ETHNOGRAPHY AND EVALUATION RESEARCH
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# Student Outcomes from the LA-STEM Research Scholars Program:

## Qualitative Results of the External Evaluation of the LA-STEM Research Scholars Program at Louisiana State University, 2007-2008

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# I. Executive Summary

Despite recent increases in graduation rates for minority students in science and engineering disciplines, non-Asian minorities are still underrepresented at the undergraduate level (NSF, 2008). The Louisiana Science, Technology, Engineering and Mathematics (LA-STEM) Research Scholars program seeks to recruit and retain talented students to science, technology, engineering and mathematics (STEM) majors, and encourage their entry to graduate degree programs. In its objective to attract and support a diverse student talent, LA-STEM also seeks to remedy the problem of the underrepresentation of minority undergraduate students in STEM disciplines at Louisiana State University (LSU).

Drawing on models of success, the LA-STEM Research Scholars program targets high-achieving students as incoming freshmen, admits them as a cohort, and provides comprehensive support, including a high-school-to-college bridging program, academic enrichment, peer mentoring, program staff support, and financial scholarships, among other structured elements. One of the primary ways in which LA-STEM seeks to recruit students to the program, retain them in STEM majors, and encourage their entry to graduate school is through early and sustained engagement in faculty-mentored research experiences (during both the summer and academic year). This strategy is a feature of similar formalized programs targeting student retention and recruitment to graduate education, especially for underrepresented groups (i.e., NSF-Research Experiences for Undergraduates, NSF-Louis Stokes Alliances for Minority Participation Program, NIH-Minority Research and Training Programs, SOAR at Xavier University, the Meyerhoff Scholars program at University of Maryland, Baltimore County, the MBRS-RISE and MARC U*Star programs, California State University, Los Angeles, etc.) That is, undergraduate research is seen as a way to foster students' interest in and ability to successfully pursue education and careers in STEM fields, and as a means to help them overcome barriers of education and opportunity.

Upon the request of Dr. Isiah M. Warner, Vice Chancellor, Office of Strategic Initiatives (OSI), Louisiana State University (LSU), Ethnography & Evaluation Research conducted an external evaluation of the Louisiana Science, Technology, Engineering and Mathematics (LA-STEM) Research Scholars Program. The scope of the external evaluation is directed at:

- independent documentation of program impacts for student and faculty participants, and for LSU as an institution and that provides other summative information concerning the degree to which program objectives are being met;

- providing formative information that may be incorporated into program assessment and further program development.

This report presents the qualitative results of our analyses of the interview data for the external evaluation and addresses student outcomes from key components of the LA-STEM Research Scholars program, including financial scholarships, the Summer Bridge

program, belonging to a community, program staff support, peer mentoring, academic enrichment courses, diversity awareness, and research experiences and their importance to students' academic success. Two separate reports for the external evaluation of the LA-STEM program present the quantitative results of surveys administered to Summer Bridge students and to students and faculty regarding the benefits of research experience (Thiry & Hunter, 2008a, 2008b).

## A. Evaluation methodology

The P.I.s Hunter and Thiry conducted a comprehensive external evaluation for the LA-STEM Research Scholars program using both quantitative and qualitative methods, including surveys, individual and focus group interviews, and on-site observation.

For qualitative evaluation, we conducted semi-structured, in-depth interviews with a range of individuals, including students, faculty research advisors, program staff, and key Louisiana State University administrators. An effort was also made to interview a comparative group of non-participating students. Interview samples were constructed from comprehensive lists provided by the Office of Strategic Initiatives (OSI) so as to balance the representation of various demographic characteristics (such as gender, race/ethnicity, and major) and also to target issues of particular interest to the LA-STEM initiative.

Interviews with student samples explored participants' attitudes toward their experiences in LA-STEM, including Summer Bridge, peer mentoring, undergraduate research, and academic and professional development courses, among others program elements. Students' were also asked to comment on the strengths and weaknesses of LA-STEM, offer advice, and to raise any issues they wanted concerning the LA-STEM program. Students' self-report of academic progress and success was also solicited. Particular attention was given to establishing the degree to which LA-STEM contributed to the development of students' career aspirations and objectives, especially in interviews with graduating seniors.

Faculty research advisors who had mentored a LA-STEM student (or students) were also interviewed. We asked them about their knowledge of the LA-STEM program's objectives and about their engagement in LA-STEM, the types of projects they chose for student researchers and their perceptions of the benefits to students of program participation, overall, and of undergraduate research experience, in particular. We also solicited any advice they had to offer directed at improving the LA-STEM program.

We interviewed LA-STEM program staff to gain their views about the program and explore how things were going. In our interviews we asked staff to provide a brief history of the LA-STEM program to better understand its context within the institution. We asked staff to talk to us about their work within LA-STEM and how they saw the program working to support students and their success. We also used our time with staff to discuss issues raised by students and to learn staff's perspectives.

Interviews with LSU administrators explored institutional factors affecting program success, such as support for LA-STEM, cultural/environmental issues particular to LSU's history, and ways in which institutional objectives (such as the Flagship agenda) aligned with LA-STEM objectives.

All interview protocols and the study design overall, were submitted for review and approved by the University of Colorado's Institutional Review Board, to ensure that the study met high ethical, professional and legal standards for research involving human subjects. Interviewees read and signed an informed consent agreement that described the study and their rights as research participants to anonymity, confidentiality, and other protections of the information they provided.

We conducted a content analysis of all interview data. In this process, taped interviews and focus groups are transcribed verbatim into a word-processing program and submitted to *NVivo 7.0*, a computer software program used for qualitative data analysis. In conducting a content analysis, the analyst reads through all of the documents—the text data—searching for information relevant to the evaluation questions. Text segments referencing distinct ideas are tagged by code names. Codes are not preconceived, but empirical: each new code marks a discrete idea not previously raised. All of the code names that are developed are collected in a codebook. When the analyst reads a text passage that relates an idea previously encountered, the same code name is reused to mark the relevant passage. Thus codes and their associated text passages are linked, amassing a data set of code names and their frequency of use across the data set. Once all of the text data is coded in this manner, codes similar in nature are grouped together to define themes; the clustered frequencies, represented as grouped themes or categories, describe both the range and relative weighting of issues in participants' collective report. The number of observations is generally larger than the number of speakers, and thus is a measure of the depth of broad topics. The number of speakers, however, is a better measure of the distribution of views on a topic. We use both types of counts in reporting results of the qualitative analyses of the interview data.

## B. Demographic characteristics of participant samples

In all, 84 individuals were interviewed regarding their experiences with the LA-STEM program.

A total of 57 students were interviewed: 49% were men and 51% were women; 46% of the students interviewed were white, not of Hispanic origin, 42% were Black, not of Hispanic origin, with the remaining 13% claiming other racial or ethnic designations. A range of majors was represented among student interview participants, including: biological sciences (21%) chemistry (18%), physics (14%) biochemistry (5%), computer science (5%), several engineering fields (chemical, biological, electrical, civil, mechanical and industrial) (cumulatively, 32%), with the remaining 6% of majors in other science and technology disciplines.

A total of 27 faculty, program staff and administrators were interviewed: 52% were men and 48% were women; 59% were white, not of Hispanic origin, 19% were Black, not of Hispanic origin, with the remaining 23% claiming other racial or ethnic designations. A range of majors was also represented among faculty research advisors who were interviewed, including: biological sciences (33%) chemistry (7%), physics (7%), computer science (7%), several engineering fields (chemical, biological, electrical, and mechanical) (cumulatively, 27%), with the remaining 20% of faculty research advisors working in other science and technology disciplines. Sixty percent of faculty research advisors were tenured (either an associate or full professor); 27% were untenured (assistant professors) and 13% were non-tenure track research faculty.

## C. Program outcomes

### 1. Student recruitment to LA-STEM and LSU

Most LA-STEM students were somewhat or very oriented toward a major in science, technology, engineering or mathematics (STEM) before entering college. However, few were so strongly committed to their field that the college and LA-STEM experience had no shaping influence on their interests. Forty-two of 47 students that we asked (89%) said that they had developed an interest in science, generally, or their major field, specifically, *prior* to entering college; about half said that they had developed their interest in the sciences prior to entering high school. Despite students' strong incoming interest in their field, more than 25% reported to us that participation in the LA-STEM program had helped them to clarify which STEM discipline to major in, or led them to change their major within the STEM disciplines, since they had entered college. (Gains in career clarification as a result of engaging in hands-on research are discussed fully in the section of the report detailing student outcomes from their research experiences.)

Students reported a wide range of academic preparedness coming into college. Slightly less than half (23) had taken honors or AP science and mathematics classes in high school, or Calculus 1. However, an equal number of students had taken no advanced classes at all during high school. A few students (5) stated that they had experience with doing science research prior to college. Despite the range in students' self-reports of the level of their science and mathematics preparedness, most students told us they felt sufficiently equipped by their high school education to handle college-level science and mathematics classes. Those few students who felt their academic preparation was subpar told us they had had limited opportunity to take quality science and mathematics classes during high school.

LA-STEM appears to be recruiting a range of students who are interested and talented in STEM fields and who typically have a solid background in science and mathematics, but who are not necessarily set on a particular STEM discipline upon entry to college. LA-STEM students expressed confidence in their high school education, their academic abilities, and readiness to take on college-level coursework. At the outset of participating in LA-STEM, some noted feeling insecure when comparing themselves to other students they met during the recruitment weekend. Many of these students, however, came to see

that factors other than high academic performance were also considered in the student selection process. Acceptance into LA-STEM itself tended to alleviate students' nervousness about being unprepared.

From students' perspective, LA-STEM isn't necessarily recruiting *only* "the best and the brightest," but are recruiting talented students with a lot of potential, many of whom might not otherwise have had the motivation, confidence, or direction, to pursue a challenging STEM major. Ultimately, the selection of students for the LA-STEM program appears to be in line with their mission to recruit highly promising students that are among "the best and the brightest," rather than concentrating on choosing only the exceptional.

Students' decisions to attend LSU were largely mediated by financial concerns and how best to support their college education. Students described the scholarship monies available through the LA-STEM program as being competitive with funding packages offered by other universities who were also trying to attract high-achieving students. The level of scholarship funding made available by LA-STEM scholarships had a major influence on students' choice to attend LSU. Beyond financial support, students most commonly cited the opportunity to do research as a strong reason to accept the LA-STEM scholarship and attend LSU.

2. Summer Bridge

The LA-STEM program incorporates a high school-to-college bridging program that brings incoming LA-STEM students to campus the summer prior to the start of their freshman year. During the Summer Bridge program, students are housed together in close proximity and involved in a series of social activities, academic workshops, and college coursework. The goal of the Summer Bridge program is to ease students' transition to a large campus environment and encourage their integration into campus life by building a strong community among LA-STEM students, program staff and participating faculty members.

Students valued the Summer Bridge program for the very reasons this element was incorporated into the structure of the LA-STEM program to begin with: it helped ease students' transition to a large campus environment and encouraged their integration into college life by building a strong community among LA-STEM participants, faculty members and program staff. Living and socializing with each other on a daily basis for a sustained period built camaraderie, friendships and personal support among group members. Opportunities to meet faculty, hear about their research and to visit local scientific laboratories encouraged students' interest in doing research themselves and widened their view of future career possibilities. Students appreciated the chance to experience their first college-level courses and to understand what was expected of them in a more measured way before taking on a full course load. Many also recognized the benefits of earning "extra" course credits that would allow them to advance faster or the time and flexibility to take courses that might otherwise slow their academic progress. Students also reported that they benefited from workshops on time management, study

skills, presentation and public speaking, learning styles, and long-term goal setting. These skills improved their academic performance.

3. Mentoring

One of LA-STEM's major goals is to provide student scholars with mentorship from a variety of sources throughout their tenure at LSU. Broadly, the program seems to be reaching this goal, although perhaps not as deeply as they could in some areas.

*a. Research advisors*

In a later section of this summary we present student outcomes from participating in research experiences. Here we characterize the structure of students' research experiences with their research advisors.

As is common at a large research university, most students reported working closely with a graduate student, rather than with a faculty member; just seven students reported working one-on-one with their faculty research advisor, rather than with a graduate student, though another five told us that they had formed good, working relationships with both their faculty research advisors and the graduate students who directed work in the lab. Three students reported working in a large research lab; four said that they worked in a small lab group; only five mentioned working directly with other undergraduate researchers. Overall, a majority of students described positive, authentic research experiences and working with advisors who provided appropriate guidance. Many students viewed their research advisors as mentors. However, by some accounts, the depth and degree of mentorship that students received from their research advisors varied greatly. Two students reported that their research advisor did not provide any form of direct mentorship.

*b. Peer mentors*

Peer mentoring is an element purposely structured into the LA-STEM program. Functions of peer mentoring, like Summer Bridge, are to help ease students' transition to college and to support academic success. In this respect, peer mentorship clearly contributed to students' positive experiences within the LA-STEM program. More than one-third of students' comments about mentorship (during Summer Bridge and the academic year) mentioned ways in which peer mentors helped support them, academically and socially. Peer mentors played a critical role in helping newer students find their way. Students described their peer mentors as providing valuable advice about what to do or not do, and how best to do it—as a great ally. The majority of students reported positive experiences with their peer mentors, only a few mentioned that their peer mentor was unhelpful (either because the mentor majored in a different discipline or performed poorly academically) or that they did not have a peer mentor.

Largely, students reported that their peer mentors had served as a role model and detailed the qualities of a good mentor and ways that peer mentors were most effective; this

knowledge would be passed down in practice. Peer mentors provided a social connection that supported their mentees both academically and socially. Overall, peer mentors worked effectively to help students negotiate a successful academic pathway.

Some students had less successful peer mentoring experiences than others. A few students told us that peer mentors were hard to take seriously because they did not have much more experience than the mentees themselves, were not very good students, or were otherwise unprepared to be mentors. Some older students told us that they had relied on their peer mentors early on in the program, but that their need for peer mentoring tended to drop off as they had advanced in their course work and gained experience in college, generally. A few students told us that they did not have peer mentors. Three students told us that their peer mentor had left the program early and had not been replaced by another. The two other students were not aware of having been assigned peer mentors and although they seemed interested in having a peer mentor, were unclear about how to find one.

*c. LA-STEM program staff*

Strong support from program staff is another element intentionally structured into the LA-STEM program. Most of the students who talked about the LA-STEM staff told us that they had received academic support from the program managers and it was widely felt that the managers were accessible, helpful, and motivating. Many students mentioned they had weekly meetings with program staff. These meetings were especially helpful in the early years of college. Students told us they appreciated that LA-STEM program staff kept close, sustained track of their progress and would not let them "slip through the cracks." Strong academic and personal support offered by friendly, caring, and resourceful program staff were cited by students as highly positive aspects of the LA-STEM program. Students often described program staff as mentors who were active and pro-active in helping them to succeed, supporting them both academically and emotionally.

The only negative observations related to program staff concerned turnover in program managers, not poor performance. Indeed, the feelings of loss that students' described indicate the success of program staff in their support of the LA-STEM students. Students' from all cohorts described program staff as being "like family" and how their interactions encouraged a strong sense of belonging among a supportive community. As we discuss below, students' also credited program staff for helping them to persist in their STEM major.

*d. Faculty mentors*

The role of a faculty mentor within the LA-STEM program, as the evaluators understand it, is to provide academic counseling to LA-STEM students majoring in their science discipline, performing much the same function as a department advisor. However, students were almost entirely unaware of faculty mentors within the LA-STEM program. One student told us her faculty mentor had been instrumental in helping her find research;

a few students thought they were supposed to have one, or were waiting to get one; no other students could tell us about "faculty mentors." Given the dearth of responses to our questions, this area of the LA-STEM program requires strengthening.

*e. Being a peer mentor*

Peer mentoring is purposely structured into the LA-STEM program to support incoming students, provide leadership opportunities, and share ownership and responsibility for program success with the participant "experts" themselves. Students' reports of acting as a mentor to a younger LA-STEM student were very positive. Participating in LA-STEM as a peer mentor brought many benefits. Students appreciated their role as an expert who could counsel against pitfalls and offer practical advice and personal support based on their own lived experience. Peer mentors valued giving back to the LA-STEM program by helping and advising their peers. Through the process, they recognized how far they had come in their own personal and intellectual growth since they first started the LA-STEM program. Many reported gains in confidence and in leadership skills, learning patience, and becoming more mature. The bonds built between mentors and mentees reinforced their feelings of belonging to a community committed to supporting one another. Very few reports were offered concerning negative experiences as a peer mentor.

4. Educational Support and Professional Development

In addition to research, mentorship, and a community of learners, LA-STEM also provides its students with more direct education about how to succeed. Here we present results concerning program elements geared toward improving students' grades and the quality of their educational experience as undergraduates and program elements specifically intended to help students learn about, apply for, and gain acceptance to graduate school.

In discussing educational support and professional development through the LA-STEM program students reported the following gains:

- Encouragement during the academic year to do research
- Increased academic success, including being part of a community of learners, the program's GPA requirements, increased awareness of support services on campus, Individual Development Plans (IDPs) , LA-STEM weekly classes, and skills learned in LA-STEM that were transferable to classes and studying
- Diversity awareness, and
- Support to persist in their STEM major and increased interest in pursuing a graduate or medical degree

*a. Encouragement during the academic year to do research*

The LA-STEM program was effective in introducing students to the concept of research and the role played by research in contributing to our collective knowledge and the betterment of society. Though some students resisted the notion of having to do research

at first, most were very glad they did. We heard from many students that one of the greatest gains they had gotten from their participation in LA-STEM was the opportunity and encouragement to do research. For the most part, students told us they would not have known undergraduate research was possible had it not been for LA-STEM.

*b. Increased academic success*

Many students also indicated that participating in LA-STEM had a direct positive impact on their GPAs. Students attributed their academic success to: being part of a community of learners that supported a culture of achievement; high expectations set by program staff and the GPA requirement; and awareness of and access to academic support and other resources on campus.

As outcomes of the required weekly classes, students generally reported gains in time management and study skills, and in working collaboratively as a group and said that sessions offering professional development, particularly GRE preparation classes and information on and help with selecting and applying to graduate school, were very useful and supported their academic success.

While most reported that the weekly classes and peer mentoring sessions were very helpful and contributed to building community among LA-STEM students, of all topics raised, IDPs and weekly classes received the highest number of student comments relating mixed or negative views on the value-added of these LA-STEM program elements. These observations came largely from juniors and seniors who felt that, while the classes were helpful the first (and maybe even the second) year, after that, the courses were simply repetitious, redundant and of little or no benefit. These students often spoke with a sense of frustration: they wanted to comply with program requirements, but they no longer derived any value from the classes and couldn't see the sense in "wasting their time," especially in light of difficult and heavy course loads so common in STEM majors. It was commonly known that some students purposely created scheduling conflicts in order to avoid taking the classes. If there were new course content relevant to them, junior and senior students acknowledged their resistance would be much less.

*c. Diversity awareness*

Encouraging students from diverse backgrounds to enter and succeed in STEM fields is one of LA-STEM's most important program goals. Students were largely aware of this and, although they had mixed opinions about how it was implemented, most students we talked to agreed that the focus on diversity is an important part of the program. A majority of students' observations about the diversity-related aspects of LA-STEM were positive. Students told us that participating in LA-STEM had increased their awareness of and comfort with diversity and that many of the diversity training activities undertaken during Summer Bridge and weekly classes were helpful and enlightening. Students felt that living, working, and being encouraged to spend time with others from different backgrounds had helped foster a greater respect for difference in themselves and others.

Others had mixed feelings about the diversity activities, telling us they were ultimately helpful but also felt somewhat forced. Of the few negative comments about LA-STEM's diversity focus, most also centered on the program's diversity training activities as feeling heavy-handed. By and large, students seemed to consider both diversity and diversity awareness valuable, and were more often turned off by the format of diversity awareness sessions than by the content. However, they most frequently spoke about this aspect of LA-STEM in abstract and somewhat vague terms. Students tended to describe ways that LA-STEM assisted *other* people and groups in the abstract, rather than how it had benefitted them personally or assisted other students they knew, even when the students being interviewed were themselves members of an underrepresented group.

In addition to increasing diversity awareness among all students, LA-STEM tries to invest in the success of students from underrepresented populations. Students were aware of this, considered it important, and largely saw the program as being successful in its goal. Some students, including women, first-generation college students, and students of color, did tell us about ways that LA-STEM had helped them personally overcome institutional obstacles and successfully navigate the college experience. They appreciated LA-STEM's role in helping them to achieve their goals.

*d. Support to persist in a STEM major and increased interest in pursuing an advanced degree*

Based on their own accounts, there is evidence demonstrating that LA-STEM has helped students to persist in their STEM majors and influenced their decision to seek a graduate degree. A number of students (8) told us that strong support from program staff had played an important role in helping them to persist in their major when they might otherwise drop it due to academic or personal difficulties. Several students (12) told us that being a part of LA-STEM had strengthened their interest in going to graduate school, shown them a wider world of career possibilities, and increased their confidence in their ability to do science and to be accepted to and succeed in a PhD program. For many of the upper-division students, participating in LA-STEM had helped them clarify their field of interest and confirm their decision to pursue a STEM career. A number of students also told us that LA-STEM was their first exposure to what pursuing a PhD actually entailed and what working as a professional scientist might be like. Other ways that students told us LA-STEM supported their graduate school aspirations included preparation for and information about applying to graduate school, encouragement to pursue opportunities that strengthen a graduate school application—such as research and national competitions—and the opportunity to network with other students and faculty. The majority of graduating seniors we spoke with planned to go to medical school (8); two were going on to a STEM PhD program, and another was as yet uncertain whether he or she would go to medical school or pursue a PhD. The majority of graduating seniors we spoke with indicated that they had entered LSU and LA-STEM with the goal of going to medical or graduate school.

## D. Outcomes from undergraduate research

Our research to establish the benefits to students of undergraduate research experiences identified and detailed a comprehensive array of types of gains that fit six categories: personal-professional gains, intellectual gains, gains in professional socialization, gains in skills, enhanced preparation for graduate school and work, and career clarification and confirmation (Seymour, et al, 2004; Hunter, Laursen & Seymour, 2007, 2008). These same categories were used in analyzing and structuring the findings of these qualitative data to determine student outcomes from participating in research and the contribution of research as a program element in helping to attain LA-STEM's stated goals.

