support: Curriculum Initiatives, Course-Related Workshops, Tutoring, and Professional Development

There are several reasons why underrepresented minority students often need academic assistance. First, many urban secondary schools lack the resources and sometimes the quality teachers to insure a high level of teaching and learning. Second, minority students are often the first in their families to attend college, and although motivated may lack role models for college. Third, the STEM disciplines are demanding for all students, requiring extra learning time, particularly in quantitative areas. Halpern (1994) noted that, "The enrollment of large numbers of students from minority groups that have been traditionally underrepresented means that colleges have to respond with changes in the way they teach and in what they teach" (p 2-3). Initiatives addressing the needs of minority students have included: remediation particularly through not-for-credit courses (Kimbrough, & Harper, 2006, p 192), support services such as tutoring and workshops beyond courses (Bonsangue & Drew, 1992), and overall improvement of teaching and learning with curricular changes.

We will therefore consider activities and programs that are aligned with the LSAMP goals, even if though in some cases SUNY LSAMP does not sponsor the activities. As in the case of undergraduate research, it is sometimes difficult to say where one program ends and another begins. There are many connections and influences among programs, and these are not always easy to sort out.

Active Learning Courses and Course-Connected Workshops There are several reasons why academic support activities such as workshops and tutoring sessions are most effective when they are closely tied to courses: the approaches to teaching and

learning will be consistent; students will feel more engaged and moving in the same direction; a drop-in attitude will be avoided; and student difficulties will be more easily diagnosed and remedied. It is for these reasons that POGIL (Process Oriented Guided Inquiry Learning), PLTL (Peer-Led Team Learning) and SI (Supplemental Instruction) have been so successful. David Hanson (2006), a Stony Brook faculty member, describes in detail how to establish and support a POGIL program. Gafney and Varma-Nelson (2008) have written a detailed study of PLTL with evidence that minority students have made significant academic advances through participation in the program, as compared with similar students who did not participate. Other LSAMP alliances in different parts of the country supply funding for PLTL and opportunities for course-related workshops.

The best-known intervention developed specifically for minority students is found in the work of Uri Treisman (1992), first at Berkeley and then at the University of Texas Austin. Treisman's effort was based on several important realizations. First, he found that the African American students at Berkeley were under-performing in calculus courses but this was not because their academic background was weak. Second, he noted the effectiveness of small-group work undertaken by Asian students. Finally, he noted that the African American students tended to study in isolation. Putting this information together, Treisman initiated workshops in which the African American students were challenged to work together solving difficult calculus problems. The rest is history in the sense that the program was highly successful. It has been widely disseminated under the name, Merit Workshops, and has inspired a number of related initiatives.

Following in the Treisman tradition but with an emphasis on at-risk students, the Engineering School at SUNY Buffalo sponsors workshops in a number of areas related to the curriculum. This program works in conjunction with SUNY LSAMP. Applicants to the engineering program are carefully reviewed, particularly their New York State Regents and SAT scores. If students do not meet certain criteria, they are admitted only as "intended majors." They must then take certain prerequisite courses and participate in course-related workshops, most importantly mathematics. This program has assisted

minority students, not only through the academic support, but also by the process itself which lets them know from the outset that they are the focus of real concern.

William Wild, the director, has found that the screening process identifies about 75 percent of the students who would be at risk of failing. He explained the program's goals and activities as follows.

> *I work for the engineering school. The overall goal of my position is to improve student quality and retention. We run a number of small-group sessions, structured and aimed at training students in how to do college level work, in calculus, chemistry, and physics. There are weekly sessions but they are not tutoring. Students work through material, aimed at helping freshmen in the transition, training them to be self-sufficient after the transition. I run most of the sessions--with the help of tutors. They are usually sophomores, who went through the program the previous year.*
>
> *QQ: Do you use separate problem sets, respond to individual questions, review course material?*
>
> *All of those. The workshops are probably what a recitation could be if done by a professional teacher. The turnover of TA's is a problem. The sessions provide a structured review but the pedagogy is key and aimed particularly toward the needs of transitioning students; it's highly interactive.*
>
> *They do workshop problems, individually. We go around and see where each person is, and what is needed. We get to watch that process every week--usually in more than one discipline because students who come for calculus also show up for chemistry. We get to know the students pretty well.*

We believe that this program at SUNY Buffalo has significant strengths—identifying at-risk students early, then providing positive interventions and support. In interviews, students who had been in the program said that it made the difference between success and failure for them. Since the inception of the program, the five-year graduation rate in engineering has increased from 32% to over 50%.

Faculty who have been part of the SUNY LSAMP project have initiated workshops for physics at SUNY New Paltz and for general chemistry at SUNY Old Westbury. These

workshops are course related. Although they did not involve large numbers of students, they were beneficial in stimulating faculty interested in more active learning with the opportunity to investigate small group learning and the impact on under-represented minority students.

Professional Development The SUNY LSAMP alliance has not sponsored professional development but we mention it as a potentially important area, and supply an example from the Upstate New York LSAMP (ULSAMP) Alliance. During late May, 2008, Rochester Institute of Technology (RIT) sponsored an annual Faculty Institute on Teaching and Learning (FITL). About 240 faculty members from RIT attended. ULSAMP used the conference as an opportunity to sponsor a one-day meeting of math faculty members. The general topic for review was calculus since this is an important gatekeeper course in which students transition from elementary to advanced mathematics, or in which they hit a wall and determine that they cannot continue in mathematics or in the quantitative sciences.

In the first sessions, participants from each institution presented an overview of their curriculum, placement procedures, and some of the issues surrounding the teaching and learning of mathematics. There was ample time for questions and discussion. During the second session participants presented systemic problems they had encountered in recent years and solutions that had been implemented. Course time and learning time were considered important issues. Calculus courses with four hours of class and two hours of workshop per week were not unusual.

With regard to the impact of new methods on minority students, there was general agreement with the findings of Sheila Tobias (1990) and others that curriculum changes that encourage more active learning and student involvement hold special benefits for minority students. The FITL conference also provided a presentation on issues related to African Americans in college that was attended by the ULSAMP participants. We cannot predict the lasting value of these meetings. But the professional development at the conference helped bring the goals of LSAMP into the classroom, within the larger context of an institution’s academic programs.

Institutional Tutoring and Workshops Individual tutoring is a staple in academic support. In some countries the "tutor" is synonymous with "mentor" or "advisor." Unfortunately, in our current educational climate tutoring has a remedial connotation. A report on an LSAMP evaluation site visit to SUNY Old Westbury contained the following:

> *Tutoring is offered, particularly for General Chemistry and Introductory Biology. Some students attend regularly and said they profit from the sessions. Others attend before tests in order to review or obtain help in particular areas. Tutoring programs are difficult to maintain for a number of reasons.*
>
> - *There are on-going challenges in recruiting and training competent tutors.*
> - *Many students consider tutoring as remedial rather than as a way of resolving difficulties early, and maintaining good grades.*
> - *Students attend irregularly, coming in larger numbers before exams.*
>
> *In spite of these difficulties, the LSAMP/CSTEP tutoring at Old Westbury responds to a real need. Students reported that the tutoring was more helpful than last year, when one or another tutor was sometimes not able to answer questions in ways that students found helpful. Students and tutors also said that the tutoring generally works best when the tutors have taken the class from the same professor as the student.*

These three issues were encountered at all of the SUNY LSAMP sites: training and supervising tutors; overcoming the remedial image; irregular attendance. The solutions are not easy but they are embedded in the problem areas. First, serious efforts must be made to identify, train, and supervise tutors. The best tutors will be those who have taken and done well in the course for which they are tutoring. It is even better if they have taken the course with the same professor as those they are helping, but that is not always possible. Second, it should be made clear to students that tutoring is not necessarily remedial. Rather, tutoring is a highly effective method for reinforcing concepts and skills, practicing problem solving, reviewing material and fixing it in the memory. Students should be told this in class, by advisors, and it should be made clear in the institutional

literature. Finally, tutoring is effective only if it is done regularly, week after week, whether the students think they need it or not.

SUNY Buffalo runs a tutoring program for students who participate in the various programs with economic or minority qualifications such as LSAMP, EOP, CSTEP, McNair, and the like. Students apply to the program and are assigned a tutor or to a study group depending on their interests and needs. Payment to tutors is billed to the appropriate program. This initiative involves a good deal of record keeping, but the space, in the basement of the library, is excellent, and pooling resources provides an economy of scale in administration and in providing tutors for a wide range of courses.

Tutoring at SUNY New Paltz The tutoring center at SUNY New Paltz is housed in the library. Data showed that more than half of the students tutored earned grades of A or B, with those who attended more frequently earning higher grades. More than 40 courses were represented. Writing assistance and math workshops are major areas with many EOP students required to attend. The director runs a tutor training program with speakers on a variety of subjects—active learning, writing, learning styles, etc.

The combined LSAMP/CSTEP (AC^2) program sends students to the New Paltz tutoring center regularly, and also retains tutors for more advanced courses. Themes from interviews with students being tutored, some at the center, some through LSAMP were as follows.

- The program coordinator received mid-semester grades from professors and in turn alerted students to the fact that their grades were not good, and encouraged them start with tutors. Some didn't recognize the need on their own because of their experiences in high school. *It took me some time to decide that I needed tutoring because in high school I didn't have any problems understanding material and getting good grades,*
- All of those interviewed said that the tutoring helped improve their grades.
- All of those interviewed talked about positive relationships with their tutors. One mentioned what he thought was a bad fit with a tutor the previous year. Several said that having a tutor who had taken the course with the same professor was

particularly helpful. The tutor then knows the expectations of the instructor and the tutee feels a sense of connection and confidence in the tutor.

- Those interviewed seemed to be honest in their self-assessment of time management and persistence. Those who said they tended to procrastinate were not doing as well as those said they keep up with their course work.
- Students talked about the ways in which tutoring complemented the classroom instructor's approach. One, is that tutoring requires a certain mental flexibility. *When you go to the professor, he tells you the same way again. The professor comes in and knows exactly what he wants to say, but a tutor has to jump in wherever the need is.*
- Students also said they need tutoring because there isn't time to learn and digest the material during class. Individual study is, of course, intended to be the time to review and reinforce learning. But if a student gets stuck, the tutor can be an important aid in this phase of learning. *In class all you do is copy the notes, and you really don't have time to understand what you are copying. Also the teacher runs through the material and expects you to do the problems on your own. He does take questions but there are a lot of things you don't understand.* Do you go over your notes in tutoring? *Yes, we discuss it, to be sure I understand it.*

In these interviews there was a correlation between students admitting that they slacked off on their studies and thinking about switching their majors. It is difficult to identify cause and effect. A student doing poorly often begins to consider the possibility of changing majors. But it may also happen that a student thinking about a different major begins studying less conscientiously. Those who were doing well, studying regularly, earning good grades, answered quickly that they would not change majors. It should be remembered that this was a very small sample.

Miller et al. (2001) have provided an excellent resource on student-assisted teaching. The manual describes 31 programs that involve students in the teaching/learning process at institutions all over the country. Each program discusses issues of cost, training, and evaluation. But some programs more than others give rise to significant issues regarding the degree to which faculty members are willing to share power with undergraduates.

Best Practices Best practices for academic support through curriculum initiatives, course-related workshops and tutoring correspond to the issues identified above, and to the successful practices noted.

1. Curriculum Initiatives. The programs most successful in achieving improved performance among minority students have been those that encourage and foster active learning. Lecture, study, and test taking are no longer adequate for students in general. But this process is particularly inadequate for minority students. It is essential that students interact, work together, do much more than simply read, listen, and complete assignments in their learning.
2. Recruiting, training, supervising, and evaluating tutors and workshop leaders. It is not enough to post an invitation on a bulletin board or website. It is best to work through instructors, lab supervisors and others who have had a chance to observe and work with students. Some students do not seem themselves as tutors or do now know about the academic support programs. But once identified they become enthusiastic in attendance. There is a wealth of materials available to train tutors. The most important thing is always the personal contact with the program director. On-going supervision requires careful recording-keeping and follow-up with tutors and tutees.
3. Encouraging participation not just for remedial reasons. At a monthly lunch for LSAMP students at the SUNY Binghamton a physics professor spoke for a few minutes about the importance of going for academic assistance early and that tutoring or participation in a study group can make the difference between achieving an A rather than a B or a B rather than a C. He also pointed out that all students has difficulty understanding in some areas. If faculty members would make these points early and often with their classes, it is likely that more students would go for the assistance they need—before falling behind.
4. Regular attendance. Those administering tutoring programs routinely complain that students show up in large numbers before tests or when particularly difficult material has been introduced. Students need to learn the lesson that tutoring, like

individual study, will be most effective if it is pursued regularly—week in and week out.

5. Professional Development. Workshops and readings on pedagogy are important to alert faculty to the various methods and tools they might use to make instruction more effective, particularly for minority students.

4. Process Skills: Freshmen Success Courses and Workshops

Freshman year of college is traditionally an exciting time as young people become more independent and their minds expand with new intellectual experiences. But in recent years, the challenges have increased for freshmen. First, colleges have radically reduced the restrictions and do not wish to be regarded "in the place of parents." Curfews, required attendance at class, and restrictions on room visiting have been eliminated or radically reduced. Freshmen are placed in a sink or swim atmosphere. Second, options regarding majors have multiplied. Most colleges have certain distribution requirements, but no core curriculum. Some traditional majors such as pre-med no longer exist. Students are encouraged to plan their own sequence of courses, with guidance. Third, many areas, particularly in the STEM disciplines have become more complex and conceptual than in the past. Students are required to do more quantitative reasoning and difficult problem solving. Finally, with larger numbers of students attending college, there are more students who are academically under-prepared.

The result of these factors is that students need a lot of assistance adjusting to college. Institutions of higher learning for their part have responded. Centers for Teaching and Learning provide resources and activities to improve faculty teaching and student learning. Many colleges also offer freshman success courses.

Freshman Success Courses In addition to the activities provided by departments and resource centers, many institutions now offer freshman success courses. Most of the SUNY LSAMP institutions have initiated these courses and have employed LSAMP resources in personnel and funding. We have evidence that these courses are meeting their objectives: to help acclimate students to college; to acquaint them with the resources available; to offer guidance in effective study practices, time management and other process skills.

The following are the topics typically covered in a freshman success course:

- Adjustment to college;
- Study skills;
- Note taking;
- Time management;
- Writing: usage, grammar;
- Use of the library;
- Computer searches;
- Course selection;
- Resume preparation;
- Stress reduction;
- Concept mapping;
- Test taking.

A study of the freshman success course at SUNY Stony Brook was undertaken using pre/post surveys. The results were as follows.

Importance of Study Skills and Academic Strategies and the Need for Improvement

The survey first asked students to rate the importance of a number of skill areas, such as: organizing course materials, setting goals, note taking, managing time, and managing stress. Then in a pre and post test they were asked to rate the importance of each skill for themselves. They gave high ratings to all of the 15 skill/strategy items listed. The average of the means for both the pre and post surveys was 4.6 and that is between "very important," and "extremely important." There were slight variations but no significant changes in ratings from the pre to post survey. The lowest rating in both surveys was given for Item 11, "Participating in a study group."