Students most commonly described personal-professional benefits from participating in research (22% of observations). These benefits included establishing collegial working relationships with their research advisors and with other research group members and increased confidence to carry out research work. Another 18% of students' observations mentioned gains in understanding how science research is done. In this set of comments, students discussed their intellectual gains: learning through applying their knowledge to hands-on research work, increases in their critical thinking and problem-solving skills, and extending their knowledge and making interdisciplinary connections (gains in "Thinking and working like a scientist"). In almost equal measures, students also described how research experience enhanced their preparation to undertake graduate-level work (16%), provided various skills (16%), informed a more realistic understanding of the nature of research work and brought about changes in attitudes and behaviors necessary to working in research (15%) (the "Becoming a scientist" category), and served to clarify and confirm their pre-existing career intentions (14%). In terms of numbers of observations, students' comments show a balance among a variety of personal, professional, intellectual, career clarification and skill gains.

We also looked at the actual number of students reporting a particular gain to assess outcomes from undergraduate research experiences.

A majority of students described positive research experiences in which they developed quality working relationships with their research advisor. In the process of doing research, students gained familiarity and facility with technical laboratory skills and instrumentation needed to carry out the research. These opportunities helped students to feel more confident in their ability to do research. In addition, as a result of engaging in authentic research, a majority of students developed a higher-order intellectual gain: a clearer understanding of the nature of research work—that it is slow, repetitive, and that setbacks and failure are par for the course.

Between one quarter and one half of students reported a majority of gains across the six benefits categories, including: understanding how research is done; the transfer of learning between research and classes and the increased relevancy of coursework; improved critical thinking and problem-solving skills; gaining an understanding of how scientists work professionally; gaining a more mature understanding of how scientific knowledge is built; improved presentation skills, understanding how to design and carry

out research; and changes in behavior indicating their growth as young professionals, among many others.

Benefits mentioned less frequently by fewer numbers of students reflected particular differences in research experiences, such as whether or not a student worked in a group setting, working in a specific disciplinary field, or whether students had enough sustained engagement to achieve longer-term outcomes, such as learning to defend one's research, presenting at a professional conference, and being listed as a co-author on a publication.

Some students did report instances of poor quality research experiences—some at LSU, but mostly at host institutions. Common elements of poor research experiences included: little or no guidance and mentoring from the research advisor, being assigned only menial work tasks, being academically underprepared to understand or meaningfully contribute and finding one self better suited to other interests and work tasks.

## E. Research Advisors Views on LA-STEM and Mentoring Undergraduate Researchers

We interviewed a sample of 15 faculty research advisors associated with LA-STEM to explore their experiences with and views about the program. We asked research advisors: to describe their engagement with LA-STEM (i.e., their role and how long they had been involved, how many students they typically work with, whether they conduct research with students during the summer, the academic year, or both, etc.); about their knowledge of LA-STEM's objectives and of the program, generally; how they selected students to work with; to describe the types of projects students work on; how they typically worked with students; what they observed students gain from doing research, and about the benefits and costs of directing LA-STEM students, to themselves, their department or to LSU.

### 1. Research advisors' engagement with LA-STEM

Research advisors with whom we spoke had been involved with LA-STEM different lengths of time, though the range of their participation, overall, is balanced across the four-year history of the LA-STEM program. Several research advisors had started more recently, while others had directed LA-STEM students since the beginning of the program. One research advisor couldn't recall when he started participating: he was involved in so many undergraduate research programs, he couldn't distinguish them. One faculty member who directed undergraduate research reported that he had no prior experience with the LA-STEM program, though he had heard of it. Finally, two of the research advisors we interviewed said that they were not currently working with a LA-STEM student.

Beyond directing LA-STEM students in research experiences, a few research advisors mentioned other ways in which they had participated in LA-STEM, such as giving a presentation of their research to students during Summer Bridge, and serving on a panel about graduate school and STEM career options, among other types of involvement.

All research advisors reported working with students during the summer as well as the academic school year. About half of research advisors reported working with one or two students per semester; some said that they routinely worked with groups of students of three or more. While one reported working in a very small lab, without a lab technician, half of the research advisors directed larger research groups with graduate students and paid hourly workers. Half of the research advisors said that, typically, their students had sustained engagement on the same research project both during the summer and the academic year and longer-term student involvement of two or more years.

2. Knowledge of LA-STEM's objective and general knowledge of the program

A majority of the faculty research advisors with whom we spoke were aware of LA-STEM's objectives to recruit talented students to STEM majors, retain them, and encourage their entry to STEM graduate degree programs. Overall, however, they knew little about the LA-STEM program. As a large research university, LSU had multiple, overlapping undergraduate research programs operating across the campus, and including several large research centers. Given the "alphabet soup" of program names (LABRIN, LSAMP, NSF REU, HHMI, etc.) many acknowledged it was nearly impossible to keep them all straight. In fact, several research advisors were not entirely clear which programs sponsored which of their student researchers.

3. How research advisors select students to work with

Two-thirds of the research advisors told us that students had approached them and requested to work on their research. One of the research centers had hired a director to manage student researchers and those interested in a position at the center applied to him initially. Two research advisors said students from their classes approached them for work and two said that colleagues had recommended students seeking research positions. One advisor, who in the past had grant monies supporting UR opportunities for students from underrepresented groups, told us that he recalled approaching particular students to ask whether they would be interested in working on his research. In all cases, the research advisor and student discussed the project to see if there was a good match between the student's interest and the project.

4. Defining a student research project

Research advisors were in common agreement about the types of research projects they had their students work on. On the whole, research advisors developed projects related to some facet of their own work with the goal that results would inform their research. When asked to describe the types of projects they assign to students, two-thirds of the research advisors said that they were careful to structure the project to accommodate students at their level and to meet students' own objectives. Working with first-year students as novice researchers required advisors to carefully scaffold students' learning and level of participation. Half of the research advisors were also concerned to structure a project likely to produce results in the limited time available while taking into account students' abilities (and constraints). In reviewing advisors accounts of the types of

projects they had students work on and of the activities in which students were engaged, it is clear that, to the extent possible and appropriate, students were engaged in authentic, original research. There was only one account in which an advisor described a student doing "slave labor." In this instance, the advisor moved the student onto a "real research project" once he saw her initiative and talent.

5. How research advisors work with students

Research advisors described various ways in which they managed research with students. Four said that they worked with student researchers "one-on-one." Two-thirds of research advisors began (or had their graduate students begin) by familiarizing students to the laboratory, training them on equipment, and showing them how to do basic techniques. Whether working with a student one-on-one, in pairs, or in groups, a majority of research advisors described engaging students in conversations about the research, giving "mini-lectures" when necessary, and providing appropriate instructions and direction so that students could carry out the work as. Some research advisors working with multiple students or a lab group utilized peer learning, where more experienced, senior student researchers trained and mentored incoming, novice students. About one-third of the advisors we spoke with said they met with students weekly and a few mentioned that they held group meetings on a weekly basis so that members could check in with one another and report progress, and also to make sure that everyone was on track and heading in the right direction. Beyond directing and overseeing students' research, about one-third of advisors discussed helping their students put together a poster for an end-of-summer undergraduate research symposium and spending time to develop students' professional writing skills.

## F. Faculty research advisors views on students' gains from research experience

We asked faculty research advisors to comment on what they saw their LA-STEM students gain from their research experiences. Their responses, however, were directed at gains to students, generally, rather than at LA-STEM students, specifically. Nonetheless, the gains they mentioned matched the types of benefits identified in recent research and evaluation studies exploring the benefits to students of undergraduate research experiences and we can reasonably expect that LA-STEM students also make these types of gains. Indeed, LA-STEM students whom we interviewed provided much more comment and detail on their gains from research experience compared to the research advisors.

As with our analysis of students' assessments of their benefits, we used the gains categories developed in our research to analyze and structure faculty research advisors' observations. While research advisors' addressed the range of benefits, the number of comments offered is relatively low. Because the number of observations is small, it is difficult to draw meaningful conclusions from advisors' observations, other than that they support the view that research experiences contribute to students' personal, intellectual and professional growth.

A majority of research advisors agreed that research enhanced students' preparation by giving them the opportunity to experience hands-on research and do the types of work one would be doing as a graduate student. Some advisors mentioned the advice they gave students about graduate school and being able to write letters of recommendation as benefits. A few also noted that research experience and opportunities for professional development (presenting and/or writing) gave students an edge when applying to graduate schools.

Various skills are commonly cited by faculty as benefits of research experience, particularly gains in learning how to communicate research results through presentations of their research and for some with an assigned writing task, improved writing skills. Advisors also saw students' benefit from learning laboratory techniques and how to operate various instruments. A couple said students learned better how to manage their time as a result of research experience.

Research advisors recognized that, as a result of research, students gained a clearer understanding about the nature of research work and developed awareness that temperamental traits, such as patience and perseverance, are necessary. A number of advisors said that doing research and working with graduate students gave students greater insight into how science is practiced day-to-day. Some also referenced changes in students' behaviors and attitudes which they saw as "markers" of students becoming scientists.

Research advisors were aware of the personal-professional gains that students take away from their research experiences, primarily establishing collegiality with other group members, including graduate students. They appreciated the camaraderie and conversations about science that the group environment engendered. Some research advisors noted longer-term gains, including establishing a working relationship with the advisor or a wider sense of belonging to a community. A few advisors also commented on students' increased confidence to do science and growth in maturity as outcomes of research experience.

For gains comprising the "Thinking and working like a scientist category," research advisors' mostly observed improvement in students' understanding of how research is done and in their ability to bring their knowledge, critical thinking, and problem-solving skills to bear on real research questions. Some noted that students had gained deeper conceptual knowledge and that these knowledge gains transferred between research and course work. Only a couple advisors noted higher-order intellectual gains, such as students' learning research design or increased understanding of the open-ended nature of scientific knowledge.

Research advisors offered the fewest observations concerning ways in which research experience helps students to clarify their career intentions. The majority of advisors' comments described how research experiences provided students a first-hand opportunity of what research is like and to assess the fit between their interests and temperament and the realities of day-to-day work. Students, advisors observed, discovered whether or not

"research is for me." A few advisors said that research had increased students' interest in and enthusiasm for science.

In sum, research advisors most commonly described ways in which research experience prepared students for graduate school and taught them the nature of research work—that research work is slow and often frustrating and that setbacks are par for the course. Nearly half commented on the benefits to students of improved communication skills (including presentation and writing skills), establishing collegial relationships with group members, increased confidence to do research, and the opportunity to assess whether or not they like and are suited to a career in science research. Over two-thirds of advisors' observations across the range of benefits were offered by one-third, or fewer, of the advisors with whom we spoke, showing that advisors were aware of a wide variety of benefits generated by research experiences.

## G. Reports of poor research experiences with students

Advisors recalled more and less successful experiences of directing students in research. A majority of advisors mentioned problematic research experiences working with students who lacked interest in and motivation to do research, including accounts of working with "A" students who, it turned out, lacked critical thinking skills and the willingness to take initiative, or students who just wanted an item to list on his or her résumé. Two-thirds of advisors also reported instances where students were underprepared to take on the science of the research and advisors struggled to re-structure projects to better fit students' knowledge and skill levels. Two advisors noted times when they ran into problems with the way graduate students had directed students. One advisor reported directing a student in a research project outside his area of expertise as problematic. One other advisor reported a poor research experience not related to problems with students—a summer plagued by technical difficulties.

## H. Advisors' views on the benefits and costs of directing students in research

In describing the benefits of directing students in research a majority of advisors said that they benefited from students' help and that students' work contributed positively to their professional scholarship and career advancement. In addition, a majority of advisors reported intrinsic gains from directing students in research: students were fun to interact with, and despite the time and effort it required, seeing students grow as researchers and as young adults was described as very rewarding; a couple of advisors gained satisfaction in the knowledge that they were helping to "bring up" the next generation of scientists. One commented on long-term friendships he had enjoyed with former research students.

Overall, a majority of research advisors, and their comments, described the costs of directing students in research in terms of the time and effort it required: student research is time-intensive. Getting students set up, giving them information, directing them, answering their questions—namely, educating students—requires a large time commitment. Almost all advisors agreed that working with students slowed them down,

and several felt they could get their work done faster *without* students' help. The time spent setting up the research and training the students might not pay off. Directing students in research required advisors' extra time and effort and added to the pressures of balancing other professional commitments, such as writing up research results for publication or putting together grant proposals to secure further research funding. One advisor acknowledged that directing students in research also made it difficult to balance his personal with his professional life. For a few advisors, covering expenses associated with the students' research was a real cost of directing students in research.

## I. The Faculty Rewards System

In talking with advisors about the benefits and costs of directing students in research work, we asked whether the department or institution rewarded them in any way for this out-of-classroom work with students. Advisors were clear that they received no departmental or institutional reward for directing students in research work. By advisors' own accounts, directing students was largely seen as directly benefiting their research productivity, which increased the likelihood of publishing results and securing grants, and thereby their tenure and promotion. A majority of advisors emphasized that a strong "publish-or-perish" imperative governed the rewards system at LSU. Half of advisors' mentioned being stressed for time in trying to get everything done, not only on a daily basis, but also in terms of tenure and promotion. A number of advisors said it would be nice to receive some recognition for their work directing students in research, but others said no reward was necessary for their work. One advisor recommended against any formal award saying research with students has to be something the faculty member wants to do and instituting a reward of some kind would change that.

## J. Formative feedback

In our interviews we asked students and faculty to offer their advice on how to improve the program. We note that in following up with program staff on issues raised by students, that they were all well aware of students' views. Indeed, in the time between our first and second site visits, a LA-STEM student volunteer council had been assembled to work with program staff to come up with solutions collaboratively. Students were glad to have a voice in the process and felt program staff were open to their input.

Formative feedback offered by student and faculty interview participants to improve the LA-STEM program includes:

- Reassessment of the number of diversity activities during Summer Bridge;
- Greater attention paid to the level and relevancy of faculty research advisors' presentations and presentations given during field trips to local research laboratories;
- Considering optional attendance in weekly required LA-STEM classes for more senior LA-STEM students who have previously participated in them, or incorporate new relevant, content;

- Allowing peer mentoring sessions to be held in alternative settings to allow for more comfortable and private group interaction;
- Establishing a database of campus UR opportunities that can be accessed by faculty and students to facilitate the advertisement of available research positions and aid in matching students with faculty research mentors;
- Providing faculty research members additional information about the purpose and objectives of the LA-STEM program, LA-STEM program requirements for its OSI REU students, resources on how best to choose UR projects for students, and guidelines for effective mentoring;
- A LA-STEM publicity campaign at LSU should be considered to raise the profile of the program and advertise the awards and accomplishments of LA-STEM students
- Monitoring of the growth the LA-STEM program and the degree of community cohesion
- Hiring of additional program staff to support the expansion of the LA-STEM program, including one staff member who would be available to students outside regular office hours.

## K. Interviews with Program Staff

As part of this external evaluation we interviewed LA-STEM program staff to gain their views about the program and explore how things were going. In our interviews, we asked staff to provide a brief history of the LA-STEM program to better understand its context within the institution. We asked staff to talk to us about their work within LA-STEM and how they saw the program working to support students and their success. We also used our time with staff to discuss issues raised by students and to learn staff's perspectives.

We found program staff knowledgeable and professional in all respects. They all clearly understood LA-STEM's program objectives, described their work responsibilities in detail, and offered evidence of and insights into the ways in which the LA-STEM program helped support students' success. Interviews with program staff showed that they were actively working to implement improvements to the program based on formative feedback and with students' input.

They described LA-STEM as a program providing multiple elements of support with the objective of meeting student needs at every level. The Summer Bridge program eased students' transition to college life and built a sense of community among LA-STEM members. Given the history of race in the south, that many students in the LA-STEM program were in racial minorities on campus, and that some students had little experience interacting routinely with others outside their own race or ethnicity, diversity training was developed to address issues unique to LSU's context. Training in diversity awareness, diversity within the LA-STEM program, and program support particularly for students from underrepresented groups, were described as important program elements that addressed students' needs.

Ongoing peer mentoring and strong support from program staff directed at keeping students on track—and from falling through the cracks—were elements also seen as playing important roles in promoting students' success. Academic enrichment and professional development, and access to campus resources ameliorated difficulties students encountered due to under-preparedness. Introduction to what research is and exposure to wider career possibilities (especially outside of medicine) and opportunities to engage in authentic research were considered central to achieving program objectives to retain students in STEM majors, and encourage and prepare them to go on to STEM PhDs.

Program staff acknowledged that strong leadership from Dr. Warner—his passion and dedication—was a driving force behind LA-STEM and, as a role model, inspired students to succeed. From our interviews with program staff it is clear that they are committed, well-qualified, professional and action-oriented: certainly important elements contributing to program success.

Finally, program staff recognized that strong financial support of "the best of LSU" attracted talented, high-achieving students who might otherwise go elsewhere and provided support for students who otherwise would have to work to supplement their educational costs and, therefore detract from students' academic performance.

Overall, program elements operated as a network of student supports. Multiple elements were structured into the LA-STEM program, and staff's accounts demonstrate the ways in which, individually, and as an articulated whole, program elements support students' success in STEM majors and encourage their interest in pursuing STEM PhDs.

## L. Benefits to Louisiana State University from the LA-STEM program

Across interviews with program staff and administrators we asked how LA-STEM fit into the institutional context of Louisiana State University and whether LSU derived benefits from the LA-STEM program.

Program staff said that the LA-STEM program, even within its short history, was already gaining a prestigious reputation. For instance, we were told that applications to LA-STEM were now coming from across the US and that the program was attracting students considering top-ranking research universities. Program staff also told us that faculty were actively seeking out LA-STEM students to work with. They also reported that research faculty at campus and nearby research centers where LA-STEM students had conducted research were routinely reporting back that they were impressed with the students they had worked with and described them as having graduate-level skills and abilities. Being known for having high-caliber science students was seen as helpful in supporting LSU's mission to attract talented science faculty. The LA-STEM program also exemplified LSU's goal to strengthen undergraduate education.

In talking with program staff and administrators it was clear that LA-STEM program was seen as a central support to LSU's mission to fulfill the objectives set out in the Flagship

Agenda. Administrators, particularly, were clear in expressing the many ways in which the LA-STEM program supported LSU's institutional goals. In attracting talented and highly-motivated students to the STEM disciplines, LA-STEM directly contributed to LSU's commitment to raising the status of the institution and thereby helped to recruit desirable faculty to LSU and build stronger departments as well.

However, more importantly, with its objective to promote the success of students from underrepresented groups, the LA-STEM program was also seen as supporting LSU's mission to redress historic racial inequalities in higher education in the south by increasing the representation of diversity on its campus and encouraging a racial climate and providing the resources necessary to supporting the success of students from underrepresented groups.

Insofar as LA-STEM program objectives were well aligned with LSU's Flagship Agenda, positive program and student outcomes from LA-STEM were seen as directly benefitting LSU. Our final site visit occurred in the spring, approximately two months prior to the graduation of the first LA-STEM cohort: the LA-STEM program's first opportunity to demonstrate hard outcomes for student retention and recruitment to graduate school.

## M. Program sustainability

Faculty, program staff and administrators were asked to comment on those factors they saw affecting the sustainability of the LA-STEM program.

When asked if they thought they would continue their participation in LA-STEM, ten research advisors offered an unqualified, "Yes." Another two said they wanted to *increase* their involvement in LA-STEM. Another two said they would continue to be involved, but would not actively seek out students to work with. One said that, due to tenure pressures, he would likely limit his involvement.

In commenting on the extent that other faculty in departments mentored students in research, it was evident that there was a quite a range. Two faculty said that they were the only members of their department working with undergraduates. Six said that one or two of the faculty in their departments directed students in research. Three said that their departments supported research with students. One of the research centers on campus required its faculty to work with undergraduates. In general, it was thought that there were enough STEM faculty at LSU to sustain undergraduate research.

Not surprisingly, sustainability of the LA-STEM program was solely predicated upon the success of acquiring adequate and ongoing funding. Senior program staff had taken the initiative to write proposals to secure funding to establish LA-STEM, and writing grant proposals remained a primary strategy for sustaining it. However, given the inability to guarantee that a proposal will be funded, the sustainability of LA-STEM on this basis alone remains an open question.

We raised the issues of institutional support and sustainability of the LA-STEM program with LSU administrators with whom we spoke. They expressed strong support for the LA-STEM program. Situating LA-STEM within the higher ranks of the LSU administration—in the Office of Strategic Initiatives and overseen by a Vice Chancellor—clearly indicated this program's importance to the university. Administrators reiterated the ways in which LA-STEM's program objectives aligned with those of the institution and said that funding invested in the Flagship Agenda and other STEM initiatives on campus (in mathematics, engineering and computer science) demonstrated institutional support and ongoing commitment to the success of the LA-STEM program. Given the industry base of Louisiana and state and national concerns to prepare a scientific workforce that includes greater diversity, administrators agreed that the LA-STEM program made it fundamentally easier to substantiate requests for funding when approaching the state legislature.

## N. Reproducibility of the LA-STEM program

Program staff and administrators were asked to offer their insights on whether and how LA-STEM, as a model program, might be reproduced at other campuses with similar objectives. Program staff and administrators agreed that the LA-STEM program was reproducible at other institutions with similar objectives. Program staff did warn that it was important to take into consideration local institutional and student needs to develop or adapt relevant elements (i.e., diversity training within LA-STEM). Program staff and administrators cited one element as particularly critical to program success and difficult to replicate: the highly-dedicated, prestigious leadership of Dr. Warner.

## O. Conclusions

Qualitative analysis of our conversations with students, faculty, program staff and administrators indicates that the LA-STEM program is effective in meeting a range of program objectives and also that structured program elements contribute significantly to the support of students' academic success. Because the LA-STEM program is based upon theoretical and program models that seek to improve student retention and persistence in STEM fields, we reference other relevant research and evaluation studies framing findings from this evaluation.

Model programs, such as LA-STEM, incorporate structural elements founded upon grounded theoretical research on student retention and persistence to graduation. Such programs focus on students' academic and social integration into campus life by building community among members (Stoecker, Pascarella & Wolfe, 1988; Tinto, 1987, 1993; Astin, 1982, 1992; Astin & Astin, 1992; Pascarella & Terenzini, 1991, 2005; Seymour & Hewitt, 1997). The academic and social integration of underrepresented groups into scientific life is especially important because these students often lack prior access to experiences and opportunities that presage membership in a scientific community (Dryburgh, 1999; Mulkey & Ellis, 1990; Lewis, Ginsberg, Davies & Smith, 2004; Nettles & Millet, 1999). Further, high-achieving students from underrepresented groups may be

isolated from their peers and the development of peer support networks for these students is essential (Fries-Britt, 1998; Wilson, 2000).

The LA-STEM program shares many common elements with other comprehensive support programs that seek to improve student retention and persistence in STEM majors, particularly for students from underrepresented groups. Structured elements in the LA-STEM program address key factors identified in the research literature as affecting underrepresented groups, such as inadequate academic and social integration, knowledge and skill development, support and motivation, and advising and monitoring. An examination of twenty exemplar programs designed to recruit and retain minority undergraduate STEM students demonstrated that most concentrated on five major areas of support: mentoring, financial support, academic support, psychosocial support (e.g. counseling, building a sense of community among participants, family involvement, etc.), and access to professional opportunities, such as research or internships (Gandara & Maxwell-Jolly, 1999; see also Tsui, 2007). These program elements were similarly identified by LA-STEM students and program staff as contributing to students' academic success.

LA-STEM has been successful in recruiting a diversity of talented and highly-motivated students, who are intrinsically interested in science and want to pursue STEM majors. Students' choice to attend LSU was highly influenced by LA-STEM's financial scholarships and early opportunities for undergraduate research. Similar programs and research have found that sufficient financial support of students was an important factor affecting retention and persistence (Pascarella & Terenzini, 1991; Astin, 1993; Maton, Hrabowski & Schmitt, 2000; Maton & Hrabowski, 2004; Barlow & Villarejo, 2004; Building Engineering & Science Talent (BEST), 2004; National Research Council, 2005).

LA-STEM students were very positive about their Summer Bridge experience, particularly the peer interactions and sense of community fostered by the program. The large majority of students were glad to have participated in Summer Bridge and some said that Summer Bridge was "the best thing" about the LA-STEM program. In fact, the personal and social benefits of participation in the Summer Bridge program were the most valuable aspects of the experience, according to students. Though students did not always value individual components of the summer bridge experience as highly (such as some of the faculty research presentations and field trips to local laboratories), they clearly valued the experience as a whole. Students' comments demonstrated that the Summer Bridge program helped them to learn about life as a college student and gain awareness of resources, information and skills that helped them to succeed academically at LSU. High school-to-college bridging programs have been found to contribute to the success of other similarly-focused programs (Maton, Hrabowski & Schmitt, 2000; Clewel, de Cohen, Deterding & Tsui, 2006).

Most importantly, as a result of Summer Bridge, students formed a social network with their peers and began to create a community of scholars which they would carry with them into their undergraduate career. Students appreciated belonging to a high-achieving

community of learners with similar academic interests. Students attributed their academic success to a culture of achievement within the LA-STEM program, reflected by the high expectations set by program staff and the GPA program requirement, and supportive peers. In line with other research and evaluation studies, building connections and friendships with other group members and feeling a sense of belonging to a community of like-minded learners were cited by LA-STEM students as contributing to their academic success (Astin, 1993; Tinto, 1993; Walters, 1997; Alexander, Foertsch & Daffinrud, 1998; Maton, Hrabowski & Schmitt, 2000; Maton & Hrabowski, 2004; Barlow & Villarejo, 2004; Building Engineering & Science Talent (BEST), 2004).

Academic enrichment offered by LA-STEM was also mentioned by students as supporting their success. As outcomes of the required weekly classes, students generally reported gains in time management and study skills, and in working collaboratively as a group and said that sessions offering professional development, particularly GRE preparation classes and information on and help with selecting and applying to graduate school, were very useful. Academic support and enrichment has also been documented as a critical program element by Maton, Hrabowski & Schmitt ( 2000), Barlow & Villarejo (2004), Maton & Hrabowski (2004), Building Engineering & Science Talent (BEST), (2004). While most reported that the weekly classes and peer mentoring sessions were helpful and contributed to building community among LA-STEM students, of all topics raised, Individual Development Plans and weekly classes received the highest number of student comments relating mixed or negative views on the value-added of these LA-STEM program elements. These observations came largely from juniors and seniors who felt that the classes had become repetitious, redundant and of little or no benefit. Some students also said that the value of peer mentors declined as they progressed in their college career. Nevertheless, the program overall clearly had a positive impact on participants and their personal, professional and intellectual growth and development.

Peer mentoring—during Summer Bridge and beyond—reinforced group connections, provided positive opportunities for leadership within LA-STEM, and generated personal gains for both the mentees and the mentors. The contribution of peer mentoring to student retention and persistence are gains also documented by Astin & Astin (1992), Walters (1997), Nagda, Gregerman, Jonides, von Hippel & Lerner (1998), and Hathaway, Nagda & Gregerman (2002).

Strong support from program staff is another component of LA-STEM which students cited as important in contributing to their academic success. Students said that the academic and social support they received from program staff was a highly positive aspect of the LA-STEM program. Students often described program staff as mentors who were active and pro-active in helping them to succeed. Students' from all cohorts described how program staff felt "like family" and how their interactions encouraged a strong sense of belonging among a supportive community. There is evidence demonstrating that LA-STEM and the LA-STEM program staff have helped students to persist in their STEM majors and influenced their decision to seek a graduate degree. A number of students (8) told us that strong support from program staff had played an

important role in helping them to persist in their major when they might not have otherwise due to academic or personal difficulties. Other research and evaluation studies have also highlighted the importance of program staff support in contributing to student retention and persistence (Tinto, 1993; Walters, 1997; Maton, Hrabowski & Schmitt, 2000; Barlow & Villarejo, 2004; Maton & Hrabowski, 2004; Building Engineering & Science Talent (BEST), 2004).

Many students told us that LA-STEM was critical in introducing them to research, teaching them what research was exactly, and showing them the broader potential of contributing to science. In addition, several students told us that being a part of the LA-STEM program had strengthened their interest in going to graduate school, shown them a wider world of career possibilities, and increased their confidence in their ability to do science and to be accepted to and succeed in a PhD program. A number of students also told us that LA-STEM was their first exposure to what pursuing a PhD actually entailed and what working as a professional scientist might be like.

In this sample of talented, highly-motivated students, a majority said that their research experiences, particularly, had served to clarify, confirm and strengthen their incoming interest in going to graduate or medical school. These findings confirm studies that show research experiences among populations of largely white, affluent students serve to confirm or clarify students' pre-existing plans to attend graduate school (Lopatto, 2004, 2007; Seymour, Hunter, Laursen & DeAntoni, 2004; Hunter, Laursen & Seymour, 2007). However, other recent research and evaluation studies have focused on establishing the effects of research experiences on retention, persistence, and promotion of science career pathways for underrepresented groups. Results from these studies have shown increased rates of student retention to graduation, high rates of students going to graduate school, and high rates of students earning advanced degrees in STEM fields or other professional degrees, largely M.D.s (Adhikari, Givant & Nolan, 1997; Foertsch, Alexander, & Penberthy, 1997; Walters, 1997; Alexander, Foertsch & Daffinrud, 1998; Nagda, Gregerman, Jonides, von Hippel & Lerner, 1998; Maton, Hrabowski & Schmitt, 2000; Hathaway, Nagda & Gregerman, 2002; Barlow & Villarejo, 2004; National Research Council, 2005; Clewell, de Cohen, Deterding & Tsui, 2006).

The qualitative evaluation shows that, individually and collectively, students participating in research experiences through the auspices of the LA-STEM program take away a comprehensive array of gains documented by recent research and evaluation studies as contributing to students' enhanced educational experience and their personal, professional, intellectual and technical growth (Fitzsimmons, Carlson, Kerpelman & Stoner, 1990; Kremer & Bringle, 1990; Kardash, 2000; Rauckhorst, Czaja & Baxter Magolda, 2001; Ward, Bennett & Bauer, 2002; Zydney, Bennett, Shahid & Bauer, 2002a, 2002b; Bauer & Bennett, 2003; Lopatto, 2004, 2007; Hunter, Laursen & Seymour, 2007; Seymour, Hunter, Laursen & DeAntoni, 2004; Russell, 2005, 2006; Russell, Hancock & McCullough, 2007) and that also support objectives and recommendations by the 2002 Boyer Commission Report and funding agencies and organizations promoting college science education (NSF, 2000b, 2003; National Research Council, 1999, 2000, 2003a, 2003b).

A majority of students described positive research experiences in which they developed quality working relationships with their research advisor. In the process of doing research, students gained familiarity and facility with technical laboratory skills and instrumentation needed to carry out the research. These opportunities helped students to feel more confident in their ability to do research. In addition, as a result of engaging in authentic research, a majority of students developed a higher-order intellectual gain: a clearer understanding of the nature of research work—that it is slow, repetitive, and that setbacks and failure are par for the course.

Between one quarter and one half of students reported a majority of gains across the six benefits categories, including: understanding how research is done; the transfer of learning between research and classes and the increased relevancy of coursework; improved critical thinking and problem-solving skills; gaining an understanding of how scientists work professionally; gaining a more mature understanding of how scientific knowledge is built; improved presentation skills, understanding how to design and carry out research; and changes in behavior indicating their growth as young professionals.

Benefits mentioned less frequently by fewer numbers of students reflected particular differences in research experiences, such as whether or not a student worked in a group setting, working in a specific disciplinary field, or whether students had enough sustained engagement to achieve longer-term outcomes, such as learning to defend one's research, presenting at a professional conference, and being listed as a co-author on a publication.

Some students did report instances of poor quality research experiences—some at LSU, but mostly at host institutions. Common elements of poor research experiences included little or no guidance and mentoring from the research advisor, being assigned only menial tasks, being academically underprepared to understand or meaningfully contribute to the research, and finding one self better suited to other interests and work.

Faculty research advisors were knowledgeable of LA-STEM"s program objectives to retain students in the sciences and recruit them to STEM PhDs. Across the range of topics covered in our interviews with research advisors, we found that their observations matched those recorded in our large qualitative research study. Descriptions of how they selected students and research projects, how they worked with students, the types of student gains they observed, the costs and benefits of directing students in research work, examples of poor student research experiences, as well as of the rewards systems, were all in line with what other research advisors at other institutions have had to say.

Research advisors' observations on the benefits to students of research experiences referenced gains they had seen among students they had worked with generally, rather than for specific LA-STEM students. In almost equal measures, advisors described how research experience: enhanced students' preparation to undertake graduate-level work; gave them various skills; informed a more realistic understanding of the nature of research work and brought about changes in attitudes and behaviors necessary to research; provided various personal/professional gains, such as establishing collegial working relationships with their advisors and with other research group members; and

gave students hands-on experience of what it was like to "think and work like a scientist." Only a few advisors commented on ways in which research experience served to clarify students' thinking about their career intentions. Research advisors' comments support the view that students' gains a broad range of benefits contributing to their personal, intellectual and professional growth.

A majority of advisors recalled times when directing students in research work was problematic. Most commonly, research advisors reported that working with students who lacked interest in and motivation to do research were "no fun to work with." A majority of advisors also reported instances where students were underprepared to take on the science of the research and advisors struggled to re-structure projects. Given the objectives of LA-STEM to have students participate in research early and often, it may be worthwhile to directly address issues of project selection and scaffolding students learning in future Faculty Mentoring Workshops.

In describing the benefits of directing students in research a majority of advisors said that they benefited from students' help and that students' work contributed positively to their professional scholarship and career advancement. In addition, a majority of advisors reported intrinsic gains from directing students in research, such as enjoying interacting with students.

In talking about the costs of directing students in research, a majority of research advisors described their difficulties in terms of the time and effort it required: student research is time-intensive. Almost all advisors agreed that working with students slowed them down, and several felt they could get their work done faster *without* students' help. Directing students in research required advisors' extra time and effort and added to the pressures of balancing other professional commitments.

In our evaluation studies of undergraduate research programs at research universities, advisors report the same intrinsic rewards as do those at the liberal arts colleges, but their discussion of costs is often dominated by publish-or-perish pressures for faculty and by the need for timely progress on research by graduate students and postdocs who serve as advisors. Young faculty especially are often eager to take on undergraduates, both to hand down their own positive research experiences, and to staff their new labs with low-cost, readily recruited, help, but they find it difficult to juggle their educational and research goals, and do not perceive that research work with students is rewarded within existing institutional rewards structures. Given the growing variety of successful undergraduate research programs that do exist, it is very evident that these challenges are not insurmountable, but neither are they issues to be taken lightly.

We found program staff knowledgeable and professional in all respects. While early LA-STEM cohorts had clearly been upset by turnover in program staff, a new team was in place and they were working to make sure program requirements were plainly understood by students and consistently enforced. They described LA-STEM as a program providing multiple elements of support with the objective of meeting students' needs at every level. From program staff members' points of view, all of LA-STEM's program

elements were considered critical to achieving program objectives. However, program staff acknowledged that strong leadership from Dr. Warner—his passion and dedication—was a driving force behind LA-STEM.

In talking with program staff and administrators it was clear that LA-STEM program was seen as a central support to LSU's mission to fulfill the objectives set out in the Flagship Agenda. Administrators, particularly, were clear in expressing the many ways in which the LA-STEM program supported LSU's institutional goals. Importantly, with its objective to promote the success of students from underrepresented groups, the LA-STEM program was also seen as supporting LSU's mission to redress historic racial inequalities in higher education in the south by increasing the representation of diversity on its campus and encouraging a racial climate and providing the resources necessary to supporting the success of students. Insofar as LA-STEM program objectives were well aligned with LSU's Flagship Agenda, positive program and student outcomes from LA-STEM were seen as directly benefitting LSU.

The majority of research advisors planned to continue their participation in the LA-STEM program. Though department and faculty buy-in of directing undergraduates in research was reported to vary considerably, the general view was that there were enough STEM faculty at LSU to support LA-STEM and other undergraduate research programs. Given that a number of faculty originally contacted for an interview had no recollection of mentoring a LA-STEM student, a publicity campaign at LSU to raise the profile of the program and advertise the awards and accomplishments of LA-STEM students should be considered.

Overall, sustainability of the LA-STEM program was largely predicated upon the success of acquiring adequate and ongoing funding. Senior program staff were continuing to write grant proposals for further funding support, but acknowledged that ongoing funding from the NSF was unlikely in the longer-term. We raised the issues of institutional support and sustainability of the LA-STEM program with LSU administrators with whom we spoke. They expressed strong support for the LA-STEM program. They reiterated the ways in which LA-STEM's program objectives aligned with those of the institution and said that funding invested in the Flagship Agenda and other STEM initiatives on campus demonstrated institutional support of and an ongoing commitment to the success of the LA-STEM program. Administrators were encouraging that funding from the state and Board of Regents would be continuing. However, absent any source of secure future funding, the sustainability of the LA-STEM program remains an open question.

Program staff and administrators agreed that LA-STEM's program elements were readily reproducible elsewhere, given sensitivity to varying student needs and institutional contexts. However, they emphasized one factor as particularly critical to program success that was difficult to replicate: highly dedicated and distinguished leadership, such as that provided by Dr. Warner.

The collective commentary of students, faculty, program staff and administrators, indicates that the LA-STEM program has been effective in meeting its program

objectives of recruiting diverse and talented students to LSU, retaining them in STEM majors, and in encouraging their entry to advanced degree programs. By students' and staff members' accounts, structured program elements worked effectively to integrate them academically and socially to campus life at LSU and played significant roles in promoting their academic success. LA-STEM's success in achieving program objectives validates theoretical research informing the ways programs are structured to promote student retention and persistence in STEM majors, particularly for underrepresented groups, and contributes to what we know about "what works."

## II. Introduction

Between 1998 and 2008, jobs in science, technology, engineering, and mathematics (STEM) fields will increase at four times the rate of other employment opportunities (NSF, 2000a). However, there are concerns over how these positions may be filled given the persistent homogeneity of the domestic STEM workforce: in 2000, white and Asian Americans constituted 82% and 10% of the STEM workforce, respectively (NSF, 2000a). Despite the national need for a highly skilled and diverse STEM workforce, undergraduate retention and degree completion in STEM disciplines is a consistent problem, particularly for minority students (Bonous-Harmouth, 2000). In 2005, only 17% of bachelor's degrees in science and engineering were awarded to minority students—African-Americans, Hispanics, and Native Americans—even though these groups comprised 28% of the U.S. population (NSF, 2008; U.S. Census, 2006). Additionally, only 9.5% of doctoral degrees in science and engineering fields in 2005 were awarded to minorities (NSF, 2008). Despite slight gains in the graduation rates of minority students in STEM disciplines in recent years, the undergraduate years are still a "leaky" point in the academic pipeline. In addition to concern with meeting workforce needs, demands for equal access to opportunity has led to an increased focus on the recruitment of underrepresented students into STEM fields.

The Louisiana Science, Technology, Engineering and Mathematics (LA-STEM) Research Scholars seeks to recruit talented, high-achieving students to STEM majors at LSU, retain them to graduation, and encourage their entry to STEM PhD programs. With a goal of increasing the diversity of student talent, LA-STEM seeks to promote greater participation among students from underrepresented groups in STEM disciplines at Louisiana State University (LSU).

Drawing on models of success, the LA-STEM Research Scholars program targets high-achieving students as incoming freshmen, admits them as a cohort, and provides comprehensive support, including a high-school-to-college bridging program, academic enrichment, peer mentoring, program staff support, financial scholarships, among other structured elements. One of the primary ways in which LA-STEM seeks to recruit students to the program, retain them in STEM majors, and encourage their entry to graduate school is through early and sustained engagement in faculty-mentored research experiences (during both the summer and academic year). This strategy is a feature of similar formalized programs targeting student retention and recruitment to graduate education, especially for underrepresented groups (i.e., NSF-Louis Stokes Alliances for Minority Participation Program, NIH-Minority Research and Training Programs, SOAR at Xavier University, the Meyerhoff Scholars program at University of Maryland, Baltimore County, the MBRS-RISE and MARC U*Star programs, California State University, Los Angeles, etc.) That is, undergraduate research is seen as a way to foster students' interest in and ability to successfully pursue education and careers in STEM fields, and as a means to help them overcome barriers of education and opportunity.

Upon the request of Dr. Isiah M. Warner, Vice Chancellor, Office of Strategic Initiatives (OSI), Louisiana State University (LSU), Ethnography & Evaluation Research conducted

an independent external evaluation of the Louisiana Science, Technology, Engineering and Mathematics (LA-STEM) Research Scholars Program. The scope of the external evaluation is directed at:

- independent documentation of program impacts for student and faculty participants, and for LSU as an institution and that provides other summative information concerning the degree to which program objectives are being met;
- providing formative information that may be incorporated into program assessment and further program development.

This report presents the qualitative results of our analyses of the interview data for the external evaluation and addresses student outcomes from key components of the LA-STEM Research Scholars program, including financial scholarships, the Summer Bridge program, belonging to a community, program staff support, peer mentoring, academic enrichment courses, diversity awareness and research experiences and their importance to students' academic success. Two separate reports for the external evaluation of the LA-STEM program present the quantitative results of surveys administered to Summer Bridge students and to students and faculty regarding the benefits of research experience (Thiry & Hunter, 2008a, 2008b).

## III. Evaluation Design and Methods

The P.I.s Hunter and Thiry conducted a comprehensive external evaluation for the LA-STEM Research Scholars program using both quantitative and qualitative methods, including surveys, individual and focus group interviews, and on-site observation. (The external evaluation plan is presented in Appendix A). Two separate reports present the quantitative results of surveys administered to students and faculty for the external evaluation of the LA-STEM program (Thiry and Hunter, 2008a, 2008b). This report presents the qualitative results of our analyses of the interview data for the external evaluation.

### A. Description of participant samples

We note that student data on gender, race/ethnicity, major, GPA, graduation, etc., are being comprehensively tracked by the Internal Evaluator, Dr. Eugene Kennedy to document program outcomes using institutional records. This type of data collection and analysis was not within our purview or an objective of the external evaluation. Rather, our task has been to independently document evidence of program outcomes using qualitative and quantitative methods.

We conducted semi-structured, in-depth interviews with a range of individuals, including students, faculty research advisors, program staff, and key Louisiana State University administrators. An effort was also made to interview a comparative group of non-participating students.

Interview samples were constructed from comprehensive lists provided by the Office of Strategic Initiatives (OSI) so as to balance the representation of various demographic characteristics (such as gender, race/ethnicity, and major) and also to target issues of particular interest to the LA-STEM initiative. For instance, interviews with 35 students focused on undergraduate research experience; 16 interviews focused on Summer Bridge; three interviews probed the importance of peer mentoring in Summer Bridge.

During the first site visit in fall 2007 site, we interviewed 27 students (with 20 students participating in 5 focus groups, and 7 individual interviews), 6 faculty members and 1 staff person. During our site visit in spring 2008, we interviewed another 30 students, 8 faculty members, 6 LA-STEM program staff, and four administrators (all individual interviews).

Following our spring site visit, we interviewed: three students who were no longer participating in the LA-STEM program; an additional faculty member; and one additional informant working closely with LA-STEM (grouped as an administrator interview).

## B. Content of the interviews

Interviews with student samples explored participants' attitudes toward their experiences in LA-STEM, including Summer Bridge, peer mentoring, undergraduate research, and academic and professional development courses, among others program elements. Students' were also asked to comment on the strengths and weaknesses of LA-STEM, offer advice, and to raise any issues they wanted concerning the LA-STEM program. Students' self-report of academic progress and success was also solicited. Particular attention was given to establishing the degree to which LA-STEM contributed to the development of students' career aspirations and objectives, especially in interviews with graduating seniors.

Faculty research advisors who had mentored a LA-STEM student (or students) were also interviewed. We asked them about their knowledge of the LA-STEM program's objectives and about their engagement in LA-STEM, (i.e., how many students they had mentored, over what period of time, etc.), the types of projects they chose for student researchers and their perceptions of the benefits to students of program participation, overall, and of undergraduate research experience, in particular. We also asked faculty research advisors to comment on what they saw as program strengths and weaknesses and the benefits and costs to them of directing research with students. We also solicited any advice they had to offer directed at improving the LA-STEM program. We note that while we received a list from the OSI staff containing contact information for over 60 faculty members who were recorded as having worked with LA-STEM students, we had difficulty in obtaining the 15 we did interview; several replied to our email solicitation saying they had no knowledge or experience with the LA-STEM program.

We interviewed LA-STEM program staff to gain their views about the program and explore how things were going. In our interviews we asked staff to provide a brief history of the LA-STEM program to better understand its context within the institution.

We asked staff to talk to us about their work within LA-STEM and how they saw the program working to support students and their success. We also used our time with staff to discuss issues raised by students and to learn staff's perspectives.

Interviews with LSU administrators explored institutional factors affecting program success, such as support for LA-STEM, cultural/environmental issues particular to LSU's history, and ways in which institutional objectives (such as the Flagship agenda) aligned with LA-STEM objectives. (Interview protocols for each participant group are presented in Appendix B.)

Data gathered from an observation of a LA-STEM peer mentoring and peer group study session conducted during our first site visit to LSU at the end of summer/fall semester 2007 is presented in Appendix C.

All interview protocols and the study design overall, were submitted for review and approved by the University of Colorado's Institutional Review Board, to ensure that the study met high ethical, professional and legal standards for research involving human subjects. Interviewees read and signed an informed consent agreement that described the study and their rights as research participants to anonymity, confidentiality, and other protections of the information they provided. They could decline to answer any questions, stop the interview if desired, or decline to be tape-recorded.