The second group of 15 items repeated the first 15 asking students to rate the level of need that they themselves felt with regard to acquiring these. In the pe-course survey, the means for these items were considerably lower than for the first 15 items, indicating that while the respondents considered these to be very important regarding academic success, they did not generally see themselves as in "extremely great" or "great" need of these.

Results of the post-course survey demonstrated important trends. The first three items covered large conceptual issues and the means for the post survey were considerably higher than for the pre-course survey: Item 1 "Organizing course materials," rose from 3.2 to 3.94; Item 2 "Setting goals," rose from 2.9 to 4.18; and Item 3 "Identifying big ideas," rose from 3.1 to 3.88. These results seem to indicate that the success course awakened students' realization concerning their needs in these areas. The average of means for all items rose from 3.48 in the pre survey to 3.86 in the post survey, indicating the same trend, that is that the course made students aware of the need to improve their study skills and strategies. The two lowest ratings, that is, the areas in which students see the least need for improvement were Items 26 and 27, "Participating in a study group," and "Acquiring assistance from a tutor or group facilitator." This relates to the generally low priority placed on these areas and noted in the first section above. The pre/post ratings are shown below.

Table 3. Student Self Ratings of Certain Process Skills

Please rate what you consider to be your level of need for improvement with regard to each of the following. 5 = extremely great need, 4 = great need, 3 = some need, 2 = small need, 1 = no need.	*Mean: Pre*	*Post*
1. Organizing course materials.	3.2	3.94
2. Setting goals.	2.9	4.18
3. Identifying big ideas.	3.1	3.88
4. Understanding connections among ideas.	3.45	4
5. Using available resources on campus.	3.6	3.82
6. Managing time.	4.05	3.88
7. Managing stress.	3.75	4
8. Note taking.	3.7	3.71
9. Managing test anxiety.	3.5	3.82
10. Developing a good memory.	3.55	3.65
11. Participating in a study group.	3.4	3.35
12. Acquiring assistance from a tutor or group facilitator.	3.45	3.29
13. Preparing for tests.	3.45	4.24
14. Developing concentration skills.	3.75	4.06
15. Working practice problems, exercises, and sample test items.	3.35	4.12

Pre Survey Open-Ended Items In response to an open-ended item asking what were the greatest accounting for their previous academic success, students listed a variety of areas

(Numbers indicate the number of students identifying this area.): Personal determination, perseverance, concentration, motivation, 5; working with a study group or friend, 4; parents and teachers; 3; study skills, attention, review, 3; quiet, appropriate place to study, 2; friendly competition, 2. Some of these areas are intrinsic to the student's mental and emotional life; some are more extrinsic, indicating people who have assisted them; some refer to skills; others to circumstances. We note that tutoring was not listed at all.

The second open-ended item in the pre survey asked about barriers to success. In response to this, students generally took responsibility for their learning, not placing blame elsewhere. Fifteen respondents criticized themselves for procrastination, poor time management, laziness, and the like. Only one student reported that an "inability to do the assignments," prevented success.

Responses to the next item asking what students would have to do to achieve greater success indicated consistency with what was just noted. Fourteen students said that they would have to concentrate, focus, study more, be more organized, and the like.

In response to the last item on the pre survey, 14 students reported that they hope to pursue graduate studies or enter a professional career, for example, in medicine, engineering, or veterinary work.

Post Survey Open Ended Items Throughout the open-ended post survey responses, students indicated that they were well satisfied with the course. In listing the major benefits of the course, they mentioned many of the skills that were covered: time management, 4; note-taking, 3; study techniques and skills, 6; learning about campus resources, 1; goal setting, 2. Students had very little to say regarding problems. Most said that there were no problems. Five would like the class scheduled at a different time.

When asked what they needed to do to achieve greater academic success, students responded as in the pre survey by taking responsibility for their own success or lack of it. In the post survey they tended to use more of the language of the success course: time management, 4; better organization, 4; focus, dedication, 2; take better notes, 2; do what was taught in the course, 3.

In the post survey more students than in the pre survey interpreted the item asking about study and careers as a short-term question. About half talked about studying with greater

concentration and using the study strategies they had learned. But nine or 10 still mentioned graduate or professional school.

Students were generally well satisfied with the course. With regard to improvements, four felt that there was too much repetition or time spent on easy skills. Two suggested that trips be included; two suggested that the course be offered in the summer; and two that it be scheduled at a different time.

Summary and Recommendations Based on responses to the pre/post surveys, it is clear that students found that the success course answered a real need and that they benefited from many of the skills and strategies covered in the course. The only surprising result was that students gave very low ratings to the need for study groups and tutors. These are usually considered important interventions when freshmen begin to have academic problems. But advisors and others should not assume that these helps are in the front of students minds when they have trouble. Based on the survey responses, most students assume that they must work harder, get better organized, and make learning a high priority. These were probably the solutions that worked for them in high school. Tutoring and study groups were for others, probably those needing remediation. Advisors and mentors should be aware of this mentality and be ready to guide students to tutors and study groups, pointing out that the best students routinely use these aids along with the personal skills and strategies covered in the course. The Meyerhoff program (2009) for minority STEM students at the University of Maryland Baltimore County (UMBC) places strong emphasis on the importance of study groups. Upper-classmen who mentor freshmen insist that working in these groups is critically important to success.

Summer Prep Programs Several SUNY sites provide summer programs for incoming freshmen. SUNY Binghamton and Buffalo have such programs administered jointly by EOP (Educational Opportunity Program) and others. At Buffalo several LSAMP students reported that they were required to enter this program and that it gave them an important review of basic mathematics and science skills. They felt they would not have succeeded majoring in science without this pre-college program.

Special Topics Workshops Several sites have undertaken workshops on special topics such as prep for the Graduate Record Exam, improved writing, and preparation of a resume. At least one site has waved the fee required for preparation courses offered by a

company dedicated to this work and has reported favorable results. The site also found that the investment of LSAMP funds in such an activity, purchasing services, actually saved money since it was not economical or efficient to hire someone for a limited number of specialized courses. This is particularly true for the MCAT exams and the GRE area tests. SUNY Old Westbury offers a series of writing seminars in the preparation of resumes, personal statements, letters of introduction and the like. These seminars also cover the basics of proper usage and grammar. Students are given a book stipend of $5 per session which can be applied to the purchase of textbooks in the bookstore.

Transfer Students Many of the students at the SUNY LSAMP sites have transferred from other institutions, some from two-year SUNY community colleges and others from four-year colleges and universities. Directors and coordinators of the SUNY LSAMP program have been concerned about this pool of students for several reasons. First, the primary goal of the SUNY LSAMP program is to increase the numbers of students majoring in and graduating with degrees in the STEM disciplines, and transfer students are an important subset of the student populations. Second, one of the strategies adopted by the program is to strengthen cooperation with community colleges in order to provide smooth transitions and to encourage and support students who are considering science, mathematics, and related majors. Third, it was hoped that studying the transfer population might provide unique insights into the university and students' response to support activities.

To gather information about these concerns, a questionnaire was drafted and reviewed by the SUNY LSAMP sites. Twenty-three transfer students at Binghamton University completed the survey during the 2002 spring semester. Of the 23 respondents, 14 had transferred from SUNY community colleges; 7 were from four-year institution; 2 did not state their former institution. There appear to be few if any significant differences between responses of community college and those of four-year college transfer students. Therefore, the analysis is based on all responses.

The Transfer Process When asked how they selected Binghamton to continue their education (Item 21), a majority of students (14) mentioned either that they themselves had investigated the institution's academic reputation in their fields of interest, or they had received advice from counselors, friends, or relatives regarding the quality of the institution. Several mentioned convenience, location, or economic reasons for their selection. Two students were introduced to

Binghamton through positive experiences participating in the Bridges program. A large majority of students (82.6%) found that the admissions process was not difficult. But only 26% agreed that advisors at their former institution were helpful in the transfer process. Nevertheless, it does not appear that the paperwork requirements, and acceptance of credits were significant barriers in the transition. Twenty of the 23 respondents said that they had selected a major; two were in the process, and one had not yet made the selection. When asked if they felt they were treated differently because they were transfer students, 19 of the students said no. Two said they found it difficult to adapt socially because other students had already formed groups of friends. Only one student felt that the institution did not do enough to support transfer students.