## C. Method of qualitative analysis

Our methods of data collection and analysis are ethnographic, rooted in theoretical work and methodological traditions from sociology, anthropology, and social psychology. Classically, qualitative studies, such as ethnographies, precede survey or experimental work, particularly where existing knowledge is limited, because these methods of research can uncover and explore issues that shape informants' thinking and actions. Good qualitative software computer programs are now available that allow for the multiple, overlapping, and nested coding of a large volume of text data to a high degree of complexity, thus enabling ethnographers to disentangle patterns in large data sets and to report findings using descriptive statistics. Although conditions for statistical significance are rarely met, the results from analysis of text data gathered by careful sampling and consistency in data coding can be very powerful.

Taped interviews and focus groups are transcribed verbatim into a word-processing program and submitted to *NVivo 7.0*, a computer software program used for qualitative data analysis. In conducting a qualitative analysis, the analyst reads through all of the documents—the text data—searching for information relevant to the evaluation questions. Text segments referencing distinct ideas are tagged by code names. Codes are not preconceived, but empirical: each new code marks a discrete idea not previously raised. All of the code names that are developed are collected in a codebook. When the analyst reads a text passage that relates an idea previously encountered, the same code name is reused to mark the relevant passage. Thus codes and their associated text passages are linked, amassing a data set of code names and their frequency of use across

the data set. Once all of the text data is coded in this manner, codes similar in nature are grouped together to define themes; the clustered frequencies, represented as grouped themes or categories, describe both the range and relative weighting of issues in participants' collective report. The number of observations is generally much larger than the number of speakers, and thus is a measure of the depth of broad topics. The number of speakers, however, is a better measure of the distribution of views on a topic. We use both types of counts in reporting results of the qualitative analyses of the interview data.

## IV. Demographics of Participants

A total of 57 students were interviewed: 49% were men and 51% were women; 46% of the students interviewed were white, not of Hispanic origin, 42% were Black, not of Hispanic origin, with the remaining 13% claiming other racial or ethnic designations. A range of majors was represented among student interview participants, including: biological sciences (21%) chemistry (18%), physics (14%) biochemistry (5%), computer science (5%), several engineering fields (chemical, biological, electrical, civil, mechanical and industrial) (cumulatively, 32%), with the remaining 6% of majors in other science and technology disciplines.

A total of 27 faculty, program staff and administrators were interviewed: 52% were men and 48% were women; 59% were white, not of Hispanic origin, 19% were Black, not of Hispanic origin, with the remaining 23% claiming other racial or ethnic designations. A range of majors was also represented among faculty research advisors who were interviewed, including: biological sciences (33%) chemistry (7%), physics (7%), computer science (7%), several engineering fields (chemical, biological, electrical, and mechanical) (cumulatively, 27%), with the remaining 20% of faculty research advisors working in other science and technology disciplines. Sixty percent of faculty research advisors were tenured (either an associate or full professor); 27% were untenured (assistant professors) and 13% were non-tenure track research faculty.

Thus, in all, a total of 69 interviews with 84 individuals were interviewed regarding their experiences with the LA-STEM program (57 students, 15 faculty members, 7 LA-STEM program staff, and 5 administrators). Demographic information for the student, faculty, program staff and administrator samples are provided in Appendix D).

## V. Student Recruitment to LA-STEM and LSU

### A. Recruitment: How students found out about LA-STEM

Students originally found out about LA-STEM from a variety of different sources:

- Friend or other LA-STEM student: 10 students
- High school counselor: 10 students
- High school teacher: 7 students

- LA-STEM staff member, e.g. via a presentation at a summer institute during high school: 6 students
- Promotional materials sent directly to students: 4 students
- LSU website: 2 students
- Nine students told us they did not learn about LA-STEM until *after* they started at LSU.

## B. Who is entering LA-STEM? High school preparation

Most LA-STEM students were somewhat or very oriented toward a major in science, technology, engineering or mathematics (STEM) before entering college. However, few were so strongly committed to their field that the college and LA-STEM experience had no shaping influence on their interests.

Forty-two of 47 students that we asked (89%) said that they had developed an interest in science, generally, or their major field, specifically, *prior* to entering college; about half said that they had developed their interest in the sciences prior to entering high school. Despite students' strong incoming interest in their field, more than 25% reported to us that participation in the LA-STEM program had helped them to clarify which STEM discipline to major in, or led them to change their major within the STEM disciplines, since they had entered college. (Gains in career clarification as an outcome of research experience will be discussed more fully later in this report.)

Students reported a wide range of academic preparedness coming into college. Slightly less than half (23) had taken honors or AP science and mathematics classes in high school, or Calculus 1. However, an equal number of students had taken no advanced classes at all during high school. A few students (5) stated that they had experience with doing science research prior to college. Despite the range in students' self-reports of the level of their science and mathematics preparedness, most students told us they felt sufficiently equipped by their high school education to handle college-level science and mathematics classes. Students who attended Louisiana School for Math Science and the Arts (LSMSA) felt particularly well prepared. Those few students who felt their academic preparation was subpar told us they had had limited opportunity to take quality science and mathematics classes during high school. This is not to say that all students who tool only regular science and mathematics courses in high school felt unprepared, however, those students who did report feeling under-prepared for college-level science and mathematics courses had not taken any advanced science and mathematics courses in high school.

Despite students' reports that they felt well prepared to handle college-level science and mathematics courses, some students (15) said that they had been anxious about whether they would be offered a LA-STEM scholarship, perceiving acceptance into the program as highly competitive:

> I really was worried! I was surprised when I got into it, because honestly, I'm not as strong as many of the other students. There are some with 31s, 32s on the

> ACT, and here I'm coming in with a poor little 24, and I was like, "Oh! I'm not gonna be able to hold up to them!" And then I got here and was like, "Hm, something mustn't've been done right." But I mean, I was a hard worker in school, but I didn't think I was good enough to get in. [LASBPMS2]
>
> We got to the, the selection weekend and there were so many people that were like, "Yeah, I got a 30, 31 on the ACT. I've got a 4.0". And you know, I always did well in school but I wasn't way, way ahead of everybody. And I was just like, "Oh goodness (LAUGHS). There's no way. How am I supposed to compete with these people?" [LASBPMS3]

Some students pointed out to us that, having been accepted into and become involved with LA-STEM, they now understood that several factors other than high school GPA and top scores on the ACT or SAT were considered in selecting students for LA-STEM and felt equal to their peers:

> I was sitting next to people in my interviews who had perfect scores on their ACTs. And I'm a good student, but I don't have perfect scores on standardized tests. So I was convinced that I wasn't getting in. I thought that it was all about grades. But when I found out, when I actually got into the program, you realized that the people who had the 36s on their ACTs were the people who didn't have social skills, that don't know how to talk to people, and none of those people got in. You realize that it's not about that. [LAREUFG2]
>
> The interviews were really interesting. You have people that went to a school called LSMSA, where they're kind of in the college campus environment. And they could, some of them have done research at their campus, and [at] a normal high school you don't get that opportunity. You don't even get exposed to that. So, that was a little intimidating. But I found out, once you're in, everyone just helps each other. [In] interviews you think, "Oh, this person is better than me." But then you actually see a performance in college, how people do, and you might be surprised of how well you can do. [LAREUS20]

LA-STEM appears to be recruiting a range of students who are interested and talented in STEM fields, and who typically have a solid background in science and mathematics, but who are not necessarily set on a particular STEM discipline upon entry to college. LA-STEM students expressed confidence in their high school education, their academic abilities, and readiness to take on college-level coursework. At the outset of participating in LA-STEM, some noted feeling insecure when comparing themselves to other students they met during the recruitment weekend. Many of these students, however, came to see that factors other than high academic performance were also considered in the student selection process. Acceptance into LA-STEM itself tended to alleviate students' nervousness about being unprepared.

From students' perspective, LA-STEM isn't necessarily recruiting *only* "the best and the brightest," but are recruiting bright, talented students with a lot of potential, many of

whom might not otherwise have had the motivation, confidence, or direction, to pursue a challenging STEM major. Ultimately, the selection of students for the LA-STEM program appears to be in line with their mission to recruit highly promising students that are among "the best and the brightest," rather than concentrating on choosing only the exceptional.

## C. Why students chose to attend LSU

Most students chose LSU over other schools they had the option of attending. Of the 35 students who talked about their decision-making around their choice of college, only nine said that LSU was the only school that they applied to. The most frequently mentioned reason for choosing LSU was the appeal of the financial support being offered by the LA-STEM program. A majority of students who discussed the importance of substantive financial aid packages as influential in deciding which university to attend said that the scholarship was very important. Indeed, 14 said that it was their primary motivating factor:

> *[The money] was really an important factor, because if I didn't have the funding, if I didn't get the scholarship, I wouldn't have been able to attend LSU. Because my parents couldn't afford it and I didn't want to risk putting myself in that kind of debt. [LAREUS18]*

> *Originally, I was probably gonna head to Southern, but I got the LA-STEM scholarship, so I came here. [LAREUS25]*

> *Honestly, [LSU] was my backup school. Where I went to high school, people wanted to go to like every private school in the nation, …In the process of looking at colleges, I found LA-STEM actually offered a scholarship and it made me want to come here... The scholarship was a full-paid ride. It was enticing, so…. And my parents are just an hour away so it's a lot closer too. It turned out to be the right choice. [LAREUS26]*

Yet, for many students, the scholarship offered by LA-STEM was just one of one of several motivating factors:

> *When I heard about the scholarship I was thinking, "Whoa, that's amazing." I had never thought I would even have that kind of scholarship money coming. And then I found out it was geared towards the sciences which is what I pretty much knew I was gonna be doing. So that kind of really caught my eye. 'Cause I knew this guy had just, something specifically for me. [LAREUS23]*

> *I'm not gonna lie, [the stipend] was a perk. (LAUGHS) I went for it, I heard it was a lot of opportunities, and actually it was also for connections too, 'cause I don't know anybody here. You walk in here and, when things go down you try and figure out, like college was all new to me. So my mom, it's all new to my mom too. So we're just kind of like, it was nice to have LA-STEM to tell us different*

> *things to expect. I had had friends from school that did go to LA-STEM, they just say it's a really nice community bond kind of thing, somewhere you can go to. And also it is nice to have the money too, so it was both, half and half. It is nice to [not] have to worry about that. You don't have to worry about paying room and board and for food and stuff. [LAREUS3]*

> *It was definitely the research in the science and math departments. I listened to a presentation and I didn't know - also PhD programs - I didn't know how easy it would be to get a PhD in Math. And I spoke to Miss Sibley and Dr. [X] about it, and they encouraged me, so I was really attracted to the PhD program, and also the stipend really helped. [LASBFG3]*

Several students told us they appreciated the stipend even though it had not been a primary motivator. Only a very few students told us the stipend had no influence on the student's decision, or that they had not even known about the stipend when applying:

> *LSU was my choice. Whether I'd got the scholarship or not, I was still coming here, so I guess in the long run, it didn't actually sway any decision because I only applied to two schools and I was only planning on going to this one. So, LSU was basically my choice whether I had to pay all the tuition or I had to pay none of it. [LASBFG1]*

Apart from the stipend, the most frequently mentioned motivation for students' to attend LSU was the LA-STEM program and the opportunity to engage in science research their first year of college:

> *I think the most appealing aspect of this scholarship was how they throw you out into the research field and give you an extra push, because I wouldn't've ever thought about doing research. That's not something you hear most college students doing, is undergraduate research. And that's what I was interested in, to kinda get ahead, so it's nice. [LASBFG1]*

> *It wasn't really about the money as much as just about the opportunity that LA-STEM would give about just going away and pretty much just like a big open door for whatever field you wanted to research in within science and math and the STEM disciplines. That was the biggest thing. [LASBFG3]*

On the other hand, a few students mentioned applying to LA-STEM *despite the research requirement*; these students were initially resistant to research, either because they did not know what it was, or they felt it would be extra work they would not enjoy.

> *I was pretty intrigued by what [LA-STEM] was offering me. As far as the research part, I had no idea what it was talking about. I had read everything about the program, but it was saying you'd have to be interested in research, and I was like, "What's research?" I really didn't know. But I saw the fact that it was*

> *paying for a stipend every semester and stuff like that, and I was like, "Well this is a good opportunity," so I went ahead and filled out for it. [LAREUS19]*

The following excerpt is from a focus group interview:

> *INTERVIEWER: How important was the research experience to becoming involved with LA-STEM?*
>
> *STUDENT 1: Initially?*
>
> *INTERVIEWER: Was it an incentive, or….?*
>
> *STUDENT 1: (LAUGHTER) Honestly...*
>
> *STUDENT 2: Initially, it wasn't all that...*
>
> *STUDENT 3: I was mad!*
>
> *STUDENT 2: I was mad too. Like when you learn that research was a part of it, you're like, "I don't wanna do research!" But when you start looking at what this program is geared toward, grad school with a PhD…. Well, a PhD is a research degree. So what they're doing, they're trying to give us a head start above the people who aren't doing research yet.*
>
> *STUDENT 1: Yeah. You've gotta learn. Might not like it, but hey.*
>
> *STUDENT 4: I was the same way. I didn't really know what research was. What I knew of research was what we did in labs in high school. I didn't really know what it was. And I was open to it, because I really had no idea, but at the same time, I felt like when we came in and we were doing research, that was gonna be confined. That they were gonna assign us to it. [LAREUFG2]*

Other motivating factors that were mentioned less frequently included the desire to be part of a more intimate community on a large campus. The following quotation shows how this student, after having attended a very small high school, was concerned about feeling lost on a large anonymous campus:

> *I came from a really small high school; we had a graduating class of 42 people. And coming to LSU, I was talking to people and they're like, "What you're gonna have to realize is that you're just a number. You're gonna be in classrooms your freshman year where you're gonna have 600 people in there. Your profs are not gonna know you. You can go talk to 'em, but they're still probably gonna not know you by name." So, I was scared. And that's what really attracted me to LA-STEM. 'Cause I would have-, it's kinda like a support system. You know everybody and they help you through everything. [LAREUFG2]*

Another student was looking to build connections with students' who were similarly motivated to do well and succeed:

> *I've been kind of looking for something to not feel like a number at LSU anymore since the size here is a little overwhelming. I want to pursue higher learning, things like that. I want to be associated more around the top students and I was kind of looking for some way to do that, and right away the LASTEM program, I realized right away that that's where most of the top students at LSU would probably be in this program. [LAREUS12]*

Some students also mentioned program support in learning about and applying to graduate school as their motivation for pursuing the LA-STEM program and LSU:

> *INTERVIEWER: So, why did you choose to come to LSU?*
>
> *STUDENT: Because of LA-STEM. I mean, it was a very appetizing offer. You basically get walked through college. They tell you, they kinda guide you as to what you need to do. What is gonna get you into grad school. And it's like, even with the stuff like the IDP, it tells you what you need to do this semester to reach your goals, basically. [LAREUFG2]*

Other motivating factors linked to the LA-STEM program and students' choices to attend LSU (mentioned by one student each) included: the opportunity to do Summer Bridge, the academic challenge posed by the LA-STEM program, the program's diversity, the mentorship and networking opportunities offered by the program, and automatic admittance to the Honors College.

Other reasons mentioned by students *apart* from the LA-STEM program included: the general affordability of LSU compared to other universities; other LSU scholarship opportunities, such as Chancellor's TOPS program; the school's academic reputation; the campus atmosphere; the varied opportunities available at a large research university; and encouragement from a friend or family member who had attended LSU.

In sum, students' decisions to attend LSU were largely mediated by financial concerns and how best to support their college education. Students described the scholarship monies available through the LA-STEM program as being competitive with funding packages offered by other universities who were also trying to attract high-achieving students. The level of scholarship funding made available by LA-STEM had a major influence on students' choice to attend LSU. Beyond financial support, students most commonly cited the opportunity to do research as a strong reason to accept the LA-STEM scholarship and attend LSU. They saw the program as highly competitive and were invested in being accepted, with one student telling us that his goal his senior year of high school was "to get into LA-STEM." Ultimately, while the scholarship offered by the LA-STEM program played a major role in students' decisions to attend LSU, for many, the additional opportunities and benefits offered by the LA-STEM program—especially the chance to do research as a freshman—also held a strong appeal for students.

## VI. Summer Bridge

The LA-STEM program incorporates a high-school-to-college bridging program that brings incoming LA-STEM students to campus the summer prior to the start of their freshman year. During the Summer Bridge program, students are housed close together, and involved in a series of social activities, academic workshops, and college coursework. The goal of the Summer Bridge program is to ease students' transition to a large campus environment and encourage their integration into campus life by building a strong community among LA-STEM students, program staff and participating faculty members. In this section, we present student outcomes from LA-STEM's Summer Bridge program.

Students were very positive about the Summer Bridge program, telling us that it was one of the best parts of the program. Of 511 evaluative comments about Summer Bridge, 438 (86%) were positive. Students told us the program was fun, busy, and went by quickly:

> *I really enjoyed the summer bridge actually. It was an amazing experience because I got to know the college campus. I got to get a small taste of the college lifestyle before I jumped in. And, I got used to class, I got used to my classes, I got used to campus, I got used to living on campus. [LAREUS4]*

> *Summer Bridge was really, really, really fun actually, even though I took two really hard classes, which I shouldn't have then. (LAUGHS). I thought it was really fun and it got me even more excited to come to LSU. 'Cause it's not like I didn't want to come, I did, but I was still thinking about [another college] and they were still calling me "Well, your first year at LSU, if you don't like it just call us back, our offer still stands". You know, so I wasn't like as excited as I probably should have been to get LA-STEM. So it was like, probably one of the best things of this course. Summer Bridge was just, everything about it was just great. Everything. [LAREUS11]*

Several students described being resistant to giving up their summer vacations but, ultimately, were glad they did:

> *It was fun. It was a lot of fun. Being from here, I was in a little bit of a different situation than everybody else because my parents lived five miles down the street. All my friends were still here. And so I'm like, "This is my last summer to spend with my friends before they all go away!" I think all of us kind of went into it with the attitude like, "Man, why do we have to do this?" And then in the end, kind of realized that we had fun. (LAUGHS) [LASBPMS3]*

Some of the best parts of Summer Bridge, students told us, were the community building aspects, the introduction to college life, the opportunity to get a jump on their course requirements, the service learning projects, and the exposure to research.

Negative comments about Summer Bridge largely came from students who had entered LA-STEM as sophomores or juniors and, while required to participate in Summer Bridge, did not get much out of it. Students also mentioned some issues around organization and scheduling, fit of material and activities to students' level of understanding, and the difficulties of coordinating students' different majors. We will discuss these issues later in this section. As well, two important elements of Summer Bridge—peer mentorship and diversity training—will be discussed separately in later sections of this report.

## A. Student outcomes from Summer Bridge

In addition to asking students for their general impressions of the Summer Bridge experience, we probed to find out more specifically what they had gained from Summer Bridge. The gains most frequently reported by students were (298 observations):

- Support transitioning from high school to college: 92 observations (31%)
- Social integration: 91 observations (31%)
- Encouragement to do research during Summer Bridge: 43 observations (14%)
- Academic preparation: 41 observations (14%)
- Gains in skills: 31 observations (10%)

### 1. Support transitioning from high school to college

Students told us that Summer Bridge helped ease their transition from high school to college life. About one-third of their comments addressed the advantages of living on campus and taking classes over the summer. They felt this was a less intense way to ease into and get a feel for college classes before taking on a full course load in the fall:

> *It definitely did [help] because I took Chemistry and I took a Communication Studies class. So, it gave me a good idea of what science classes at LSU would be like and, I mean, it was a rough semester (LAUGHS). And also just how grading scales work, because in high school you're used to having a lot of grades and I guess that's one of the big transitions. In college you might have, like, two tests and a final, and a homework grade and that's it, that's your grade. And I'm glad that I got to really be introduced during the summer as opposed to having a full course load with five classes in the fall trying to adjust. [LAREUS17]*

> *I loved the Summer Bridge. It's a kind of like, "Aaaah!," when you first get in, but looking back, it was like the most relaxing and comfortable experience. 'Cause you're a freshman, your fall semester is gonna be kind of crazy, especially since you have all these new classes, all these new people, and then you have football and stuff like that on top. But in the summer it's just you, there's 30 other people basically. Mostly you're bonding. And you can take some classes, and summer classes are just kind of easier 'cause you just have two. And so it's easier to concentrate on doing good on that and just getting used to the campus. [LAREUS20]*

> *[Summer Bridge] was really influential. That's exactly what it was; it bridged together between high school and - not college experience, not necessarily; it didn't give you everything you would see, because that's impossible. But it was a nice transition. A confidence booster. And those are two of the most important things when you're coming first out of high school and into a big campus setting like this. It just helped with the transition and for me the confidence to see that I could take a class and be successful in it over the summer. 'Cause you have enough time to get it done. [LAREUS25]*

One student suggested that new students be required to take two classes during Summer Bridge, rather than simply fulfilling a certain number of credits, so that they can learn to balance a course load.