Problems Although they reported that the admissions process went well and they were satisfied with their choice of Binghamton, students did not find the transition easy. In response to the first question on the survey, "My transition from community college (or other institution) to four-year college proceeded smoothly, without problems," a surprisingly low number of students (26.1%) agreed. In other words, three out of four students felt that the transfer did not go smoothly or were ambivalent on this point, and unable to agree. (Some were neutral, neither agreeing nor disagreeing.) The difficulties seem to be related to academic work.

Academic Adjustment When asked about difficulties in studying science and mathematics, six students said there were none, but the rest of the responses appeared to reveal somewhat serious difficulties. Students talked about the academic load in general, as well as particular courses or professors. A number of students talked about time; others about the general level of difficulty; and others about their study habits. Comments included: "my schedule was hectic… I had trouble finding time to study… my math foundation was a little shaky… many of the science and math courses are large and overcrowded, so professors cannot give special attention to a student's needs… I was faced for the first time with attending lecture and discussion separately."

The sentiments expressed above are reaffirmed in response to Item 9 for which 55% of the students agreed that, "My grades have gone down since transferring." Twenty-two percent of the students said that their grades had gone up and 22% said that their grades had remained about the same. Students generally found the instructors to be as good as or better than those in their former institution (Items 11 and 12). A majority reported that their interest in science and mathematics has increased since enrolling at Binghamton (Items 13 and 14), and a large majority (74%) reported that their foundation in mathematics and science was adequate. There are some

inconsistencies in these responses. In particular, students said that their grades have gone down, but they believe that their previous introductory courses were adequate.

Answers to Item 27, "What would help you achieve greater success in math and science, and in you career aspirations?" reveal that these students are taking responsibility for their own learning. Only two respondents said that instructors' methods or style needed change. Nine respondents said that they themselves needed to improve their study habits, become more disciplined, organized, and use their time more effectively. Four said simply that they needed to be more dedicated. Four others said that additional support in the form of tutoring or organized study groups would be helpful.

Support A large majority of students (78.3%) reported that the institution provided very good academic support, and 95.5% said that the Binghamton Success Program has been very helpful to them. In response to Item 25 which asked which LSAMP or other support activities had been most helpful, 10 students cited the Binghamton Success Program with comments related to mentoring, support, information, meeting people, professional development, and the like. Five students referred to tutorial help, and four mentioned book stipends as important. Two students listed mentoring from faculty. Organizations mentioned as providing support included: SHPE (Hispanic Engineers), NSBE (Black Engineers), NSF (National Science Foundation financial and academic support), and CIW (Carnegie Institution of Washington).

Similar to the Freshman Experience Although this survey was not completed by freshmen at any of the SUNY sites, the responses and patterns are consistent with the responses of freshmen in interviews when asked about how well they had adjusted to college life. They found the academic work more difficult than they had expected, felt under-prepared and intimidated, and needed help. In some cases, these reactions were simply the normal and traditional response of those entering college and finding that a new level of work is needed. For other students, however, the dangers were real, so that support and adjustments were needed to avoid failure.

The differences for those responding to this survey is, of course, that these are not freshmen. They are mid-way through their college careers, and recovery time may be limited if they find themselves in difficult situations. The average GPA for the 21 students reporting was 3.0, with 10 students reporting a GPA of below 3. None of the GPAs was below 2. So it seems that these transfer students were doing reasonably well, but about half of those in this cohort were not

excelling. In general, it seems that transfer students do have problems adjusting and that they may need an extra level of support and mentoring.

Best Practices Suggestions regarding best practices for the success courses and skills workshops are not complex, but we believe that barriers to implementation are substantial.

1. Freshmen Success Courses have had proven success. The topics to be covered are well known, but it is important to have an instructor who is energetic, believes in the value of the program, is alert to individual differences, and is able to incorporate a modest level of advising within the course. The major difficulty we have found is that most universities are not comfortable requiring the course and many students do not appreciate the need. Consequently, many students who should enroll in such a course, do not. A best practice in this regard would be to require that some students take the course, depending on certain college entrance criteria.
2. With regard to special study skills, writing, and exam preparation workshops, what we have learned is that these should be widely available, advertised, and that a good instructor is the most important element. Colleges and universities are becoming increasingly aware that STEM programs include activities that will improve student writing.
3. Based on the survey administered, we found that the processes of transferring from community college and adjustment at four-year institutions are not easy. Many transfer students need something like the freshman success course and a program of academic advising that will assist them as they engage in higher level mathematics and science courses and make decisions about majors and career directions.

5. Student Contact: Community Building, Advising, Communications, Social Support, Financial Support

During the course of the grant, SUNY sites developed a variety of ways of identifying and categorizing LSAMP students. For record-keeping and reporting to NSF, students who fit the under-represented minority criteria and were majoring in the appropriate

STEM areas were included in the numbers reported. Some sites used grade point averages to select students for particular benefits such as stipends for books, trips to conferences, and other benefits. Some sites put a large portion of their LSAMP budgets into more substantial stipends to help defray tuition and other expenses for a relatively small number of LSAMP students.

Community Building At a number of the SUNY LSAMP sites the number of minority students majoring in STEM disciplines is small, and theses students benefit from activities that bring them into contact with others who share similar backgrounds, interests, challenges and goals. LSAMP developed a number of ways to enhance this sense of community.

- Regular lunches for LSAMP students and guests. At some sites these lunches included visits by professors and graduate students giving the undergraduates a sense that the community is large and is ready to support them into the future in their academic pursuits.
- Trips to conferences or local chapters of science organizations. These trips provide an understanding of the latest in research and scientific endeavors, but they also offer minority students the opportunity to meet peers from other institutions, to socialize, and gain important information about how the academy functions and interacts with industry.
- Peer mentoring and peer-led study groups. As above, the primary purpose of these activities may be academic, but it often happens that they provide the foundation for productive non-academic friendships and support.

Advising by LSAMP Coordinators The LSAMP coordinators maintain record-keeping systems and communications with students in a variety of ways and about different areas. The following are the more common activities:

- Regular emails to inform students about LSAMP events, related activities on campus, research opportunities, and graduate school information.
- A warning system to identify students with academic difficulties, early in a semester—to be followed by a meeting and discussion of issues and possible remedies.

- An open-door advising system to discuss issues, particularly related to switching majors, special opportunities, and the like.
- Writing recommendations for internships and graduate school.
- Maintenance of a database of participants, with a listing of courses completed, GPA, internships, activities, and special situations.

Since one of the primary goals of the LSAMP program is to retain underrepresented minority students in the STEM disciplines, advising sometimes became a delicate process. Coordinators and others involved with the program want to advise students about the best ways to remain as STEM majors. But in some cases it is also important to help students decide what major is best for them. A number of students have found that the major they had selected, Computer Science for example, is not what they thought it would be. Others found that their interest shifted during college—from biology to chemistry, for example. And some switched out of STEM areas without the knowledge of LSAMP personnel.

There were some problematic areas with regard to the question of majors. At SUNY Stony Brook a number of biology and chemistry majors switched to a new major, health sciences in their junior or senior years. This was an attractive switch for some students who were in danger of not completing the required number of advanced courses before their intended graduation date. The problem from the perspective of LSAMP was that the new major did not qualify as one of the approved STEM fields according to the NSF guidelines. In addition, there was concern that the major did not carry the weight of the traditional discipline majors, and would not be sufficient for students who might want to apply to graduate programs in the sciences. The LSAMP advising function was thus placed in a somewhat delicate position—balancing the goals of the program, the best interests and academic abilities of the students, and the internal dynamics of the university. The result in this case was settled on a student-by-student basis, with no overall guidelines being developed.