> *They say that you should take between four to seven hours. Well, the first Calc is like a five-hour course. So, I think what they should include is making people do two courses, at least. 'Cause you're gonna be bombarded completely with six, seven classes your first semester. So you need to know how to balance your time with more than one class, and that is part of the whole summer. [LAREUFG2]*

Summer Bridge also introduced students to university resources outside of LA-STEM. About one-fourth of their comments referenced additional academic resources, such as the Center for Academic success:

> *They definitely do a good job of ensuring that all the students know about the resources available to them on campus to succeed. I'm thinking that LASTEM is the first place that I really got all of that. It wasn't through orientation about LSU. I was already here for a year; I had heard maybe about some things. But through the Summer Bridge and afterwards they talked about the Center for Academic Success. They have Sandra McGuire come in. I love that lady. They talk about the Writing Center. They talk about the tutoring in Allen Hall and all these areas, and I've just grown to be really comfortable with these programs and so I know if I do have a problem there's a place to go. [LAREUS14]*

Students also valued their early introduction to the campus itself:

> *You got to live on campus, so before any of the other freshman even got here we knew stuff. We'd learned where the buildings were, we knew where we were going. We acclimated ourselves to the campus, so that aspect of it was great. Because I mean, most time you come up, you're on campus and you're just like "Aah! What's going on? It's overwhelming. But in the fall we were used to - it was on a larger scale - but we were kinda used to it; we had been going to class and so we knew high what to expect from college. [LAREUS21]*

> *I learned where all the classrooms were before, so my first day of college, I just looked at my schedule. I was just looking at my schedule and I wasn't afraid. I didn't have to go look for my classrooms. I pretty much knew where all of them*

> *were. And I was at least familiar enough with the campus where if I asked someone, they could tell me using landmarks. Yeah, definitely comfortable with being here just 'cause I already stayed in the dorms. I stayed in the same dormitory as I do now even, and I knew some people here and I knew I wasn't the only one. I just felt a lot more comfortable. [LAREUS8]*

This familiarity put them in good stead at the beginning of the year when compared to friends who were incoming freshmen:

> *I remember the fall semester, and all of my peers walking around like, "Oh my gosh. I don't know where to go. I don't know what to do." And I was like, "Oh, I've been here. I remember. Go there, there, and here." And so it really smoothed things over. It helped me to get to know campus. It helped me to get to know different resources and things that I probably wouldn't have known, that I would've had to find out myself if I was to come in the fall. So it was really a smooth transition. [LASBPMS2]*

> *I feel like we would've been lost without Summer Bridge. I remember one of my friends saying we didn't feel like freshmen when we came in our freshman year, 'cause we were one step ahead of everybody else. So our friend called us 'Super-Freshmen' 'cause we weren't like freshmen. [LAREUFG2]*

The few students who told us that Summer Bridge did not help them transition to college, were typically students who entered LA-STEM after their freshman year of college:

> *I did the Summer Bridge, I was accepted into STEM, I'm a sophomore, so I was accepted a year later, so it didn't really have too much of an impact on me, just because I'd already been to college before for a year. [LASBFG3]*

2. Social integration

About one-third of students' comments about the Summer Bridge program noted that it helped to smooth their social transition to college by introducing them to a group of students and thus providing familiar faces on campus that they otherwise would not have had coming in as freshmen. Nearly half of students' comments on the benefits of participating in Summer Bridge mentioned the way in which Summer Bridge fostered community among participants:

> *Especially coming from Summer Bridge, just meeting all the people in the program was more than I could've ever asked for, 'cause I came to LSU with 30 more friends than I would've had otherwise. And I know people that I can hang out with, someone to have lunch with or something, instead of just having to sit around by myself all the time. [LAREUS1]*

> *Whenever we got here this fall, I was walking around with one of my friends from my high school, who is not in LA-STEM, and I was seeing all my LA-STEM*

> *friends around campus and I was saying, "Oh, hey! How's it going?" and she was like, "How do you know all these people?" It's so nice to be able to be on such a big campus, but still run into people you know. I think that's my favorite part about this scholarship. [LASBFG1]*

Most students felt that these community bonds were fostered by living together and by spending the summer in close proximity to one another:

> *I had an amazing time in the dorm, like we had so much fun. And I lived in the dorm a year after and I loved it. We had our own hall for just LA-STEM students. I just would open the door, walk down, hang out with my friends; they'd have their doors open and we would just hang out all the time. Whenever we weren't doing homework we'd go hang out. And then if I'm doing homework on a day that we didn't have tutoring and I needed some help from our head [peer] mentor, I'd run down, knock on his door, get some help, run back, finish my homework and then I'd actually end up running back down to the hall and hanging out with them the rest of the night. So, the community that was built was amazing. I'm still friends with pretty much everyone. [LAREUS4]*

Students also thought that organized activities and mandatory weekends contributed to community bonding:

> *We did a lot of bonding activities. Learning everybody's names and things. They were a good addition. I think that whenever you share common interests, or common feelings about being in boring situations, it kind of brings you together. And then we would have these required weekends where we'd stay on campus, and they'd usually have maybe one activity planned for the weekend, which would take up a couple of hours. But then you'd have the rest of the weekend just to hang out in the dorm and we found a lot of interesting ways to spend time. We had water fights in the halls and it was a lot of fun. [LASBFG1]*

> *STUDENT 1: One Saturday we went bowling. We had a water fight with water guns, we all started to run around…*

> *STUDENT 2: …Had a talent show. The social activities, I think, is what really bonded us together. 'Cause we got to be around each other outside of academic settings and we could act crazy. It was fun. [LASBFG5]*

Socializing in the evenings with other LA-STEM students and participating in other organized social activities with other LA-STEM students were also seen as highly positive program elements. The parties at Dr. Warner's house and water balloon fights were particular favorites.

A few students also told us that Summer Bridge fostered community simply by introducing them to other young people with similar interests and personalities (an

experience that was perhaps rare for some of the 'best and the brightest' at their home schools):

> *STUDENT 1: The program itself does foster, y'know, they put us in these activities and make us work together with people, and all those things that just help you build relationships with people. But I think, in general, the types of people that they pick, they pick people that they think will get along. They pick personalities that might be able to work together. So, just coming in last summer, everybody was already open to meeting new people. And we all just got along with each other. So everything went smoothly straight from the beginning. … When I was here last summer, I discussed it with some of the other people in the program, like, "They really know how to pick a group of people." 'Cause we are all completely different people, yet at the same time we can all just get along perfectly. It was great. [LAREUS1]*

> *STUDENT: We definitely - friendships. Not from before, because we didn't know each other, but all of us are here are here because we have something in common, because I think that we are basically the same type of person. You know, we're all ambitious; we all have goals; we all care about our schoolwork. We're here because we are scholars, and that is something that we all have in common, and for me personally, and I think for a lot of people, it's easy to talk to other people who are like yourself. And even though we might be from different majors, might be from different places in the country or in different cities in Louisiana, or we might have different religions, or different races - that all kinda takes a backseat, because the things that are most important to us, which is our education, that's what's most important to them as well. So, it was really easy to work with other people – [LASBFG1]*

Most students (37) told us that friendships they built during Summer Bridge carried over into the academic year. These continuing relationships were quite strong, forming the basis by which students became roommates, developed study groups, and discovered lasting friendships:

> *[Summer Bridge] has had a huge impact because we all work together. I have friends that, you know, we compare notes with each other and when we do homework, we work on the work together; we explain concepts together. And I've become friends with all these people that I probably otherwise would not be friends with, because I'm usually more shy. I'm not someone who approaches people right away and asks for help, so it was nice for me to meet these people right away. It's helped me out, and I've in turn helped them out a lot as well. It's still going on right now. I plan to actually room with one of the people I've been working with since Summer Bridge next year. We're in the same major and everything like that. We've been working together, we've been taking classes together, and things like that since Summer Bridge. [LAREUS12]*

Some students told us that friendships that carried over from Summer Bridge were not necessarily easy to maintain because the group became more diffuse during the academic year and students did not see each other very often. This was especially the case for students who were alone in their discipline among LA-STEM scholars, or who otherwise shared few classes with other students from their Summer Bridge cohort:

> *STUDENT 1: We're unfortunately pretty separated [now]. I just so happen to be next door to someone who's in LA-STEM but I think that's just a coincidence. … Most of us are on campus, so it's not too hard to find each other if you need to, but we're not in the same classes anymore. During the summer—since there were only a few classes that were offered during the summer—we happened to be in each other's classes. But now that there's like...*
>
> *STUDENT 2: A million!*
>
> *STUDENT 1: …Yeah, a million classes you could be in. Chances are you're not gonna be in the same class as someone else. So, I guess in our Tuesday and Thursday classes—that's the LA-STEM class—we find out who's taking what classes, and if we just so happen to have the same teacher but at different times, then you could organize a study group or something. But, we're not together as often anymore. [LASBFG1]*
>
> *During the academic year, we're more spread out. We're not around each other as much. 'Cause, over the summer, we used to eat lunch together, pretty much go to class together, because we all had the class at the same time. And now it's like, we'll see each other walking around campus somewhere, and we won't get to see each other until we have our UC class. So, over the summer, it's more close-knit together, whereas during the academic year you have everything going on and stuff. [LASBPMS2]*

A few students suggested that one possible solution to this problem might be continuing to house students together after Summer Bridge was over. A few students also suggested that the LA-STEM program should provide more opportunities for each of the cohorts to get together as a group during the academic year. Some mentioned that it might be a good idea for the entire LA-STEM group to meet and socialize occasionally so that students had an opportunity to meet more LA-STEM participants.

3. Encouragement to do research during Summer Bridge

One benefit of the Summer Bridge program was that it introduced students to real science in a way that many of them had never been exposed to before. The two main ways it did this were through field trips to research laboratories and presentations by professional researchers.

Overall, students found the field trips to be a positive experience. Field trips were fun, engaging and inspiring:

> *When we came to summer bridge we [took a field trip] to CAM-D. It was good because I actually like seeing the research hands on. We went to the lab and we saw, I think it was an electron accelerator or something like that. It was really cool to see the type of things that we could actually be involved in, because I think they had undergraduates there at the time. So, it was really interesting because, when you think of research as an undergraduate, it's like test tube cleaning or secretary work. You don't really think you can have a hands-on approach to it. So actually going to the lab was like, "Wow! That could be me!" [LAREUS17]*

Three students specifically told us that seeing scientists working in a laboratory environment and having the opportunity to talk with them helped to clarify their ideas about what they wanted to major in or the career they might want to pursue:

> *We went to an industrial factory where we talked to several Ph.D.s, mostly chemistry Ph.D.s, and I saw what they did and then we had several discussions about how to become, the tenure process and everything it takes to become a professor, and then what professors actually do and it just, it made my choice for me. It was informative and that's what I needed. [LAREUS4]*

One outcome of students' exposure to different research laboratories and faculty presentations of their research was that students reported increased interest in doing research. They wanted to know more about what real research is like and what professional scientists do:

> *INTERVIEWER: [Did you go on the] field trips?*
>
> *ALL STUDENTS SIMULTANEOUSLY: Uh huh. Yeah.*
>
> *STUDENT 3: And that was really mind-blowing. I don't know. Some of the stuff they talked about, it was like, "I remember learning about that in physics, and now I'm seeing it actually applied." I didn't think they actually used this stuff, I just thought it was stuff they kinda made us learn, just out of cruelty! (LAUGHS) But it's an actual particle accelerator!*
>
> *STUDENT 1: I liked the visit to LIGO. I thought that was pretty exciting. It made me want to do research over the summer. [LASBFG3]*

However, a number of students said that the field trips were "over their heads" or lacked relevance to their own interests:

> *INTERVIEWER: What about the field trips that they organized? Were those useful to you?*
>
> *STUDENT 1: They were good. Some of them were a bit long, like the topics were way too advanced, for me at least.…*

*STUDENT 2: At least for me! (LAUGHS)*

*STUDENT 1: Yeah. I did not understand a word that they were saying, but I noticed that the physics majors did understand them. I guess they just had strong backgrounds in those subjects. But I thought that it was interesting. It was a good experience, and maybe one day I could go back and understand what they're talking about.*

*INTERVIEWER: Would it have been helpful, say, if they had targeted a field trip that was more relevant to you as engineers?*

*STUDENT 2: I think so. I definitely think so.*

*STUDENT 1: And LIGO, too, was kinda physics.*

*STUDENT 2: [But] the field trips were fun!*

*STUDENT 1: They were fun. [LASBFG1]*

Overall, students—especially engineering majors—were less positive about the science presentations than about the field trips. While some told us they were fun and engaging, more than half of students observations [21/36] complained that the presentations did not relate to their disciplines and, thus, did not give students a sense of how the science worked in their chosen fields:

*STUDENT: There's probably at least 10 or 15 engineers, and there wasn't really any engineering lectures. A lot of it was math; we only had one math major. A lot of it was physics; we only have three physics majors. The majority of the people are majoring in chemistry, biology or engineering. We had a good bit of chemistry going on. I know Dr. Warner, he's a chemistry guy, so he really pushes that, but as far as anything with biology or anything with engineering, it was kinda lacking.*

*INTERVIEWER: Okay. So in the future you would recommend maybe they could…?*

*STUDENT: More diversity from the different disciplines that we have majors in. Maybe focus a bit more on certain disciplines where the majority of the participants in the summer bridge are that major. We had a lot of, um, lecture topics that were repetitive. [LASBFG1]*

*We got a lot of biology and chemistry professors to come and talk to us, but the engineering side was lacking a bit. I didn't get to see a whole lot of engineering things that I was excited about. I think we've gotten a lot better about that since we've spoken up and said we wanted to make some changes in that area. [LAREUS19]*

*The focus on the faculty presentations was more towards the Chemistry majors, which was understandable. Chemistry, biology, they have more professors that were willing to go talk. But it was difficult as a physics major; we had one physics professor come talk to us and he talked to us about computing. He didn't even talk to us about physics. So, that was the only issue with that, and we've expressed that many a time and it seems that they've pretty much fixed that. They have a lot more people coming in, a lot more variety than what was there before. [LAREUS4]*

4. Academic preparation provided during Summer Bridge

As noted earlier, students appreciated the opportunity offered by Summer Bridge to gradually "ramp-up" to the coming semester by taking classes during the summer. Aside from learning how college classrooms operated differently from high school, students liked the idea that they were able to get ahead on fulfilling their course requirements. Gaining course credits for classes taken during Summer Bridge freed up room in students' schedules, giving them more flexibility during the academic year:

*Coming here last summer, with the Summer Bridge program, helped a lot, 'cause I got to take Calculus 2 then, which put me ahead by a year in math. And just getting to see how the class worked out, and the teaching, made it easier in the fall. I started out with Calc 3 in the fall, and then I took differential equations in the spring, and at that point was technically done with all the math I had to take. But three more classes gets the minor, so that's why I'm doing that. It put me ahead and now I can take more classes that I might not've been able to otherwise. [LAREUS1]*

Students also reported receiving useful academic advising and tutoring during the Summer Bridge session:

*The best thing about [Summer Bridge] was a requirement that we had to do open house tutoring. We had to go three hours a week to the same location, and they had certain times - like three times a week - they had times that you could go. And it was just basically everybody over there studying together, which I didn't have much to study for, but it helped the other students a lot! (LAUGHS) That was just really good, developing study habits. It made people sit down and do it, so at least in the Fall you know that you gotta sit down and do it. [LAREUS20]*

*They require us to meet with one of the managers or a person higher up in the program to discuss just things that are concerning us, and I know this summer, I was having some second thoughts about what my major was going to be, and so I met up to talk with one of our program managers and talking to him was really helpful and really helped put things in a perspective. He was able to refer me to our Center for Academic Success and places that I could look and see what kind of careers I could do with the different majors I was contemplating and stuff like that. So it was just really helpful to have them require us to go in and talk to them,*

*'cause in talking to them, sometimes problems we didn't know we had come up, and we're able to fix it. [LASBFG2]*

5. Gains in skills

As elements of Summer Bridge, program staff provided students with information and learning strategies to help improve academic performance. Program staff provided workshops on time management, study skills, presentation and public speaking, and long-term goal setting.

A few students also mentioned increasing their social skills and becoming more outgoing. They attributed this to being among a community of people with similar interests and personality types:

*[Summer Bridge] also gave me a lot of other skills, like public speaking. 'Cause I had a huge problem with it, so I got a chance to do it more and more, and present myself in front of people during presentations. That was one thing that I can take with me throughout life. [And] just interpersonal communication and day-to-day communication, talking to people whether formal or informal. [LAREUS10]*

*[Without LA-STEM] I wouldn't have known anybody. I think from my graduating class 2 other people came here and then there are maybe 10 other people about that I had already met from previous years at my high school. But besides that I didn't know anybody. And I guess I'm kinda shy at first, so it helped to come in and kind of be in a situation where you're pushed to get to know people. So that helped a lot. And then when Fall comes and all their friends come here, you get introduced to their friends so you kinda grow through them. [LAREUS23]*

*I felt that was a good part, to make connections. Right now, as freshman, there's gonna be somebody in your class that's from LASTEM. Being in LASTEM kinda helped my social skills, too, so I feel a little more open to people. […] I actually like people who are spontaneous, adventurous, like doing stuff. I would like somebody who could speak my language in certain subjects, but you know, I could do without that if they were a good person and they just loved doing stuff. Just going out there and like, "Put up the books - we're gonna go to the mall and get dinner, get out for a little bit." And all these people [in LA-STEM] are like that, so I was like, "Sure, why not?" I mean, we have our priorities, so we still do our work, but still. [LASBS2]*

Students largely reported "mixed" feelings about the benefits of the service-learning project, which involved designing a playground. Some students found it enjoyable; others didn't see the purpose of it. Overall, while students felt the service-learning project was fun, they had trouble understanding its relationship to their studies. Students did not appear to have derived much investment into the community from it.

### B. What could be improved about Summer Bridge?

For the most part, students were positive about Summer Bridge and felt that it worked well. Most of their advice for improving the program centered around organization and scheduling issues. Several students told us that Summer Bridge *has* improved and gotten more organized over time.
From students' feedback, one area that could be improved would be making activities, field trips and lectures more inclusive of different majors. However, we did hear from several students that Summer Bridge was already working on how best to address this issue. Summer Bridge was not as valuable for students who entered as sophomores and juniors as it was for freshmen.

In summary, students valued the Summer Bridge program for the very reasons this element was incorporated into the structure of the LA-STEM program to begin with: it helped ease students' transition to a large campus and encouraged their integration into campus life by building a strong community among LA-STEM participants, faculty members and program staff. Living and socializing with each other on daily basis for a sustained period built camaraderie, friendships and personal support among group members. Opportunities to meet faculty, hear about their research and to visit local scientific laboratories encouraged students' interest in doing research themselves and widened their view of future career possibilities. Students appreciated the chance to experience their first-college level courses and to understand what was expected of them in a more measured way before taking on a full course load. Many also recognized the benefits of earning "extra" course credits that would allow them to advance faster or the time and flexibility to take courses that might otherwise slow their academic progress. Students also reported that they benefited from learning strategies to help improve academic performance, the workshops on time management, study skills, presentation and public speaking, and long-term goal setting. From students' accounts, LA-STEM program staff were aware of issues seen as problematic and were working to improve Summer Bridge based on their input.

## VII. Mentoring

One of LA-STEM's major goals is to provide student scholars with mentorship from a variety of sources throughout their tenure at LSU. Broadly, the program seems to be reaching this goal, although perhaps not as deeply as they could be. In 36 out of 38 interviews, students reported getting some kind of mentorship from one or more of the following sources:

- Research advisors
- Peer mentors
- LA-STEM program staff
- Faculty mentors
- Being a peer mentor

## A. Research advisors

In a later section of this report we present student outcomes from participating in research, and there we will detail the benefits to students of gaining collegial working relationships with their research advisors. Here we characterize the structure of students' research experiences.

As, is common at a large research university, most students reported working closely with a graduate student rather than with the faculty member; just seven students reported working one-on-one with their faculty research advisor, rather than with a graduate student, though another five told us that they had formed good, working relationships with both their faculty research advisors and the graduate students who directed work in the lab. Three students reported working in a large research lab; four said that they worked in a small lab group; only five mentioned working directly with other undergraduate researchers.

Overall, a majority of students described positive research experiences in which their research advisors provided appropriate guidance. Many students viewed their research advisors as mentors. However, the depth and degree of mentorship that students received from their research advisors varied greatly, by some accounts. Two students reported that their research advisor did not provide any form of direct mentorship.

Despite the fact that not all students had an equally close and collegial mentoring relationship with their research advisor (whether that role was filled by a faculty member or a graduate student) almost all students reported deriving some value from their experiences. We asked students what qualities had made for a successful mentoring experience. They told us a good mentoring experience included a research mentor who was:

- accessible
- patient
- accommodating of the student's school schedule and academic priorities
- good at helping the student understand the scientific process by signposting and talking about the "big picture" of the research
- invested in the student's success
- good at communicating

Students, especially those who reported none or limited mentorship, also commented on what was *not* helpful in a faculty research advisor. A bad mentoring experience included:

- Advisors who were inaccessible, busy, high-profile, not in the lab very often, lacked time or commitment to mentor students
- Advisors who provided little direction or discussion of the research leaving students unclear or confused about what he or she was supposed to be doing
- Advisors who used students as "slave labor" rather than engaging students in authentic research

Students also offered advice for their faculty research advisors:

- Build a relationship with your mentees; stay involved in their lives
- Remember that students do not know everything; be patient with them, provide encouragement and validation
- Give students real research and intellectual stimulation; talk to them about the big picture of research
- Talk to mentees about your job; What is it like to be a scientist?
- Make sure you have the time and energy to really commit to mentorship before taking on students

## B. Peer Mentors

Peer mentoring is an element purposely structured into the LA-STEM program. During Summer Bridge, several more senior LA-STEM students volunteer to serve as peer mentors for all of the new, incoming students. At the end of summer, freshmen are paired with more senior LA-STEM students, with every effort being made to match students by academic major so that the older, experienced student is well-positioned to advise his or her mentee about courses and which faculty members to take, to help with homework, or provide resources and practical tips. Functions of peer mentoring, like Summer Bridge, are to help ease students' transition to college and to support their academic success. In this respect, peer mentorship clearly contributed to students' positive experiences within the LA-STEM program. More than one-third of students' comments about mentorship (during Summer Bridge and the academic year) mentioned ways in which peer mentors helped support them, academically and socially.

Most frequently, students told us that their peer mentors were helpful, accessible, and fun to talk to. A few told us that peer mentors are the *most important* part of the LA-STEM program:

> *There's always somebody that you can talk to that knows something about what you're going through or what you're getting ready to go through and they can always give you some advice. I think the [peer] mentoring is one of the best... probably the best thing is, it's definitely the best thing about the program 'cause you're never on your own, you know there's always somebody you can get in touch with. [LAREUS23]*

About half the students we talked to about peer mentors told us that mentors are able to give good advice because they had recently been through similar academic and personal experiences as the students they were mentoring:

> *You get to really, really know one person very well and the way they select you is based upon your time in the program and then your major. So you're not stuck with like, a Computer Science major. I would have no way to help them, whereas with [my mentee] I can tell him "Oh, you should take that teacher. I think that that suits your learning style" or something. And then my freshman year, my*

> *mentor was a year above me so when I came in he was like, "Oh, these are the classes you take, maybe you should put that class off later. You know, these two are kind of hard classes. That might be a little difficult for you. You might want to separate them into semesters." So he was really able to help me know how to be a very good mentor for someone else and he was graduating so at the same time he gave me advice on his graduating process. Taking the GRE, applying for grad school, so I got to watch him go through that process. I learned so much through mentoring. [LAREUS16]*
>
> *The peer mentors actually helped with telling how classes were gonna be, better than anything. 'Cause, you know, they've been there. They definitely helped with saying, "Okay, this is what certain teachers do," and it's like, "Be careful, don't slip up. Go see your teachers. Get to know your teachers." [LASBS2]*

The consensus among both peer mentees and mentors, is that peer mentors are most helpful when they share specific majors and classes with their mentees:

> *I don't think it's really that much benefit [to peer mentoring] unless-, the times it's most beneficial is-, when I was a peer mentor in Physics, my mentee is in Physics, he's having a problem with this particular course and I can say "Who do you have?" And maybe he has a hard professor or a professor I know that gives homework that's kind of deceiving for the test or something. And I can say, "Maybe you should go and see this other professor." And that's very direct, very specialized. [LAREUS14]*
>
> *With peer mentors you have people in your major. So I'm dealing with other mechanical engineers who have taken Statics, Dynamics, some of the hardcore classes in engineering. And so whenever I'm scheduling, you know, signing up for activities, anything, I can consult with them and actually hear a first hand experience of how a class is going to be or how demanding something's gonna be or whether to watch our for something. I have someone who has a foot in the door, I think kind of got me better. [LAREUS17]*
>
> *The mentoring thing, it's kind of an issue, them not being here. I have a lot of friends that are sophomores, and a little bit of juniors in the program, but they're not my major. They can at least help me right now; I'm kind of in general math and science classes. But when I get into like Analytical, Organic, and then even the other junior and senior year [classes] […] I have no clue, you know, what they'll actually mean to me when I get there, because I've never met anybody that's been there yet. [LAREUS20]*

Some other ways students reported peer mentors being helpful:

- Peer mentors were organized, strong leaders, and positive role models
- Peer mentors were collegial, not condescending
- Peer mentors helped students network with other mentors and research faculty

- Peer mentors helped students organize and make the most of their Individual Development Plan (IDP)
- Peer mentors' enthusiasm for research and LA-STEM was contagious
- Peer mentors offered emotional, as well as academic support. They talked to students about personal problems, and students felt that simply having someone to talk to was therapeutic. Some students said they were more comfortable talking to peer mentors about certain issues than to program staff.

Some students had less successful peer mentoring experiences than others. About half as many negative as positive comments were offered by students when describing their experiences with peer mentors. Generally, bad peer mentoring experiences were caused simply by a lack of things that made for *good* peer mentoring experiences. Students told us peer mentoring was less valuable when:

- Peer mentors did not offer much advice or engage with students during weekly mentoring sessions
- Peer mentors were *not able* to offer valuable advice because they had not had the same classes as their mentees or had done poorly in them
- Peer mentors were condescending

A few students told us that peer mentors were hard to take seriously because they did not have much more experience than the mentees themselves, were not very good students, or were otherwise unprepared to be mentors:

> *They assign [peer mentors] by major generally, but there's nobody else in my major so we were kind of like an 'Other Engineering' lump there. My mentor was a biological major and then I think he switched over to biological engineering. I didn't really like being assigned to him because I was in a class with him, and he missed class and [was] always asking for homework a lot like, "What was the assignment? Oh, you know, what happened in class today?" So I couldn't really look up to him. And then he switched his major so he's just as far as me; he's really not ahead. It was kind of an annoying situation. I knew that I couldn't get any help. [LAREUS6]*

Some older students told us that they had relied on their peer mentors early on in the program, but that their need for peer mentoring tended to drop off as they had advanced in their course work and gained experience in college, generally.

A few students told us that they did not have peer mentors. Three students told us that their peer mentor had left the program early and had not been replaced by another. The two other students were not aware of having been assigned peer mentors and although they seemed interested in having a peer mentor, were unclear about how to find one.

Peer mentors played a critical role in helping newer students find their way. Students described their peer mentors as providing valuable advice about what to do or not do, and how best to do it—as a great ally. The majority of students reported positive experiences

with their peer mentors, only a few mentioned that their peer mentor was unhelpful (either because the mentor majored in a different discipline or performed poorly academically) or that they did not have a peer mentor. Largely, students reported that their peer mentors had served as a role model and detailed the qualities of a good mentor and ways that peer mentors were most effective; this knowledge would be passed down in practice. Peer mentors provided a social connection that supported both academically and socially. Overall, peer mentors worked effectively to help students negotiate a successful academic pathway.

### C. LA-STEM program staff

Strong support from program staff is another element intentionally structured into the LA-STEM program. In talking about mentorship a less than one-quarter of student observations about mentorship discussed LA-STEM staff as mentors. It was difficult to distinguish clearly between students' comments about staff roles as advisors and/or as mentors since there is clearly a continuum of involvement between the LA-STEM program staff and students. Aside from comments about turnover in program staff, generally, students talked about the benefits that LA-STEM staff had provided. Most of the students who talked about LA-STEM staff told us that they got academic support from the program managers and it was widely felt that the managers were accessible, helpful, and motivating. Many students mentioned they had weekly meetings with program staff. These meetings were especially helpful in the early years of college. Several students told us they appreciated that LA-STEM program staff kept close, sustained track of their progress and would not let them "slip through the cracks." Many students described the program staff as being like family.

> *INTERVIEWER: if you could give advice to other students who are considering the LA-STEM program, what would you say to them?*
>
> *STUDENT: I'd tell them definitely go for it. It might seem overwhelming when you hear about all of their requirements and stuff, but they help you meet your requirements. They don't just let you in and say, "You have to do this. Bye." They actually help you deal with your problems, help you do things. They actually try to, uh, let you know about resources that can help you improve your grades and not doing... if you're struggling in the class 'cause they, they know about all of the resources that are available on campus. Any time I go in there and I say something about this and they go, "Hey, you can go to this person, this person, this person. You can go here, here." And I'm like, "Well, I didn't know anything about all this." So they know what you need, they know how to help. And they try their best to help you. I like that a lot about the program. So they tell you what you need to do and they help you do it. So that's why, that's a really good thing. 'Cause I know a lot of people will just give you a list of requirements and tell you, "Ok this is what you have to do, go do it and I'll see ya later." The [program staff] say, "Ok this is what we want you to do. Try it and see how it works for you. If you have any problems come back to us. If you don't have any problems come back to us and let us know how things are going so hopefully we*

> *can keep it going that way." So they're really, they try to be involved with what's going on with us as much as possible. [LAREU23]*
>
> *INTERVIEWER: Has the LA-STEM program provided the right kinds of support that you've needed to succeed at LSU?*
>
> *STUDENT: The program itself…certain aspects of it have, I could say, yeah, they have. For example, just being able to talk to the program managers and tell them, you know, what your problems are. It's pretty nice to have someone that will sit down and just interview with you when we have our meetings with them and they're always approachable. We can, set meetings with them and they'll want just to talk. And they usually give pretty good advice about how to approach situations. But it's also really nice to have somebody that's not your friends, an outside source that's actually interested in what's going on with you. So it's kind of, I guess, I've really kind of liked that idea of that kind of a family here that's kind of looking out for me. So, that's probably been one of the biggest benefits for me, in terms of the program throughout the year. [LAREUS12]*

In addition to providing academic support, tracking and advice, some students also described relationships with program managers that were more akin to deeper mentoring relationships. Nine students told us that they considered one or some of the LA-STEM staff to be a mentor. Students reported that staff advised them about their academic careers, wrote them letters of recommendation, and encouraged them to enter national competitions. These students felt that the program managers had their best interests at heart and cared personally about their success:

> *The main thing I like is really the networking of the whole thing um, like, for the summer internship like I would have never found that if it wouldn't have been for the LA-STEM program and they, they're really looking out for us and you can tell that they have our interest in mind and there's no like, ulterior motives, they really want us to succeed and they really want us to do well. And so, I mean sometimes I think they have kind of strict requirements but at the same time it's only to make us, you know, strive to be better and to actually be competitive applicants for grad school or whatever we plan on doing afterwards. [LAREUS17]*

In terms of services provided, students had no critical comments. However, during interviews, students told us they couldn't comment on some aspects of the services provided by program staff because they had not encountered them. For example, one student told us that he did not have regular meetings with staff and was not aware that he was being tracked. A few students told us they did not rely on LA-STEM staff because they felt they should be responsible for taking care of their own problems.

The only major issue of criticism concerning LA-STEM program staff was directed at the turnover of program managers and counselors in the LA-STEM program after the second year. We heard from quite a few students about the turnover of program management. New staff members were seen as having made major changes to the program, to which

veteran students were initially quite resistant. Students told us that they eventually adjusted to the new managers, and expressed a sincere interest in helping the new managers succeed.

Students criticized the management turnover from two angles, commenting both on how it had negatively affected them personally and on how they saw it negatively affecting the program as a whole. Most commonly, complaints of this kind came from students who felt they had lost important personal bonds that they had developed with the original program managers who had counseled them and supported their progress early on in the LA-STEM program. The following discussions are representative of how closely the initial, small LA-STEM cohorts had bonded with a supportive, caring program staff:

Exchange 1:

> *STUDENT 1: I feel like LA-STEM is going down a bad road. I dunno if you all see this too. I feel like it's becoming more impersonal. Not necessarily between us, but between all of us and the office. I just feel like, y'know, people are always leaving, people are always coming, and we don't really know who works here sometimes, and it's just real impersonal. I know when y'all were here, y'all were really close with the managers.*
>
> *STUDENT 2: Yeah, we had MLK. Monica, Lisa and Karin. And it was like, they were your mothers. From another, I guess, life. (LAUGHTER)*
>
> *STUDENT 3: It was funny, 'cause just as we were making her our mother--we loved her dearly--she left us! That's why-*
>
> *STUDENT 2: Turnover.*
>
> *STUDENT 3: Yeah. I wanted to cry, because she basically-. I went through a lot of stuff this summer, and she got me through this entire summer. And she's still on the campus, and I go see her every week, just because she was that important to me. So, it feels like, once we've formed this little bond with the managers, they leave.*
>
> *STUDENT 1: That's why I say it's just really impersonal. [LAREUFG2]*

Exchange 2:

> *STUDENT: Our first set of program managers were probably the ones that I was closest to. They were the ones that like, I mean, Karin's still here but she's kinda in and out with her Master's program and her baby, and, you know. But there was Ms. Lisa who left, I don't know…mid-sophomore year, of my sophomore year. She knew who my dad was, she knew who my brother was, like, you know, and, she…didn't just say "Uh huh, ok." Like she was real about things, like, "Let's fix it! Let's get to the bottom of it," and I just felt, I mean, when somebody*

*knows what your brother's name is and what your dad's name is and asks how they're doing, it's a lot more personal and you feel like you can talk to somebody a lot more....*

*INTERVIEWER: It sounds like early on when you may have really encountered some difficult problems as a freshman or a sophomore that the program staff were there for you when you needed it.*

*STUDENT: Right, they were. [LAREUS7]*

Exchange 3:

*STUDENTS (SPEAKING TOGETHER): I've also seen the program change management, you know? It went from Monica, Lisa and Karin...(SHORT PAUSE) to Monica and Karin...(SHORT PAUSE) to Ms. Sibley, and now we have all the new management, so I've also seen that!*

*INTERVIEWERR: Ok, well comment a bit about that. Has that been difficult, for you? Or?*

*STUDENT: Um... The first time it was difficult because (SPEAKING SOFTLY) nobody was used to it. We had these great… Well, lemme put it to you this way, the 18 of us...(SHORT PAUSE) knew Monica, Lisa and Karin really well. …There were only 18 of us...(BRIEF PAUSE) and now that there's a 100 of us! ...I don't see how those people can do it! (LAUGHS) But...(BRIEF PAUSE) Monica, Lisa and Karin we knew really well and it really hurt us for them to go. Once again we, you know the people that replaced them were great people...(SHORT PAUSE). And at first nobody wanted to get to know 'em…. But, we gradually moved into it. You know--we adjusted.*

*INTERVIEWER: So you were a little resistant to change? (CHUCKLES)*

*STUDENT: Not a little, we were very resistant to change. We were pretty upset when Lisa alone said she was leaving, and she was the first to, you know, move on. We were really upset when that happened. (LONG PAUSE) But it worked out.*

*INTERVIEWER: I guess that strong feeling is one testament to how well the Bridge program and the LA-STEM program were working...(BRIEF PAUSE) in helping you to feel like a small community, and that you belonged, and that people cared about you. It sounds like, you know, in some sense you felt like you were being abandoned!*

*STUDENT: Yeah! Really! It really did! [LAREUS18]*

More broadly, students' major criticism of the staff turnover was that they felt it had made the program more impersonal. We heard this complaint most often from older students who remembered the smaller and more intimate community during the first two years of LA-STEM. Students recognized that the growth of the program over the four years made it difficult to retain the original intimacy that early cohorts experienced. However, some students, even those sympathetic to program staff's numerous responsibilities, said that the turnover in program staff contributed to their feeling that the program managers did not know who they were as individuals:

> *INTERVIEWER: Did you have any advice for the LASTEM program? Is there anything else that you wanted to say about the program?*
>
> *STUDENT: I suppose I would just take this time to reemphasize what I would say is the major problems. The major problems are the sort of two faces that you see, the public face and then the fact that there really is no accountability. That they're understaffed, that they talk about the personal nature of the program and you feel disenfranchised. I don't feel part of the program, you don't feel that they're a part of the program sometimes because you keep turning over new program managers. The primary concern for the program, I think, should be retaining the managers and possibly, I think the big thing would be, hiring other people in the office, whether it's one or two graduate students or a full-time employee or something…. Because you have 100, I don't know how many are in the program now, maybe over that. One hundred, 120 students? All turning in assignments. You expect them all to turn in time sheets. You expect them all to turn in reports that they've done community service. You expect them all to schedule mentoring meetings every semester. That's 120 meetings, 60 hours, even if they're half hour meetings done clockwork, which doesn't happen.... You just can't fit all that um, into three people…. They don't have someone checking to see who in particular doesn't have things. And so what they do is they just sort of look and they say "This looks like less than 120 forms here so there's people who aren't..." So they send out a mass email that says, "Hey everybody, do this." Which doesn't make me feel like any more part of the family, doesn't make it feel like you've been noticed, you've been caught. So that's why you continue to have people who don't do it because there's no repercussions…. And it's because they're so overwhelmed with other work to do. [LAREUS14]*

Students also felt this turnover was the root cause of much of confusion and disorganization in the program, as incoming staff initiated and implemented new and different rules and requirements for the LA-STEM program:

> *INTERVIEWER: You were saying the program requirements were…*
>
> *STUDENT: It just, sometimes it gets to be a little frustrating when, you know, in my experience in the past four years we've gone through three sets of program managers and I don't know whose fault that is or why people have left... And so with that comes, each time, like, with a new set of faces with a new set of goals*

> *and objectives to where they think the program should go and how they, you know, think that they can improve the program. [LAREUS26]*

Finally, students expressed a great deal of confusion about why managers left the program so frequently. Some felt upset that their departures were never discussed openly with the LA-STEM student community, and a few intimated a belief that something must be driving managers away from the program:

> *STUDENT 1: It must be something really internal that's going on with the program managers leaving. 'Cause Dr. [X] had everything going for her. She has a PhD in chem. She chose to be a program manager here. So why would she leave in a year? So something about that is not selling to us.*
>
> *STUDENT 2: We kinda wanna know why-*
>
> *STUDENT 1: And it was never addressed to us either. She just leaves….*
>
> *STUDENT 2: So we're just totally in the dark. [LAREUFG2]*

Despite feeling some confusion and frustration over losing program managers with whom they had built strong personal relationships, students were understanding and had some positive things to say about the new hires. Several students (mostly but not exclusively younger students), told us that changing managers has been good for the program because the incorporation of new energy and new ideas had helped the program evolve. Students were clearly supportive of seeing the new managers succeed:

> *We have to have our meetings with them…. I like the new program managers 'cause they're very enthusiastic, and they're very intelligent and young. You know, so it's like a lot of new energy. …They want us to do well…. I think the two right now are very promising…. And we have a lot of, they have like 100 students they have to manage basically and that's a lot of people to keep track of. I think the new program managers are pretty promising, if they'll stay a while. (LAUGHS) It really worked itself out as soon as Dr. Warner realized that there was a problem and solved the problem and now it's over and that's part of the past and we're moving forward from there.... (BRIEF PAUSE) Comparing the first semester of LA-STEM... (BRIEF PAUSE) under Monica, Lisa and Karin, to this semester now, I'd say that this semester's better. …It's evolving; it's not anything that's stagnant. [LAREUS18]*

Students also felt that the program was becoming more organized with the input and direction provided by the new staff members:

> *It makes it interesting because each person brings in new ideas and sometimes a turnover is, causes chaos and that kind of stuff. But I think this time, the most recent managers that we have, have been so organized, which is, has been a big*

> *problem in the past with the other managers here, so. And this time everything's laid out for us. We know exactly what we have to do. [LAREUS13]*

Students were positive about the new managers. Students told us that they were good people, that they cared about the students and that they had made an effort to seek out and take seriously students' opinions when making decisions about the program:

> *I think that it should be noted that the people that are running the program, our program managers, they are an extremely talented and an extremely gifted group of people that deserve a whole lot of credit that unfortunately sometimes they don't receive. And, um, though we might not give them the praise they deserve all the time, they are truly the things that keep us all together and keep us very, very inspired all the time, which is very hard to do. It's very hard to inspire a group of people as large in number as this program and I think they do a phenomenal job. They should be commended for it, the work that they've done so far. Especially with the funding that we have presently right now and they've managed it quite well. [LAREUS16]*

Students told us that the program's managers get less credit than they deserve for taking on such a difficult job. We heard from students that they have faith in the program and expect that things will continue to improve over a period of adjustment.

> *If I were to say what they'd done well, we'd probably be here for another hour! (LAUGHS) ...I can't fault them on anything. The program managers, they've just gone through the process of changing, so we've gotta get to a point where they've got the program where they want it to go, 'cause, and I completely agree that they should have their own input on where it should go. It shouldn't be just some set thing, like, we get one person's ideas and that's what we follow all the time. It should be changing. Some of the people in the program don't necessarily understand that and don't like change that much, but I think, y'know, it's welcome. I mean, coming in last year, I really didn't know much was changing, because we had the new program managers already. So it was like, "Well, this is all I've ever known. Why are you people complaining? There's nothing to complain about." But, I mean, like I said, I can't really fault 'em on it, 'cause they're still in the process of getting things down, and everything's, y'know, set, I'm sure it'll go smoothly. I have faith in the program that it'll do well. [LAREUS1]*

Students advised the program to make long-term retention of management a priority, and also suggested hiring additional office staff to take on more of the administrative elements of management in order to free program managers up to focus on building personal relationships with students.

Overall, strong academic and social support offered by highly personable and resourceful program staff was cited by students as a highly positive aspect of the LA-STEM program. Students often described program staff as mentors who were active and pro-active in

helping them to succeed, supporting them both academically and personally. The only negative observations related to program staff concerned turnover in program managers, *not* poor performance. Indeed, the feelings of loss that students described indicate the success of program staff in their support of the LA-STEM students. Students from all cohorts described how program staff felt like "family" and how their interactions encouraged a strong sense of belonging among a supportive community.

## D. Faculty mentors

The role of a faculty mentor within the LA-STEM program, as the evaluators understand it, is to provide academic counseling to LA-STEM students majoring in their science discipline, much as a department advisor. However, students were almost entirely unaware of faculty mentors within the LA-STEM program. One student told us her faculty mentor had been instrumental in helping her find research; a few students thought they were supposed to have one, or were waiting to get one; no other students could tell us about faculty mentors. Given the dearth of responses to our questions, this area of the LA-STEM program requires strengthening.

## E. Being a peer mentor

Earlier we discussed the role of peer mentoring in supporting student and program success. Here we present student outcomes of serving as a peer mentor. Students' reports of acting as a mentor to a younger LA-STEM student were very positive. Of the observations related to the personal benefits and costs of mentoring another student, 104 were positive, another 10 were "mixed" observations (noting either a limited or qualified gain); only 10 were negative in character. Again, peer mentoring is an element purposely structured into the LA-STEM program to support incoming students, provide leadership opportunities for the mentors, and share ownership and responsibility for program success with the participant "experts" themselves.

Gains to students from peer mentoring include:

- The opportunity to help other students "give back to the program and community" (seen as a good in itself by students, this also illustrates investiture in the program/LA-STEM community)
- The opportunity to get to know students outside of their year and to build community and relationships
- Increased confidence in ability to teach, lead, mentor, be a role model; leadership skills and experience
- Increased confidence in student's own knowledge, understanding of the field (teaching others helps you learn); provides perspective on how far student has come since he or she was a mentee
- Learning new things from mentees: mentees' enthusiasm—for program, research, classes—is contagious
- Increased maturity, responsibility and patience
- Improved communication skills

Costs include:

- Most students say there are no significant personal costs to mentoring
- Some scheduling conflicts
- Some time is wasted during badly organized mentoring sessions
- Being a peer mentor uses up your one free summer

Mostly students were very positive about their peer mentoring experiences and it is clear that they took their role as a peer mentor seriously. They reported gains in self-confidence and how helping others in the LA-STEM community brought a sense of gratification. Assisting mentees with homework reinforced their own learning and they recognized how it helped to build community among like-minded LA-STEM students.

> *I realized how much I like helping other people. There's a new computer science major and I'm his mentor and he's really nice and he's taught me a lot about different types of people because he's very different, but yet he's so the same. It's really nice helping him and helping other people…. I help a lot of people study and it's really fun. 'Cause they usually take chemistry or a lot of them took calculus and I was good at that so that was fun and it helps you remember things that you kind of forgot…. I liked it a lot and I felt like I learned how to be more of a leader because I'm not that extroverted but I can still be a leader. I was still helpful to them introverted as I was…. I just had people wanting to know where everything was and how to get places and coordinate things…. But people expecting me to know certain things or be willing, be expert enough to tell them where to go, and like telling a group of people what to do was a little more challenging, but since they came into the program expecting these mentors, they listened to me and they knew. So it wasn't difficult…. As the summer went on, I was like, "This is such a great experience. I can be a positive influence to them as they can to me!" So it was just kind of like, kind of like a communalism kind of thing, and it felt really good to be a peer mentor! [LASBPMS2]*

> *I just enjoy interacting with people for one, but I like giving back too. I feel like I've been helped through the process, like getting my classes, scheduling, everything else. I also like tutoring, helping them. Even just hanging out sometimes, just kind of taking a load off. Because engineering is really stressful sometimes. So sometimes encouraging them to like, "Hey ya'll, you just need to relax. Just go watch a movie, go lay down, take a nap, do something." You know, "Just calm down. It'll be all right." [LAREU17]*

> *With my group, we all have just pretty much the same focus. We're all the same major. We have a fairly well-bonded group. We can pretty much talk. We get there and we pretty much work problems…. I have two mentees that are younger, that are actually freshmen, and one that's a junior. So we, we sit there and we discuss and then my two mentors…we all help each other and I find that the work that we get done in there is quality work that actually helps me because I*

> *remember it more after working with them. So I find that there is not really much of a downside to being a peer mentor. [LAREUS4]*

Some students told us that they had learned to mentor by having good peer mentors themselves:

> *INTERVIEWER: Did they help you with mentoring at all? Did you get any sort of advice or training about being a mentor?*
>
> *STUDENT: We got some basic advice. Most of it was more learned from the peer mentoring that occurred during class, along with some basic ideas, you know, "This is what you should do." But more of it's been what we've come up with…. My group has tried to convey as much of what we know to the newer groups, especially during Summer Bridge. And with peer mentoring, it also gets passed down during each semester because it's, it's a process of, "Ok, you've got a mentor. They're mentoring you. The next year you've still got your mentor but you've also got some mentees that you're mentoring." And so you kind of learn those dynamics. [LAREUS5]*

However, some students struggled with mentoring because their own peer mentors had not been very effective or committed so they did not have a good role model and felt unsure how to be a good mentor:

> *I think LA-STEM's really limited in what they can push to get out of it because they already require accountability for peer mentoring meetings with, uh, assignments or whatnot based on them, but I don't think that there's very much review of those, or it's not very critically reviewed. I think I suppose if they expected more out of the senior mentors and required it for their grade…. I know when I was a mentee for the first year my mentor just was like, "I'm out of here. I'm gonna be graduating in December," and just seemed really uninterested in what I was doing or what anyone else was doing and it was just kind of like were reading off the script, "Blah, blah, blah. Do you have something to say about that?" And then they tune out after that. [LAREUS14]*

In summary, participating in LA-STEM as a peer mentor brought many positive benefits. Students appreciated their role as an expert who could counsel against pitfalls, offer practical advice and offer personal support based on their own lived experience. They valued giving back to the LA-STEM program through mentoring their peers and, through the process, recognized how far they had come in their own personal and intellectual growth since they had first started in LA-STEM. Many reported gains in confidence and in leadership skills, learning patience, and becoming more mature. The bonds built between mentors and mentees reinforced their feelings of belonging to a community committed to supporting one another. Very few reports were offered concerning negative experiences as a peer mentor. Based on a few mentees' accounts, however, it may be helpful to provide students more formal training or guidance about how to be an effective mentor.