Advising and Support by a Course Professor Instructors and professors do not ordinarily consider advising as one of their core responsibilities—in connection with course work. But at a faculty development conference at Rochester Institute of

Technology, a faculty member described a number of course-related activities that stretched beyond the usual professorial responsibilities. He outlined the following activities that he found increased his rapport with students and helped them integrate the calculus course learning into their academic and social lives.

- He asked students to complete a brief form on which they indicated why and how they made their choice of college, and also to briefly describe their out-of-class interests. This information served as the basis for an interview.
- Students were given the opportunity, for extra credit, to submit reports about on-campus speakers. This out-of-class activity also provided material for interviews and discussions.

These activities helped build relationships through which the professor understood the motivations, interests, and concerns of students. The students in turn saw the professor as more than a one-dimensional figure, interested in his discipline. He became, rather, an adult interested in his students with their individual interests and differences.

At the same conference a psychologist, working in enrollment management, discussed issues of male African American college students. His general conclusion, and this has been echoed in many conversations and focus groups conducted in the course of the LSAMP and other evaluations, is that African American students need some time to discuss racial and ethnic issues. These may be the traditional issues of racial bias and prejudice. But there are a number of other more subtle areas for profitable discussion, such as networking and finding the right kind of mentor, role model, and advisor.

At a SUNY-sponsored STEM conference held in Albany, NY, in October 2009, there were several discussions of ethnicity and the selection of research topics. While it is clear that there is no such thing as “Black physics,” or “Hispanic chemistry,” it is also clear that historically some important topics have been overlooked until researchers with an interest based in ethnicity looked into them. Natural remedies for cancer based in the use of certain plant extracts, for example, have sometimes been dismissed as superstitions until researchers sympathetic to the cultures in which they were practiced examined them for scientific evidence. Results have had far-reaching effects in oncology treatment.

The point of minority-serving programs is that there are particular needs that should be addressed. Providing appropriate services requires careful planning and development. SUNY LSAMP has provided speakers and workshops, but it and similar programs might look in a more programmatic way at enhancing this aspect of its services. Activities that have been successful include:

- Cooperation with NSBE (National Society of Black Engineers) and SHPE (Society of Hispanic Professional Engineers) which host large professional conferences at which students can meet professionals, make presentations, and see possibilities for their future.
- Hosting minority speakers to discuss relevant topics who can describe their work, challenges and successes, typical issues for minority students, and the best strategies for coping.
- Providing social activities, not limited to minority students, so that African American, Hispanic, and Native American students can take their place as leaders, tutors, discussion leaders, etc. in mixed groups.

LSAMP and Related Programs This report has noted in several places that there are other programs, activities, and grants devoted to the support of underrepresented minority students in the sciences. These programs differ in funding, in their target populations, and in what they offer students. But they have a great deal in common in areas such as overall goals and strategies, and these programs can enhance their effectiveness through cooperation. This is particularly true in the areas of social and academic support. We have noted the following related to cooperation and synergy.

- Programs share expenses for conferences, travel, tutoring, special workshops such as GRE prep, and other events.
- At schools with smaller minority enrollments, larger numbers of students can be brought together for discussions, speakers, and special events by including a wider range of disciplines.
- Direction and coordination of minority-serving programs can reduce overhead and enhance cooperation in services.

Best Practices Communications with LSAMP students cover a broad set of issues and include a number of challenges. The area is not as well defined as some of the other areas considered. The issues are nevertheless of great importance, and we believe that success in this area can make the difference in retaining or losing good students in the STEM disciplines. The following emerge as best practices in the area.

1. Community Building. Building community requires a combination of social and informational or academic events that will attract, engage, and support students. LSAMP should make the most of related programs—looking for opportunities that will provide synergy and greater effectiveness.
2. Record Keeping. Accurate record keeping is most important, providing the program with information needed to communicate information about events and opportunities such as internships and graduate school, and also to contact students in the cases when early warning is needed for academic interventions.
3. Advising. In addition to the advising provided by those with the institutional responsibility and by LSAMP personnel, course professors can offer advising that will help students see a course and discipline in a wider context.

6. Interest in Graduate School

One of LSAMP's goals is to foster student interest in graduate school. One way to do this, mentioned above, is to promote undergraduate research. This has been effective at all of the SUNY LSAMP sites. The experience provides an immersion in the central activity of graduate school and students are able to judge whether they have the temperament and personal resources required for extended research.

Another strategy to develop motivation and interest in graduate school lies in the coordination of LSAMP with AGEP, a sister program (Alliance for Graduate Education and the Professoriate) designed to engage and support under-represented minority students in the STEM disciplines in graduate school. These two programs are run under different offices at the National Science Foundation. Consequently, NSF does not require coordination.

Four of the SUNY LSAMP sites participate in AGEP as well as LSAMP programs, and a number of different organizational arrangements have been tried. AGEP has been more

centralized than LSAMP in the sense that the lead institution, Stony Brook, hired staff, acquired space, and implemented programs before the other sites. This site was also fortunate in hiring a director and assistant (later coordinator) who worked well together, and remained with the project. Stony Brook AGEP hosted an annual one-day conference for undergraduates with a wide range of informative sessions about graduate school, described more fully below.

Coordination between the two programs was therefore idiosyncratic—depending primarily on people and individual initiative. All of the Stony Brook AGEP sites held summer research programs for undergraduates from their own or other institutions. Some of these were jointly funded, but they did not provide a programmatic link with the undergraduate activities at the institution. One institution hired a coordinator to work with both LSAMP and AGEP, but this was abandoned after about a year. In general, each of the programs had its own staff and, like graduate and undergraduate schools in general, they were separate with some overlapping activities. At SUNY Buffalo AGEP hosted research lunches attended by graduate and undergraduate students. These lunches provided a forum in which graduate students gained experience in preparing and presenting their research, and undergraduates, as the audience, gained insights into graduate school

In general, it would fair to say that SUNY LSAMP and AGEP did not cooperate or develop the synergy that might have been achieved. There are a number of possible reasons for this shortfall: (a) As mentioned above, grants for the two programs are awarded from different areas in NSF and so no cooperation is required by the funding; (b) Undergraduate and graduate departments are administered separately and do not have many natural points of contact; (c) The initial grants were separated by about five years with only one common principal investigator; (d) Administration and staffing for the two programs have been separate.

A third area, in addition to undergraduate research and the AGEP connections, that promoted interest in graduate school was in the development of special conferences about graduate school. Stony Brook hosted an annual “Gathering of Scholars” conference with talks on all aspects of graduate school, and a poster session for the

undergraduates participating. On average about 100 students attended each year. The following describes the results of one year's evaluation survey.

Sixty participants completed the brief evaluation survey. They came from 21 institutions. Respondents agreed in very high percentages with the scaled items, with an overall average of 94.5% that the conference provided useful ideas and strategies. Written comments also revealed a high level of enthusiasm about the event. There is a strong indication based on these surveys and on conversations at the time of the conference that both students and faculty find the activities personally important as they make decisions and plans or guide others in planning for graduate school. One common theme found in the site visits and interviews was the recognition among students that they have to start early—as they look for the graduate school that is best for them and begin the application process. Moving the Gathering from the spring to the fall seems to have been important in this regard.

A final activity that has been documented in creating interest in graduate school is contact with professors from graduate schools. These contacts often arise as the result of summer research in which undergraduates work with new lab mentors, or through meetings with researchers at other institutions involved in research related to the undergraduate's interest. These experiences often bring the undergraduate to a concrete interest in a particular institution or person with whom to work.