## VIII. Educational Support and Professional Development

In addition to research, mentorship, and a community of learners, LA-STEM also provides its students with more direct education about how to succeed. In this section we present results concerning program elements geared toward improving students' grades and the quality of their educational experience as undergraduates and program elements specifically intended to help students learn about, apply for, and get accepted to graduate school.

In discussing educational support and professional development through the LA-STEM program students reported the following gains:

- Encouragement during the academic year to do research
- Increased academic success, including being part of a community of learners, the program's GPA requirements, increased awareness of support services on campus, Individual Development Plans (IDPs) and LA-STEM courses, and skills learned in LA-STEM that were transferable to classes and studying
- Diversity awareness, and
- Support to persist in their STEM major and increased interest in pursuing a graduate or medical degree

### A. Encouragement during the academic year to do research

We heard from many students that one of the greatest gains they had gotten from their participation in LA-STEM was the opportunity and encouragement to do research. For the most part, students told us they would not have known undergraduate research was possible had it not been for LA-STEM:

> *[Research] sounded so complicated, like something you would do like when you're older, and maybe knowledgeable and stuff. I don't know really. It wasn't until I came to LA-STEM and they were saying, "Yeah, you can start with research." And I'm like, "I'm not that smart!" (LAUGHS) I knew I wanted to go towards the biology and I really didn't know what to do with it. I had some ideas why just, the research, I was kind of like, "Okay I'll do, try it." And I like it so far. And I just didn't know you were able to do that. [LAREUS3]*
>
> *INTERVIEWER: Would you have done research without LA-STEM do you think?*
>
> *STUDENT: I don't think so. I think that I wouldn't have known that I needed to do it even. I wouldn't have known that it was so available on campus. I don't think I realized how much of a research-based school LSU is. [LASBPMS3]*

Students also commented frequently that they were initially resistant to research or that they would not have chosen to do it without encouragement from LA-STEM but, having

done it, had discovered they enjoyed it or, at least, that much could be gained from doing it:

> *If I wouldn't have been with the LA-STEM program I would not even be interested in [research]. I'd probably get my degree, go out and work, make money, do whatever I had to do. But actually being involved in research—knowing that there is that possibility to go on, to specialize, to make a difference— I think that's probably the greatest benefit. LA-STEM guides you in that direction. It makes those opportunities available to you and it helps you get there too. [LAREUS17]*
>
> *INTERVIEWER: And so what inspired you to become involved with research?*
>
> *STUDENT: This program. (LAUGHS) I wouldn't probably be doing it without them.*
>
> *INTERVIEWER: Really. So what was it, specifically?*
>
> *STUDENT: Well, they just tell you it's good for you. And before I probably would've been like, "I don't have time." But they make you do it anyway.*
>
> *INTERVIEWER: So, since it was a program requirement, then you did it.*
>
> *STUDENT: Yeah.*
>
> *INTERVIEWER: But it turns out you actually really like it.*
>
> *STUDENT: Well, yeah! I think it's completely necessary and I wouldn't have it any other way.*
>
> *INTERVIEWER: Yeah. But you don't think that you would've done it without that requirement?*
>
> *STUDENT: No. (LAUGHS) Not at all. [LAREUS2]*

In addition to learning about research in general, students appreciated being exposed to information about summer research opportunities that they probably would not have heard about otherwise:

> *I definitely would not be anywhere near where I am right now without the LA-STEM program because when I got into the LA-STEM program, that's where I found out about MIT's summer research program, because we had a person come talk to us from MIT and that's why I applied. And so, as a direct result of that, the skills I gained [at MIT] got me hired by [a high profile research advisor at LSU] as well. [LAREUS12]*

Some students also told us that LA-STEM had made it easier for them to get good research positions. Students were cognizant of the fact that the research stipend allowed them to be accepted into labs where they otherwise would not have been able to work due to the research advisor's inability to fund them:

> *It does help that they give you a stipend for [research]. 'Cause it's really hard to, as a freshman, to go into a research lab and get paid. 'Cause sometimes they don't have it in their budget. LA-STEM makes it easier where it's just like, "No, you don't have to pay me," and most people are willing to take you in as a freshman. [LAREUS3]*

For others, the positive reputation of the LA-STEM program influenced their acceptance into a research position:

> *[With] most professors you say, "I'm a LA-STEM student" and they're like, "Oh yeah? You wanna come work for me?" They know that you're gonna be a hard worker and you're in it to really learn and benefit their lab. That you're not going to slow people down. [LAREUS16]*

A few students told us they appreciated LA-STEM's pre-existing network of faculty mentors at LSU:

> *They really get good professors who have been mentors. You have lots of different windows of professors who know what LA-STEM is and are willing to take in undergraduate workers when they usually don't, as well as those professors that are willing to go the extra distance to help undergraduates. [LAREUS14]*

## B. Increased academic success

Many students indicated that participating in LA-STEM had a direct positive impact on their GPAs. Although most LA-STEM participants considered themselves capable students, only a few told us they thought they would have done equally well academically without the support of LA-STEM. The five major elements of LA-STEM to which students attributed their academic success were:

- Being part of a community of learners
- The program's GPA requirements
- Increased awareness of support services on campus
- Individual Development Plans (IDPs) and LA-STEM courses
- Skills learned in LA-STEM that were transferable to classes and studying

### 1. Being part of a community of learners

Students cited several ways in which LA-STEM had supported their scholarly achievement. The most commonly cited benefit by far was being part of a community of learners. Many students told us that being surrounded by like-minded peers with similar

goals motivated them to continuously challenge themselves and promoted a culture of achievement:

> *It's really interesting to try and mix with a group of people that are so intelligent and to try and bring something new to the table each and every day. So it's an unintended form of innovative creation as far as, you know, research projects and everything. It really does help and it is like, "Okay, so what next?" You've done this, so what next? It's a driving factor because you're got your peers to own up to. So that also prepares you a lot more for the upper-level courses that you'll take and also for the upper-level degrees that you plan on pursuing because you'll always be competing with your field. [LAREUS15]*
>
> *It's really encouraging. It is. Because sometimes I feel alone and like, "Why should I care so much? Why should I be the one staying up trying to make an A on this test when everyone else is out partying, out sleeping?" Like it's college, having fun. It is really encouraging to see other students that actually care as much as I do, that actually want what I want, where I want to be. I appreciate that a lot because it's really refreshing. [LAREUS17]*
>
> *It's the same stresses that's the thing. When everything's going bad around you, you need to be motivated to keep going. And it's a big help when everybody around you is like, "Wow, this is so much right now," instead of somebody just being like, "Just come hang out." You may underestimate how hard it is for you as a person to stand up and say, "I have to do this," especially when everything around you is saying that you could do something else. And it makes it a lot easier on you being with a bunch of people who are really having to go through it. It's a big help. [LAREUS19]*
>
> *STUDENT 1: You have to hang around those people that are gonna push you to do better, not people that are gonna bring you down. And everybody in this program is trying to go up and not down. Wants to achieve.*
>
> *STUDENT 2: I agree. You don't have to think about, "Do they have my best interests at heart?" You already know.*
>
> *STUDENT 3: Everybody does. I'll be talking to [other] people and I'll tell them, "I had to study this. I had to study this." And they're like, "Why?" I go talk to [LA-STEM students] and they're like-*
>
> *STUDENT 2: Me too!*
>
> *STUDENT 3: "Well, you gotta do it!"*
>
> *STUDENT 1: "You have two tests? I have three! Let's pull an all-nighter."*
>
> *STUDENT 2: We just pulled an all-nighter. (LAUGHTER)*

*STUDENT 1: So yeah, the community, I think, is the most important thing. [LAREUFG2]*

We also heard that taking classes with other LA-STEM students was valuable and that groups of LA-STEM students regularly studied together. A few students told us they did not study with other LA-STEM students because they didn't have classes together or only saw one another infrequently. However, most of these students had developed other resources within their classes to draw upon when they needed help.

2. GPA requirement

Some students (5) told us that LA-STEM's GPA requirement motivated them to do better in their classes. These students felt that program expectations and encouragement from staff to challenge themselves had a positive impact on their academic performance:

Exchange 1:

*STUDENT 1: They focus on research and pursuing graduate-level... like, PhDs, master's...*

*STUDENT 2: Having a very high GPA... You know, they expect a lot from us.*

*INTERVIEWER: Do you think that's an important part? That they do have high expectations?*

*STUDENT 1: Yeah. It's good that they're pushing us to do this, because I think that if they weren't pushing us-*

*STUDENT 2: Then we wouldn't do it. [LASBFG1]*

Exchange 2:

*INTERVIEWER: Has LA-STEM provided you with the support that you need to be successful in college?*

*STUDEN T: I do think so. Just knowing the progression of how things should go in your undergraduate career…. And also just to have somebody that if they notice something about your grades, they say, "What are you doing? (LAUGHS) Get your act together."*

*INTERVIEWER: Like if you don't do well in class.*

*STUDENT: Yeah. And even just knowing that I have to do well to keep this scholarship. That's a big part of it. I mean that shouldn't be my incentive, but it's helping me stay. (LAUGHS). It helps me know I need to get a 3.5 every semester or higher if I'm going to keep this scholarship. [LASBPMS3]*

However, an equal number of students told us they felt the GPA requirement was unnecessary, that program expectations were lower than the expectations student's already had for themselves:

> *[The GPA requirement] didn't make a difference for me, 'cause I had already imposed a GPA of 4.0 and no less on myself, so that was just water under the bridge. [LASBFG2]*

> *I kind of have those expectations for myself already, so it was more or less, "Well, you have 'em too. Why not? I'll just—. It fits your requirements. Works for me. I'm gonna do it anyway." [LASBPMS1]*

We heard conflicting opinions about the recently lowered GPA requirements. A few students felt that lowering GPA requirements had had a negative impact on the program. This student felt like the new requirement was not challenging enough:

> *They just lowered the GPA that's mandatory to not be on probation to 3.2. I really don't feel like that's that challenging a goal to meet, if you wanna be realistic in your goals of going to grad school or getting a master's or generally being successful. I'm not very worried about getting a 3.2. [LASBFG2]*

However, others pointed out GPA requirements that were reasonable for some disciplines might be too stringent for others, particularly engineering:

> *I think a lot of times I'm harder on myself because of my grades not being [in the] 3.5 range. I have a 3.225 right now, but I'm taking both the electrical and computer engineering curriculum, trying to get both degrees, and I think it's a six course difference between the two. But the fact of the matter is I get twice the horrible courses, and that's the thing that's kind of beating me up at this point…. The homework that I'm required to do is above and beyond what some science majors do. [LAREUS9]*

> *The grades aren't really a problem for me, but I know for a lot of engineers it really is, because it's a lot of work. I will sacrifice sleep, eating, everything to make the grades, but a lot of people aren't like that. So I sometimes feel it should be catered specifically to maybe engineers or scientists. But, at the same time, I guess fairness is an issue also. Who's really to say that science is really easy or engineering is really easy, you know? It's kind of a judgment call and I don't know really who's appropriate to make that judgment call. [LAREUS17]*

3. Awareness of support services on campus

Students told us LA-STEM had raised their awareness of useful resources on campus, such as tutoring and test banks. The most frequently mentioned resource was the Center for Academic Success:

> *LA-STEM is the first place that I really got all of that [information]. It wasn't through orientation about LSU; I was already here for a year. Through the Summer Bridge and afterwards they talked about the Center for Academic Success. They have Sandra McGuire come in; I love that lady. They talk about the writing center; they talk about the tutoring in Allen Hall and all these areas, and I've just grown to be really comfortable with these programs and so I know if I do have a problem there's a place to go. Especially as a younger student, you don't know about those resources or you don't think that you can really go to them. [LAREUS14]*

Several students, including the one quoted below, said that one of LA-STEM's greatest benefits is that it does the preliminary legwork in terms of finding resources that are available but that students might not have tracked down on their own:

> *I think that an individual [who] wanted to get the same sort of thing, if they were motivated enough, could develop the same kind of resources that LA-STEM provides. LA-STEM makes it a lot easier though—a lot—because it gives you those tools instead of you having to hunt them down and try to piece it together. It gives you an already coherent structure to work with. [LAREUS5]*

4. Individual Development Plans and required weekly classes

As structured elements of the LA-STEM program, students are required to put together an Individual Development Plan (IDP) that charts a path of progress to reach their goals and to attend two classes on a weekly basis that are aimed at offering students professional development, including lessons on etiquette, time management and study skills, GRE preparation, and how to apply for graduate school. Of all topics we raised with students, the Individual Development Plans and required attendance at weekly LA-STEM classes produced the highest number of "mixed" and negative observations. Students most commonly said that there were some things about IDPs and weekly classes that were good, but there were also things about them that were bad. Others reported these activities as "a waste of time."

Several students told us they found the classes and IDP useful and that they had helped them tweak LA-STEM resources to suit their specific needs and learning styles. The following student points out that the IDP is most helpful for students when they also have a good peer mentor to walk them through the process of creating an IDP that will benefit them:

> *I think [the IDP is] very, very beneficial and for first years to be in the UC class. They teach you how to write your résumé. How to do time management, how to deal with your stress. Like the way it works is pretty much you have to attend so many days. Because one person might need stress relief class and one person might need the time management class and not the other. So it's pretty much set up like you register online for which class you want to attend. You have to attend X amount. So it's very useful. They give you great programs. How to pick a grad*

*school, how to, they have the GRE program that you can apply...like go to and it's for the GRE. They go through how to study for it, each section in detail. The classes are very, very beneficial. I'm not attending the classes this semester. Um, I have another class that interrupts with that class time but they give us class work outside of that class to do to kind of make up for it. …You have to do an IDP, which is an Individual Development Plan…. I think the IDP is great if you really know how, if you've had a good mentor. That's one thing about mentoring. My mentor went through and realized my weaknesses, my strengths and helped me get an IDP plan that wasn't just busy work. It really, really benefited me. And then the class I think is more beneficial for the younger students because if you go to the, time management the first year, you know. And if you don't get it down the first year you might need to go again your second year, you know? But they are more geared to the younger students I would say. [LAREUS16]*

We heard from others that IDP assignments sometimes felt like busywork and were less helpful than having an advisor to talk to about learning goals:

*I think a lot of the IDP stuff is, um, just unimportant. During the semester I may be like interested in something else like studying for my classes. And I think having an individual development plan sounds like a good idea, but the way it's implemented I don't like…. I don't think it should be graded. I don't think we should have a class. I don't think it should even be in our schedule. I think it would be better to just have like a counselor that you could talk to…. Maybe it's really helpful for other people. [LAREUS9]*

Students found the weekly classes required by LA-STEM somewhat useful, but sometimes repetitious or redundant. We heard most frequently that students found the classes interesting and informative the first time, but that it was aggravating having to attend the same class repeatedly, year after year:

*STUDENT 1: Everything you can possibly think of. The Center of Academic Success has came and talked to us, I think I've heard that speech ten times or something at LSU. It's the same!*

*STUDENT 2: We have the same CAS meeting. We hear the same profs come and talk to us. They give the same presentations. Have that specifically geared for the new people. We do not need to hear anything more than once.*

*STUDENT 3: I agree.*

*STUDENT 1: It's a waste of our time.*

*STUDENT 2: And being here for four years, I've heard every person that has come in. So, like, we have mandatory classes on Tuesdays that we have to go to. They have GRE class. They had a UC 50 class. And then they had someone come talk about grad school last week. I've done the GRE. The UC 50 was like*

*freshman and sophomore year. And then the other, geared toward grad school, you hear that three years in a row. So it was like, "Well, I'll just choose one to go into, 'cause I've already heard 'em all. Might as well just pick one."*

*STUDENT 3: I mean, she's in her 4th year, we're in our 2nd year, and we've already heard all of them multiple times.*

*STUDENT 1: I did Bridge this summer, so that means I've heard it about three times more than y'all have heard it.*

*STUDENT 2: Since I was a mentor, I heard it my Bridge year, then we came our freshman year, we heard it first semester, second semester, then I went back to Bridge as a mentor and heard it all over again.*

*STUDENT 3; It helps! We appreciate it!*

*STUDENT 1: The first time!*

*STUDENT 2: But it's just, after a while, we know exactly what they're gonna say. [LAREUFG2]*

Students said that they didn't see how some assignments contributed to their education, that they seemed like "busy work." LA-STEM classes and presentations were described as too broadly focused and therefore didn't serve or seem relevant to students' actual lives or academic interests:

*I mean, the making me come to class when I didn't want to, or when I wasn't getting any benefit out of it, I think that's pretty bad because, I mean, now I'm a junior. They're still making you do things that you were doing when you were a freshman! That's ridiculous! I'm like, "Why am I doing the same things? Why am I writing papers about time management, the same thing I was doing when I was a freshman?" Like, we haven't evolved! So I think they need, I think they mentioned they were gonna try to focus more on relevancy for people…. I was just feeling like it's a waste of time. We have to do this work that really we don't want to do…. Last semester a lot of people didn't get credit for the class because they weren't doing their assignments. But people don't feel like they're getting any benefit out of them. [LAREUS21]*

*STUDENT 1: Maybe if they break it down [into separate groups], like, "How to study for bio over here. How to study for chem over here. How to do your Calc 2, here. Physics, here." I'd pay attention. 'Cause I can't pass Physics.*

*STUDENT 2: Which, I don't remember them doing much of that. Do y'all remember that? Breaking it down?*

*STUDENT 3: No, they don't.*

*STUDENT 4: They don't really. It's just so general.*

*STUDENT 1: And, like a bio prof coming to talking about research, but then everybody else who's not bio has to sit in there too.*

*STUDENT 4: And, like, I wish they would have more programs on engineering. They gear mostly programs to the chem majors and a few bio, a few physics. So we never have anyone come in and talk about engineering, and it's a lot of engineering majors in there. We've heard all that stuff. We want something we're interested in to keep our attention, too. But we never get the engineering. Maybe 'cause the engineer department don't comply with LA-STEM. I dunno. [LAREUFG2]*

Students reported scheduling issues that prevented them from attending LA-STEM classes and that some students (particularly juniors and seniors) created scheduling issues intentionally to avoid having to sit through the classes yet one more time:

*STUDENT: We all get along pretty well and the thing about it is, by the time you're my age, you really don't even see that many people [from LA-STEM] that much anymore because half the juniors and seniors have figured out how to avoid coming to class because they have, they purposely schedule scheduling conflicts to not come to class, so. You don't like see anybody anymore…. And it gets harder and harder every semester and next semester I can't imagine sitting in that class for an hour and a half when I have microbiology and environmental chemistry and all these hard classes on top of each other. I'm taking 19 hours this semester…. And next semester, it's 19 hours of just hard straight coursework, you know? And then all this nitty-gritty stuff? I'm like, I can't imagine going to class, sitting there, you know, and they're talking about…I mean, for freshman that's great, but, I'm gonna get frustrated. I'm just gonna be like.*

*INTERVIEWER: You're gonna take a class that conflicts with that course, aren't you?*

*STUDENT: I'm gonna, I'm gonna find one! [LAREUS21]*

Some, however, seemed disappointed that their schedule prevented them from being able to attend class and felt like they were missing out:

*INTERVIEWER: What advice would you give to the LA-STEM program?*

*STUDENT: I really like how the program is run right now. Um…. Maybe offer two sections of the class. Because I know a lot of people can't schedule that one section. So I think maybe if they offered two sections then they could accommodate a much larger group of people. Because I know I'm not in the class now and I feel so out of the loop a lot of the times. Like a lot of things are on*

*Blackboard but sometimes, you know, Blackboard's not really the best tool to get information across. And, like, getting in touch with peer mentors and assignments and everything. I just feel really uninformed sometimes not being in the class, not going every week and getting all that. [LAREUS17]*

5. Gains in transferable skills

Despite many students' mixed views on the utility of the weekly LA-STEM classes, many also noted skill gains that they took away from them. In particular, students reported gains in skills that supported their academic success, such as how to effectively manage their time, strategies to improve studying and learning to work with others as a group:

*In the time management, they had taught us how to use time sheets; they're basically hour-by-hour on half-hour increments. So, you basically plan your life away. (LAUGHS) Those are extremely helpful to me. Never before have I ever wanted to plan that, but now I see where it's become necessary for me. I use it every Sunday afternoon or Sunday night. I sit down and I'll make my weekly plan. I don't always stick to it like I should, but at least I know what it is I have to do and available times that I can do that. So it is very beneficial to me. [LASBFG1]*

*They teach you time management - what study skills are best for your personality or your learning style—so, when you're studying for those classes that maybe you've never had to study like that before, you know how to attack the material. As opposed to just reviewing it, you know if you need to draw diagrams, or if you need to read the book and then go into the notes, or do the notes first and then go into the book. So, it helps your studying habits. [LAREUFG2]*

*STUDENT 1: We're actually doing a [group] project right now. Over the summer, we did this a few times where they just randomly grouped us and said, "Okay, you need to do a presentation on this." Right now we're doing one where they give us an imaginary [student] who's having a problem and we have to come up with a profile and time management and stuff. They have lots of group projects that they want us to do together. We've been in the program not even two semesters and we've already done, well, this will be our third or fourth project together. They emphasize a lot us working together.*

*STUDENT 2: I just think they like us to mix it up and learn how to work with different types of people, 'cause that's what we'll be doing eventually. [LASBFG3]*

## C. Diversity awareness

Encouraging students from diverse backgrounds to enter and succeed in STEM fields is one of LA-STEM's most important program goals. Students were largely aware of this and although they had mixed opinions about how it was implemented, most students we

talked to agreed that the focus on diversity is an important part of the program. Out of 93 student observations about the diversity-related aspects of LA-STEM, 74 (80%) were positive evaluations.