Best Practices The four activities described can provide the outline of best practices in creating interest in graduate school among STEM students.

1. Undergraduate Research. In our experience this is the activity that most often helps undergraduates understand and experience what graduate students do and whether graduate school might be for them.
2. Connections with Graduate School. At most universities graduate and undergraduate schools are administered separately. A possible bridge for minority students exists in the connections between support programs, in particular between LSAMP and AGEP. We have seen that coordination between these programs can increase an undergraduate's interest in graduate school.

3. Conferences. Graduate school fairs and conferences can provide a wealth of useful information. For SUNY LSAMP students the two-day conferences that targeted minority STEM students provided motivation and stimulation to consider graduate school.
4. Connection with Graduate School Faculty. Contact with a faculty researcher in a particular field has the power to take a student's interest in graduate school from the abstract to the concrete, and to focus students on the institution that is best suited to them.

7. Success in Graduate School

Focus group discussions at the University of Buffalo provided insights into the social and academic supports that graduate students need. A number of these students were participants in the Bridge to the Doctorate (BD) program supported by LSAMP. Others were supported by AGEP. A portion of the report on this sit visit and discussion is as follows.

> When asked about adjustment to graduate school, a fifth year student said, "When I first started graduate school, there was no minority community here. There was an AGEP program; all they did was cut you a check …. Then the coordinator came, she brought people together, and it has been growing ever since. She sends information, holds research lunches." Others talked about the help they received getting acclimated, finding an apartment, making friends—all of which happened through the AGEP community. Students said they gained extra motivation through participation in AGEP. A significant number of the AGEP students had worked in industrial labs or something similar and some said the work had become repetitive and unsatisfying. It seems they were working as technicians with both the interest and ability to do more, so they returned to school. Many had experienced academic and social support as undergraduates and so, as we have seen at other institutions, they had expectations and in some cases needed academic and social support in graduate school.
>
> Students credited the program with broadening their views. One student said, "The research lunches let me know that some of the things I was doing, could be

done on a larger scale. At first you only see a small part of it." A number of the students had done research as undergraduates and they reported that the experience helped create the interest and motivation that led them to graduate school. Others said that attending conferences provided an understanding of the many different kinds of research and the networks that exist among scientists. One student commented that he had not known that so much reading was required for research.

The AGEP students in general reported that the stipends, book and travel funds, and laptop loan program were important to them. Many were supporting themselves or reluctant to ask for help from relatives. The AGEP program often provided just what was needed, helping them through what might have become emergency situations. Most of the BD students reported that they would not have been able to attend graduate school, at least at this time, without the financial support provided by the program.

They reported that study groups were essential for survival in graduate school. It often happened that an assignment was long and difficult. The cooperative work, review, reinforcement, taking turns at explaining material, and mutual support, made the process one in which they made progress and gained satisfaction. They believed that without the mutual support and collegial work they would not have been successful in several courses. While AGEP did not directly sponsor or establish study groups, the coordinator held workshops explaining the value of studying together, and participants reported that the minority community formed a context in which collegial work came naturally.

The students reported having useful experiences in developing presentations skills, starting as undergraduates. The experience helped them not only present their work in a professional way, but also sharpened their critical skills. One said he was surprised to see graduate students from other institutions presenting posters with mistakes in them. Students also appreciated trips to conferences at which they encountered other students and researchers doing work similar to their own. From these experiences, they developed ideas about research projects and

post-doctoral opportunities. One student reported being a co-author on two forthcoming publications.

Most of the graduate students are required to do some work as teaching assistants. All said that this was a useful and important experience, helping them to develop skills, sort out ideas about career directions, reinforce basic learning, and enjoy a productive professional outlet in addition to their research.

On average, across disciplines and institutions, about 50 percent of students who begin doctoral programs do not complete them. The percentages vary, of course, with the average completion rate being much higher in some institutions than in others. Lovitts (2001) found that one of the few statistically significant differences between the two groups is that, when entering graduate school, the non-completers were less informed about the institution, program, and personnel at the institution they were attending than those completing degrees. (Surprisingly, even those completing degrees started with a very limited knowledge base about the institution. Only 52 percent had visited before matriculating.) This lack of information and knowledge extended to important areas. A number of students did not discover that the primary focus of the departments they were joining was not aligned with their own interests. There are, therefore, important reasons for university graduate schools to provide information and offer personal contact before students enroll, and to offer support services after they enroll.

The Learning and Studies Strategies Inventory (LASSI) Survey The NSF-sponsored Bridge to the Doctorate program, funded by the NSF, provided a special laboratory in which the needs of this select group of graduate students could be studied. These were under-represented minority students who generally entered a master's program, with the hope that they would be successful, and then transition to doctoral programs. SUNY LSAMP implemented the Bridge to the Doctorate program in 2005. The grant provided stipends for up to 12 students per year, and almost all of these places were filled. The first cohort received stipends to study at SUNY Stony Brook, the second cohort at the University of Buffalo (SUNY), the third back at Stony Brook, and the fourth at Buffalo. The LASSI survey under discussion was administered to the first two cohorts.

The LASSI survey provided useful insights about what is needed for success in graduate school. The survey covers three main areas with 10 scales: Skill (Information Processing, Selecting Main Ideas and Test Strategies); Will (Attitude, Motivation and Anxiety); and Self regulation (Concentration; Time Management; Self-Testing and Study Aids). The inventory includes 80 items (8 for each scale; 4 positive and 4 reverse), with student reports covering the 10 scales in the following order.

- Attitude—assesses students' attitudes and interest in college and academic success, e.g. I feel confused and undecided as to what my educational goals should be.
- Motivation—assesses students' diligence, and willingness to exert the effort necessary to successfully complete academic requirements, e.g. When work is difficult I either give up or study only the easy parts.
- Time Management—assesses students' application of time management principles to academic situations, e.g. I only study when there is pressure of a test.
- Anxiety—assesses the degree to which students worry about school and their academic performance, e.g. Worrying about doing poorly interferes with my concentration on tests. (This scale is reverse scored: High anxiety is considered detrimental to academic success: a high score means low anxiety.)
- Concentration—assesses students' ability to direct and maintain attention on academic tasks, e.g. I find that during lecturers I think of other things and don't really listen to what is being said.
- Information Processing—assesses how well students' can use imagery, verbal elaboration, organization strategies, and reasoning skills as learning strategies, e.g. I translate what I am studying into my own words.
- Selecting Main Ideas—assesses students' skill at identifying important information for further study from among less important information, e.g. Often when studying I seem to get lost in details and can't see the forest for the trees.

- Study Aids—assesses students' use of supports or resources to help them learn or retain information, e.g. I use special helps, such as italics and headings, that are in my textbooks.
- Self-Testing—assesses students' use of reviewing and comprehension monitoring techniques to determine their level of understanding, e.g. I stop periodically while reading and mentally go over or review what was said.
- Test Strategies—assessing students' use of test preparation and test-taking strategies, e.g. In taking tests, writing themes, etc. I find I have misunderstood what is wanted and lose points because of it.

The LASSI inventory can be used to help students improve their understanding of their own strengths and weaknesses, and make adjustments in their approaches to academic tasks. With regard to the BD students we used the inventory to gather data about the population in order to determine the need for certain kinds of academic support, to compare this population with other populations, and to consider how the inventory results were related to academic performance.

Outcomes Those who constructed and field tested the inventory have found that scoring above the 75th percentile on a scale indicates an area of relative strength; scoring below the 50th percentile indicates an area of relative weakness—one in which students should probably try to improve their study skills and strategies. The LASSI inventory has been widely used for more than 30 years. Studies have demonstrated that it is a valid and reliable measure. That is, the inventory does in fact measure what it intends to measure, and does so consistently.

One of the premises of the AGEP and BD programs is that many under-represented minority students, even at the graduate level, need academic support. The reason for having students complete the LASSI inventory was to provide further evidence of this need, and to specify in greater detail the areas of need.

Ten students from Stony Brook and 11 from Buffalo completed the survey. The following table shows average percentile scores for each site and for all the respondents.

LASSI Average Percentile Scores (N = 21)

Scale	Buffalo	Stony Br.	All
Anxiety (Reverse)	47	59	53
Attention	56	52	54
Concentration	68	57	63
Information Processing	54	66	60
Motivation	66	57	62
Self Testing	36	36	36
Selecting Main Ideas	61	68	64
Study Aids	54	55	54
Time Management	70	58	64
Test Taking	58	55	57
Overall Average	57.2	56.1	

The averages are generally above the 50th percentile and we would expect this from graduate students since the inventory was normed on undergraduates. The overall averages for the two institutions are very close, but there are significant differences between the two cohorts on several scales. Scores for students on all of the scales varied from the 1st to 99th percentile for individual students.

Self-testing was considerably lower than any of the other averages. Items on this scale ask about reviewing notes after class and before the next class, and creating possible test questions as preparation for tests. With regard to test items the following were the results.

- Item 9. I try to identify potential test questions when reviewing my class material. (UB, 3.36; SB,3.1)
- Item 18. When preparing for an exam I create questions that I think might be included. (UB, 2.45; SB, 2.7)
- Item 60. To check my understanding of the material in a course, I make up possible test questions and try to answer them. (UB, 2.64; SB, 2)
- Only 25% of responses to these items were 4 or 5. (Very much or fairly typical of me.)

Conclusions LASSI results for the BD students can be summarized as follows. Overall, it is gratifying to see that these students' scores were on average more than six percentage points above the national norm—although this norm is based on undergraduate responses. We do not have a wider sample of graduate students with which to compare the data.

LASSI results confirm the position held by the AGEP and the BD programs that some graduate students have weaknesses in areas related to motivation, study skills, time management, and the like. Neither cohort of students achieved an average above the 75th percentile for any scale, a score indicating strength in that area. This implies that academic and study skill support should be available for all BD students.

These cohorts, with identical averages from the two institutions, scored low in self-testing. This might be an area in which the programs could prepare seminars or advisement.

The fact that some students scored very low in some areas indicates that this inventory or one like it might be a useful tool for the Bridge program, providing participants and advisors with information about skill and self-management areas in which students need to improve, if they are to achieve their potential in graduate school.

Best Practices Interviews, focus groups, and the LASSI survey helped uncover a number of important ideas regarding best practices in the support of minority graduate students.

1. Early knowledge about institutional requirements, departmental procedures, and courses is vitally important. Graduate students need not only orientation but on-going communications about a program's expectations and their own progress.
2. Under-represented minority students self report a number of weaknesses in time-management, study skills, and goal setting. They can profit from special classes, advising, and mentoring in these areas.
3. There are significant differences in student preparation for graduate school and consequently the use of an inventory such as the LASSI can help identify particular needs.

Survey of SUNY LSAMP Students

During the 2007-08 academic year, participating SUNY LSAMP students at six alliance sites were asked to complete an online survey. The responses provided information about student experiences with LSAMP, their studies in STEM disciplines, and their plans for the future. The data provide evidence that the activities implemented by SUNY LSAMP met student needs and helped them progress in a variety of ways. An average of more than 90% of the respondents reported that each of the following LSAMP activities were important or very important: academic support, advisement, career planning, and research placements. A detailed analysis of the survey results follows.

Participation After several email contacts with a link to the online site, a total of 82 surveys were completed. Of these, 57% were female; 43% male. Ethnicity was reported as follows: African American, 52%; Hispanic, 40%; White, 1%; Asian, 2%; Mixed, 4%. Participation by site was:

Albany, 16%

Binghamton, 17%

Buffalo, 9%

New Paltz, 9%

Old Westbury, 24%

Stony Brook, 26%

Total credits earned by respondents were reported as follows:

0 – 30, 14%

31 – 60. 22%

61 – 90, 28%

91 – 120, 36%

Majors were listed as follows, totals, not percentages: Biology, 31; Biochemistry, 4; Computer Science/Engineering, 8; Chemistry, 2; Electrical Engineer, 4; Mechanical Engineering, 3; Physics, 3; Psychology, 4; English, 3; Aerospace Engineering, 2; Education, 3; Clinical laboratory science, 2; Mathematics/statistics, 3; CIS/MIS, 2; Biomedical Engineering, 2; Chemical Engineering, 1; Engineering Science, 2; Environmental Studies, 1; Human Development, 1; Health and Society, 1.

Respondents reported that they had participated in a number of support programs in addition to LSAMP, including, CSTEP, 76%; McNair, 19%; EOP, 19%; MARC 4%; and Other, 17%. Some students mentioned the name of the coordinated support program at their institution, for example: Binghamton Success Program and Project Excel (Albany).

Choice of College Respondents selected the following as very important in their choice of college.

- Quality of program in area of interest, 75%
- New York resident tuition, 69%
- Financial aid, 69%
- Location, 63%

Program Impact, Challenges, Readiness for College, and Benefits With regard to the different activities offered by LSAMP and coordinated support programs, respondents in the following percentages indicated that the given activity had a strong impact on their progress as undergraduates:

- Summer research programs and the associated academics, 73%
- Advising, 63%
- Research experience, 63%
- Academic support, 63%

The following percentages of students indicated each factor as a challenge or major challenge.

- Academic demands of college, 73%
- Finding enough time to do all that is required, 72%
- The way some courses are taught, 58%

In response to an open-ended item asking about challenges, respondents listed the following (numbers in parentheses):

- Academics and faculty: the way some courses are taught, clarity, grading, curves, office hours, getting to know professors, (5);
- Time: management, getting everything done, not having enough time, double majoring, (4);

- Advising: getting help with schedules, majors, curses, (3);
- Social areas: making friends, meeting new people, fitting in socially, (3);
- Feeling isolated: in certain courses as a woman or minority, (2);
- Non-school: family issues, commuting, (2);

The following two quotes from students summarize what other surveys and focus groups have revealed as issues that many students experience to a greater or lesser degree:

> *Time management is one of the things I have learned most about during my four years in college. Although I thought I was good at time management as a freshman; it was something that I had to learn and experience myself.*
>
> *My college career was a time for me to explore everything out there and learn more about the world I live in. With this in mind, I overloaded myself with other activities and didn't have enough time for my studies. Finding the balance between being able to be a good student and also be involved was a major challenge for me.*

The following are percentages of students indicating “important” or “very important” for each LSAMP activity:

- Financial aid to attend this institution, 81%
- Academic support, 89%
- Social support, 73%
- Advisement, 90%
- Career planning, 90%
- Research, 91%
- Social life, 53%
- Summer internship, 73%

The following indicate student responses regarding areas of preparedness for college.

Table 1. Percent of Students Reporting Preparedness by Area

Personal Preparedness	Very Strong	Strong	Weak	

A. Academic preparation for college.	39	40	17	
B. Time management skills.	19	31	40	
C. Ability to profit from lectures.	31	41	21	
D. Ability to work with other students.	31	45	13	
E. Enthusiasm for learning.	66	28	5	
F. Problem-solving skills.	46	45	8	
G. Organizational and study skills	30	32	33	

The table indicates that the LSAMP students generally believe they are academically ready for college, but they identify certain weaknesses. These are in areas that have been stressed in the LSAMP and related programs, particularly time management and organizational/study skills. These areas have been treated in the freshman studies courses, special workshops, advisement, guest speakers, and particularly summer and academic year research programs. The student perceptions and experiences are further evidence that the programs are on the right track dealing with these areas. The success of LSAMP can be measured in part by students' growing interest in graduate school.

Students responded to an item about graduate school as follows: *Since entering college has your interest in graduate school increased, decreased, remained the same.*

- Increased, 76%
- Decreased, 3%
- Remained the same, 21%

College Life An open-ended item asked about the most exciting part of college life. Responses clustered as follows:

- People, 22. The greatest number of responses commented on the number, variety, and diversity of people, new friends, dorm life and classmates.
- Independence/Maturity, 6. Overall growth was mentioned in different ways, "The independence of the college experience has done a lot for my growth both mentally and socially. It has taught me to think and learn at a different level and also how to be more open-minded."

- Research/Interesting Labs, 5. “Having the possibility of conducting research beside a faculty member.”
- Faculty, 4. Some students spoke with feeling about connections with faculty, “The opportunity to have professors who are passionate about the course materials they teach and bringing that enthusiasm into the classroom which motivates me and encourages me to study the material in depth.”
- Academic Success, 3. Closely related to the above, several students described satisfaction in studying and learning, “The most exciting aspect of college is getting the grade for the time and energy put in for an exam or test in a difficult class, thus reassuring me that I can make it and can be academically successful. It's even more exciting when my study partner(s) are doing just as well as I am, or even better!”

The comments above were in response to an open-ended but short answer item so we would not expect and single response to cover the range of achievements and benefits gained in college. But as a totality these responses describe the traditional benefits that young people achieve in their college years.

Challenges An item following the one discussed above asked students about the more significant challenges in college life. The following were noted.

- Time management. Twenty-two students, nearly 50% of those making comments, identified having enough time to get everything done as a challenge.
- Setting and maintaining priorities, 7. This is closely related to time management. Students talked about the importance of balancing the demands of different classes as well as the demands of academic and extra-curricular activities.
- Socialization in college. Five students discussed the transition to college in general terms; several mentioned the immaturity of some other students.
- Five students mentioned the demands of a few classes or topics within classes.

Plans for the Future. The next survey item asked students what changes they had made in their plans since entering college.

- Eleven students said they had a new or stronger desire to enter graduate school. About half said the reason for this interest was their experience with undergraduate research.
- Seven students responded that they had in some way experienced a reduced interest or motivation for medical school. Most said that they had an increased interest in research and/or a desire to teach. Three said they now wanted to pursue an MD-PhD degree.
- A following item asked about immediate plans for the year following graduation. Responses were distributed as follows.
- Nineteen students said they planned to work. Some supplied reasons or circumstances: to pay college debts; to pursue their ambitions and use their skills; as a break before graduate school.
- Seventeen said they planned to apply for or attend graduate school.
- Twelve said they planned to attend or apply to medical school.

Thinking About Graduate School In response to an item asking how participation in LSAMP changed their thinking about graduate school, students identified a number of different activities, including, events such as the McNair conference in Buffalo and the AGEP conference at Stony Brook; summer research; LSAMP meetings at which graduate school is discussed; advice from faculty and research mentors. The following comments illustrate the experiences of some of the LSAMP students,

> *I realized that graduate school is very important to a successful career and research is an important part of graduate education.*
>
> *Summer research internship gave us tons of information and workshops pointed out the need for black professionals and the benefits that come a graduate and/or doctorate degree.*
>
> *Just talking one-on-one with advisors has helped me realized that medical school is not the only way to help people and that I should go with what I enjoy and not so much what people respect as a job.*

Summary Responses to the LSAMP online survey provide the profile students who are experiencing many of the traditional benefits of college. Meeting new people and making

friends is clearly seen as a very important part of college life. But learning and gaining new academic perspectives is viewed as the central purpose of college. A high percentage of students (76%) said that their interest in graduate school had increased during college.

The challenges and more demanding areas that students reported about college are closely aligned with the LSAMP priorities. Students felt a need for better time management, study and organizational skills. LSAMP has placed increased importance on these areas, particularly through the freshman skills course.

The area of socializing, networking through LSAMP and similar organizations is viewed as important particularly as related to minorities and research or professional growth. With regard to socialization in college, it appears that students find their own way in gaining new friends—through classes, dorm life, and activities.

The survey responses, therefore, reveal that LSAMP support services have been viewed as import in helping students become more engaged academically and professionally in STEM areas while also facing the challenges associated with the curricular demands of such programs.

Areas With Potential for LSAMP

There are several approaches to the LSAMP goals that were discussed in the first phase of the project. But they received a lower priority as the project proceeded. We discuss them briefly because they are being used by other projects and might be considered by those developing programs and activities with goals related to the goals and objectives of LSAMP.

- Ongoing contact with community colleges
- Recruitment and admissions;
- K-12 outreach;

Many minority students begin their college education at community colleges, and a number of these transfer to four-year institutions to continue their education. Articulation agreements are often established so that students will know that certain courses at the community colleges are comparable to those offered at four-year locations and that credits will be accepted. Open house events, mentored research, and bridging programs can also help generate interest and motivation in students so that they look forward to

continuing their education at a four-year institution. Finally, as noted above, it is important that academic and social support be available to students after they transfer—so that they can maintain their interest and success as STEM majors.

Recruitment is an area that requires discussions, with participation from a number of areas. Various competing interests surface as applications are processed, including: resources available for financial aid, interest in SAT and other scores among the entering cohorts, creating a class that has a certain enrollment distribution regarding majors, particular abilities such as athletics or music, as well as geographic distribution and other factors. With these and other institutional priorities, it may be challenging to promote interest in increasing the number of minority students in STEM areas. But that is the task that must be faced by administrators, faculty, and staff who share the goals that have been reviewed and presented in this report.

Outreach to secondary schools is more likely to achieve results in urban areas in which many or most of the students attend city or state colleges, and a concerted effort can be made to let students know about the particular programs, support systems, and funding available at particular locations. Some LSAMP sites support visits by successful college students to return to their high schools for talks with current students about colleges and the particular benefits of the institutions they attend.

Summary

The SUNY LSAMP program has been a response to student needs. As with most projects, the breadth and depth of available resources was such that decisions had to be made about which activities to support. The agreed-upon activities centered on ways to provide academic and social support to students already accepted, assisting them to major in and remain in STEM disciplines. In each of the seven activity areas identified by SUNY LSAMP we were able to identify best practices. Aware of the danger of over-simplifying we now further summarize very briefly our findings in these areas.

1. Organizational Structures. The program worked best when personnel and resources were coordinated with projects that had related goals, using the norms of efficiency and effectiveness.

2. Undergraduate Research. This is the most important activity in leading students to experience science and to consider graduate school, and the research mentor is the foundation for a profitable research experience. Available resources impose limits on undergraduate research.

3. Tutoring, Course-Related Workshops, and Curriculum Initiatives. It is important that tutoring programs provide good training and supervision for tutors, careful record-keeping, and that they encourage students to see that tutoring and participation in workshops are not simply for remediation.

4. *Process Workshops and Freshman Success Courses*. Today's college students need assistance in areas such as time management, study and test-taking skills, improved writing and group work. There are various ways in which these skills can be taught and practiced.

5. Community Building, Advising, Communications, Social Support. Minority students often succeed or fail depending on whether they find themselves in a group of motivated peers. LSAMP can help create this kind of community with on-going activities that offer advice and encouragement within a supportive social structure.

6. Interest in Graduate School Interest, application to, and entrance into graduate school depends on a variety of related factors, usually including: undergraduate research, trips to conferences and likely institutions, early preparation for GRE's and other requirements.

7. *Success in Graduate School* Success or failure in graduate school can often be traced back to an early understanding of expectations and procedures, formal and informal, that provide the framework for a program or department. Well-developed programs can help students gain this understanding.

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