Students told us that participating in LA-STEM had increased their awareness of and comfort with diversity and that many of the diversity training activities undertaken during Summer Bridge and weekly classes were helpful and enlightening:

> *INTERVIEWER: After you graduate, what do you think will stay with you?*
>
> *STUDENT: Um…probably the diversity part of it would be since it's a diverse program. I guess before the program most of my friends were white. But my best friend now is African-American. He's also in my major, and all my closest friends in my major are all African-American, actually. So, uh, also in my lab there are several Indian students. So I guess I could say that one of the most major parts for me is just learning how to work with people of different cultures. You know, being able to, just knowing how to talk to them, how to work with them, how to be friends with…. To me, that's probably the biggest thing I'll take away from it. [LAREUS12]*
>
> *I think it has a much bigger impact as well, like, you get a better, I guess, respect and appreciation for people from other cultures and like a whole diverse group. This summer, like, I worked with a lot of people, like, Hispanic people, just, like, women in engineering, which I thought was really cool, because we don't have a lot of women engineers here. Just people from all different walks of life and it was so awesome. It was a great mesh. [LAREUS17]*
>
> *INTERVIEWER: How do you feel about the emphasis on diversity in LA-STEM?*
>
> *STUDENT: It helps because I mean, you could say, "Diversity's important, diversity's important, diversity's important." But until you're there, I mean, I'm working with German people and Portuguese people and besides that working with other people just helps. Like, um, my mentor's African-American. My mentee, or the person below me, is African-American. And working with them is...it's different because it's harder to realize that you're not in a diverse group until you are in a diverse group of people. So you can think that you're fine and diversity's okay, but then when you're in it and you're teaching someone else it's different because there's a lot of problems that come up that you wouldn't even have thought about before. So their approach on diversity, it helps when you're actually in a situation like that, when everyone's different from you or the culture's different. [LAREUS8]*
>
> *INTERVIEWER: What do you think you'll take away from your experience with LA-STEM when you graduate?*

*STUDENT: I honestly think I will take away the importance of diversity and the importance of interdependence, because just being there for a person, helping them out, knowing that your fellow peer can come see you and ask you for help and you can be there for them to help or vice versa. And the diversity aspect because, if you just live in this one simple little space with people that you know all the time, just know their ways and everything, or you're just around one set of people that are just like you, you really don't get a lot. Like, I've learned a lot, just—. I'm also a dance minor and if it wasn't for the people I've been around, I probably wouldn't even dance. Like, I just wouldn't know! I used to just be strictly ballet. But then I met somebody that was like, "Modern, oh, try Modern!" "Oh! I like Modern too!" So, something like that, you just kind of pretty much find yourself, find who you are. So I think diversity and interdependence are the biggest things that I would take from that program. [LASBPMS2]*

Students felt that living, working, and being encouraged to spend time with others from different backgrounds had helped foster a greater respect for difference in themselves and others:

*My roommate was of a different race than me and I thought it was really cool…. You get exposed to their culture a lot more. Like, I'd put on my rock music. She'd put on R&B and (LAUGHS) rap, you know? And that was fine. I went to the club and actually knew all the songs. (LAUGHS) But I really enjoyed it 'cause you… I'm, where I'm from it's like 50/50, and I played softball in the summer with all the black girls. That's not, that's not an issue with me. I like different cultures, I like, you know, I don't know. I don't like try to segregate myself…. But I think most of the, the thing, was what we did after, like you have a lot of free time in the summer… and that's when people seemed to, you know, split a little bit more alike, 'cause it's just different activities they'd like to do, you know? Like, "I wanna go to this party." "Well I don't like that. I'm gonna go do something else." But I find the diversity might be a little odd in the beginning for some people. Some people just aren't used to it…. But then, by the fall, it's like those are the people you hung out with all summer. So you have no problem being with them anymore…. So I think it, it works. It just takes a little time. I definitely think that it's important. And it's very important at this school, 'cause this school is very, um, very white. It just is. And, you know, like the black students in the program might, where they might be, you know, not the majority, but well about equal in our program, in the rest of the university they're not. And so they need all the support they can get in some sense, because it is South Louisiana, (LAUGHS) so I think it's important. [LAREUS20]*

*STUDENT 1: I think what's most useful for the diversity, the dimension that the program tries to address, is just the fact that I'm in a program, I spend time with people from different cultures and different religions or different ethnicities once a week in this big room and wound up working on projects with these people and all sorts of things. Um, they stress, you know, that on a day-to-day basis you're able to just go over to that group of people you don't usually hang out with and*

*just, you know, you don't have to feel threatened or whatnot by other people…. You know people can preach to you about diversity all day long and you not learn one extra thing because you already know that diversity is a problem in America, people accepting diversity. And you already know the makeup of your friends, whether you only hang out with Protestants or Catholics or this or that and it's not because you think that everyone else that you don't hang out with is evil. This is just, you were raised around these people. This is just how it happened to be. Um, and when they preach to you, they seemed to think that you're more afraid than you really are or that you really don't understand these other cultures or that they're, they coexist or that they're different or that you can learn from them. That's not where most people are. Most people are, it's just that they don't feel comfortable. And so, you could do more programs just where you get to interact more with people of other cultures or religions or whatnot, um, so that you feel more comfortable. That's the only way to make someone feel more comfortable is to expose them to it, not to show them a study or to show them a movie about this experiment that was done or something. We already accept that diversity and acceptance of it is a problem. It's increasing awareness—that it's ok to acknowledge that discomfort that you might have and then struggle to fight that uncomfortableness by putting yourself out there.*

*STUDENT 2: I know it was definitely an eye-opener for me, because where I come from, it's a very skewed point of view as to different people, people being different is a bad thing! 'Cause I came from a very small community north of Baton Rouge, so it's very isolated, and it was definitely an eye-opener for me in a good way. [LASBFG2]*

Others had mixed feelings about the diversity activities, telling us they were ultimately helpful but also felt somewhat forced and of the few negative comments (10) about LA-STEM's diversity focus, most also centered on the program's diversity training activities as feeling heavy-handed:

*STUDENT 1: They really emphasized bonding.*

*INTERVIEWER: What did they do to emphasize the bonding? I mean, is there anything that they did that helped with that?*

*STUDENT 1: Um, a lot of social activities. We played games. I know one time we did, the first day we built—there was a competition where we built a bridge out of newspaper and tape. So that was one thing we did. Uh, let's see...*

*STUDENT 2: When we were in class, they made us sit by people we didn't normally hang around with, so we had to get to know people that way.*

*INTERVIEWER: So other people in the Summer Bridge program that you didn't normally talk with or hang out with. Was that good, or...?*

*STUDENT 2: It was, but it seemed like it was forced.*

*STUDENT 1: Yeah.*

*STUDENT 2: In due time you would've gotten around to talking to everybody, but it's like it was kinda forced that way. But it all turned out good. LASBFG5]*

*STUDENT 1: We definitely—we had friendships, not from before, because we didn't know each other, but—all of us are here are here because we have something in common, because I think that we are basically the same type of person. You know, we're all ambitious, we all have goals, we all care about our schoolwork. We're here because we are scholars, and that is something that we all have in common, and for me personally, and I think for a lot of people, it's easy to talk to other people who are like yourself, and even though, you know, we might be from different majors, might be from different places, in the country or in different cities in Louisiana, or we might have different religions, or different races—that all kinda takes a backseat, because the things that are most important to us, which is our education, that's what's most important to them as well. So, it was really easy to work with other people. I don't know if the program really understood that, because they tried to, you know, "Well, girls and boys have to work together. Don't just group in girls. Don't just group black with black. You should mix." And we had all already done that and we were kinda just with the people who we had the most common interests with that day, before that particular lecture, just because we had just finished eating lunch with them, or whatever the circumstances were. Because every day, no one sat together at the same spot every day. And it always, just always seemed that they were trying to push us together, and they wanted to integrate black-white-black-white-black-white, so it ended up becoming a conscious effort on our part, which... I don't really….*

*STUDENT 2: It had already happened, actually. And like, they were just trying to force something upon us that we were already doing, so since that made it a little bit more conscious, we were like, "Well, I'm sorry I can't sit next to you, even though, you know, I would like to and I don't really know you as well as I want to, because you're more like me—you're white and I'm white. I have to go sit by someone else who isn't the same color as me. I have to go sit by an Asian because they're not white, and shucks, they're my roommate, but it doesn't matter, because you know, they're different." So I didn't really like that too much, 'cause we'd already fostered collaboration, and we were already together and, you know, we had already gotten to know everyone, and...*

*STUDENT 1: It was a little awkward. (LAUGHS)*

*STUDENT 2: (SPEAKING TOGETHER) Right. I guess they thought that we were not together, and we were like, "We are! We are!" (LAUGHS) And they were*

*like, "No you're not! Do it this way!" and so we were like, "Well, okay." (LAUGHS) [LASBFG1]*

Two students were resistant to the consciousness-raising elements LA-STEM's diversity focus, feeling that they already "got it" and did not need to learn more about diversity. The following extract is representative:

*INTERVIEWER: We haven't talked much about the diversity aspects of the program. Do you think that's been an important or beneficial component of LA-STEM?*

*STUDENT: (SIGH)… Yes and no. I went to a very diverse high school. Very diverse—black, white, Asian, Indian, you name it, they were there. Um, so, coming to this program and through a variety of experiences and I'm gonna say this with the best of intentions, I felt like they were always, and maybe I just felt this way, like it was always, "Well, we need to respect everybody." …We had this lady who was crazy, and everybody will agree with me. She came in and she was from Tulane or something and it was just, like, I felt like she was, I always felt like I got fussed at because I am the stereotypical white sorority girl and so I'm not that diverse person. But I can hang out with anybody. That's one thing, I may be your stereotypical white sorority girl, but I can go into a room of every…it doesn't matter to me. I don't look at it like that. But I just always was like, "Stop harping on it. The more you harp on how diverse you are, the more you're pointing out the differences of everybody instead." And I understand the importance of diversity in the sense of different approaches to different problems or understanding how other people think and feel being sensitive to all of that. I understand that. I get that. I think that's very important, but I think as a nation, maybe not so much as a state quite yet, like, it's time to get over the diverse and becoming united. Because obviously the diverse is right, left, black, white, purple, pink, whatever. That's what's separating us and I just always wanted to scream, "Why don't you teach us something else?" It's just over done. And maybe it's because I took it very sensitively because…you know, I am that stereotypical white sorority girl and I felt like the finger was always being pointed at that stereotypical person that wasn't accepting of different people just because of my appearance…. That's how I've always felt and, you know, we sat in class one day. I was talking to [another LA-STEM student], and I told him that, and he was like, "I've never thought about it that way but you're totally right." I don't know. Maybe it's a lot of my history but, like, my dad's been judged against because he is white. Because he didn't fit that diverse mold and they had to hire a quota. So in my mind I'm thinking, like, they had to have that so many of this and this to make it look the way it should at that time and so I'm just like, people get discriminated every day because they're too skinny or they're too fat or they're too tall or they're too short and it's just…in my mind I think, "Why don't you preach unity and acceptance of others instead of…diversity?" That's, I don't know, that's me. [LAREUS26]*

By and large, students seemed to consider both diversity and diversity awareness valuable, and were more often turned off by the format of diversity awareness sessions than by the content. However, they most frequently spoke about this aspect of LA-STEM in abstract and somewhat vague terms. Students tended to describe ways that LA-STEM assisted *other* people and groups in the abstract, rather than how it had benefitted them personally or assisted other students they knew, even when the students being interviewed were themselves members of an underrepresented group.

In addition to increasing diversity awareness among all students, LA-STEM tries to invest in the success of students from underrepresented populations. Students were aware of this, considered it important, and largely saw the program as being successful in its goal:

> *We have a fairly even mix when I think about the amount of students that are here. We have a fair number of minority students within the program. We also have a fair number of students, which unfortunately society has classified as non-minority students. I mean, we got a fairly even mix and I think that it does try and draw as many minorities as it can to the program to try and benefit that realization of, "You can do this too!" …We all come from all over the state, you know, everywhere. And, yeah, we've definitely tried to reach out to the underrepresented in the program, but I'd have to say that they've done a pretty decent job of keeping it diverse in the same aspect because the workplace and, um, the places where we, you know, intend on going later on in life will be diverse and you cannot try and say well, you know, "You're always going to get a leg up because you're a minority." In most cases you will not, you know? It's simply the way of the world, that's something you can't ignore. But, um, increasing diversity earlier on will increase that sense of respect between, you know, different social groups I believe, and will hopefully change those mindsets that have become so entrenched within the older generations, especially that are currently in most of the positions of power in our fields, so. [LAREUS15]*
>
> *STUDENT: I think a lot of people have wanted to see the sciences diversified. They don't want to shoot anybody down who's underrepresented. They want to encourage them to actually get involved in doing research and so everyone just be, just one group of people producing all of the information. 'Cause I think if you have a diversity of groups you're gonna get a diversity of ideas 'cause different people think different things. So, it opens up a wide, a wide range of ideas and so you'll be testing different things and gain new information. You've got different people looking at things from different perspectives. You try different things and you learn different things.*
>
> *INTERVIEWER: Is that something that you like about LA-STEM?*
>
> *STUDENT: Yeah, 'cause we're very diverse. There, there are some of every, we're all just a mixed, kind of like gumbo, just everything thrown in together. [LAREUS23]*

> *Well the program is so hard to get into…that I don't think the students that are in the program wouldn't finish college. Now, as far as finishing college in four years, or finishing college and moving on to a PhD degree, I think the program helps out a lot! But as far as people finishing college or not dropping out, I think these...you know, you have to have good high school grades and a good ACT score to get in, and then you have to do an interview. So I think that process helps you pick the "cream of the crop," I guess, without trying to sound arrogant. But, you know, there's great stuff that the program offers to minorities and women. There's a lot of conferences that these students can go to if they wish, or there's a lot of, you know…. Not only that but it helps bridge the gap between the races. In the South this is a problem. …So just to, you know, give the white students and the black students an opportunity to interact like this is a very, very good benefit of this program because it, not only frees us from our ignorance, it helps us free others from their ignorance as well. [LAREUS18]*

Some students, including women, first-generation college students, and students of color, did tell us about ways that LA-STEM had helped them personally overcome institutional obstacles and successfully navigate the college experience. They appreciated LA-STEM's role in helping them to achieve their goals and a few voiced a personal obligation to address issues of underrepresentation by helping ease the way for others like themselves:

> *I am actually the first one in my family to go to college…. In my high school, everybody, all my teachers were always like, "Oh, college is so hard! And you're going to have to stay up to all hours of the night," which I do anyway, out of my own free will for some reason. But, you know, you have these hard tests and you have to write and write and write and all that stuff. But coming here, I mean, that really wasn't what it was. I mean, your classes might be tough. You might have to put in some more work. But you don't have to work yourself to death over it. It's not that bad. And you meet so many people. Especially coming from Summer Bridge, just meeting all the people in the program was more than I could've ever asked for, 'cause I came to LSU with 30 more friends than I would've had otherwise. And I know people that I can hang out with, someone to have lunch with or something, instead of just having to sit around by myself all the time. [WHITE MALE, 1$^{ST}$ GENERATION COLLEGE STUDENT]*
>
> *INTERVIEWER: The LA-STEM Program has a specific objective of recruiting very bright and talented students, underrepresented students—students of color and women— into the sciences and encouraging them to go on to get advanced degrees. Is that an important objective for you?*
>
> *MALE STUDENT OF COLOR: Yes, ma'am. It's just like it gives the little person a voice, (LAUGHS), and it just takes us out of situations and build us up. 'Cause I really wouldn't think I would be doing this well at LSU. (LAUGHS)*

*It's been good to understand what it means to want to do certain things…. I'm paving the way for the next group. And it's good because I can tell them how to do it, because nobody could tell me. I knew I, I always knew I wanted to go to grad school, but nobody could tell me how. Nobody could tell me what I needed to do. My brother is 17, he's a junior, and he's getting ready to do all his applications and stuff, and part of the reason that I don't want to go anywhere this summer, is because I know he's gonna need me to sit there and tell him, "Well you need to do this, this, and this, and this needs to be done by now so you can be ready to, to get all your stuff together. 'Cause you graduate and you're gonna be in, in college very soon…." I think, I get a rare opportunity to tell people how it's supposed to work, and I know how it's supposed to work. I think we are in a unique position. Especially a group that's kind of geared toward underrepresented people in STEM majors. Somebody was telling me…this past summer that less than 100 African Americans a year get a PhD and I was, "Are you serious? That's unreal. 100?" So, you know, just to show people that you can do it, and that it's, there's a possibility for you to succeed. It's an excellent opportunity for us. Because I think one of the big parts of this program is that not only that it's a community, but the fact that I look around and I'm like, "Wow, look at all these future Ph.D.'s in here!" I'm looking at people who are gonna be doctors, all kinds of different things that people are about to do with their lives, and these are all people that we're in a community together. And we work together on things, and we know each other well, and it's, (LAUGHS) I'm kind of excited to see what it's gonna be like in, in 10 years when all of us are actually in the field doing things and making changes and we've all dealt with each other before…. Just the fact that there's such a large part of the community that's underrepresented in higher education like that. You have to show people that it's possible first, or you have to show people that there are actually people who do it. And a lot of people complain like, "There are no black professors at our school!" But the fact that there aren't any is pretty much, the onus is on you. Because you can decide that you're gonna do well enough to go to grad school. That's on you. You can't go to grad school if you're walking around with a 2.7. That's what you did to yourself. So to complain about it, if you're gonna complain, maybe you should be that change that you're asking for, and they give us the opportunity to do that. [MALE STUDENT OF COLOR]*

*INTERVIEWER: Are there advantages, do you think, for a woman, or for a student of color, or someone from a group that's underrepresented in science, to get a research experience, or to have a research experience in college?*

*FEMALE STUDENT OF COLOR: I think it's a great advantage, because honestly, you don't find too many people—. Well, I know for sure not too many women or people of color are in research. And I just think it's a great experience. Because I don't know if it's just they're deterred, because of statistics. Because I can say for myself, my friends, they're like, "Oh! You're doing research? Wow! Girl, I could never do that!" And I'm like, "Why? It's wonderful! Do it! You'll have fun." And I also think it's an advantage, because you have just one more*

*thing under your belt in addition to your classes, instead of basically just knowing your book material, knowing why this goes with this. Like, you just have a hands-on experience, that's your biggest advantage of all to me, having a hands-on experience. And that could even enhance your knowledge of your discipline. So I think it's a major advantage for women especially, being that we're underrepresented in chemistry and engineering and everything. So I think, you know, you go into work, "Oh yeah. I did research too." In addition to having a degree. And they're like, "Oh, okay!" So, I think it's just an advantage in terms of just having the experience.*

*Women in our major, because in the electrical engineering major, I think there's five or six girls that I see on a regular basis, and that's about it, uh, in the department, you know? It's a big help because that extra encouragement, that extra, uh, you know, set of people who have already done this before and know what's coming.... 'Cause I know if you come in, in electrical engineering, into the program, and I can help you, if you come to me in electrical engineering at all and I can help you, there are certain things that I can tell you to watch out for. And that you can come to me and ask me about, that I'm gonna have answers for you already. And that's some of the great part about it to, 'cause we have the notes, and old tests for you to study from, all kinds of stuff, you know, that it just adds. And it makes, it makes the probability of your success go up, and there's not much that can replace that. [MALE STUDENT OF COLOR]*

### D. Support to Persist and increased interest in pursuing an advanced degree

Two central goals of the LA-STEM program are to provide the academic and personal support students need to persist in STEM majors and encourage their entry to graduate school. There is evidence in the qualitative data that show LA-STEM is successful in meeting these program objectives, in broad and in particular. In this section, we describe the role of strong staff support and articulated elements of the LA-STEM program that students reported as contributing to their retention in a STEM major and increased interest in pursuing a PhD. We discuss these career effects as outcomes specific to staff support and the LA-STEM program, generally, as distinct from student career outcomes derived from hands-on undergraduate research experiences, which we detail in the following section of this report.

A number of students (8) told us that strong support from program staff had played a critical role in encouraging them to persist in their major when they might otherwise drop it due to academic or personal difficulties.

*Any time we make a C on a test, or lower, we're supposed to come here. Or at least tell 'em about it. And then, that way, they make sure we don't fall too far behind before we can catch up…. 'Cause I've failed every one of my calculus tests. Every single one of 'em. And I mean, each time I was in here, I was like, "I don't feel like I know it. I don't know how to study it. I don't know what to do*

> *anymore." And they were like, "Well, you know, this is what you should do and and duh-nuh-nuh…" So, I mean, they definitely don't let you slip through the cracks, which I do appreciate. I know she said that Mr. Anthony helped her a lot—I had actually come in to talk to someone about my major, because—since I wasn't doing so hot in calculus, I was like, "Well maybe, engineering is not for me, because that's a whole lot of math," and, you know, basically the program just kinda told me, "Stick with it." That's not exactly what I wanted to hear, but I'm sticking with it, because, who else is gonna advise me? Who else cares? No one. (LAUGHS) So, I'm gonna stick with the people who do! [LASBFG1]*

> *I know I've had some breakdowns that were just like, if they weren't there, I probably would not be a chemistry major. So they have provided support. Even the students within the program have provided support. So, they really helped a lot. Miss Sibley. She always, like, she's kinda like, I call her my second mother, because every time I'll come to her, "Oh, Miss Sibley, I don't know how I'm gonna do this. I just can't make it any more." "Well, you know, you have to just keep…" —pretty much just saying everything my mom would say to me. Because I'm not at home anymore, so it's kinda like, "Oh, this is my mom. Okay, Mom. Okay!" So, she really helped out, just reassuring me. "Don't give up. Just stay in there. Keep trying." So just things like that. Little stuff that you wouldn't even think of, y'know, of a college campus providing support like that. [LASBPMS2]*

In addition to supporting scholars' academic achievement during their undergraduate years, LA-STEM also offered students resources and information geared specifically toward successfully matriculating into graduate school. Several students (12) told us that being a part of LA-STEM had strengthened their interest in going to graduate school, shown them a wider world of career possibilities, and increased their confidence in their ability to do science and to be accepted to and succeed in a PhD program. As noted earlier, LA-STEM played a critical role in educating students about what research is exactly and its broader impact of contributing meaningful information to science and society:

> *Dr. Warner came and talked to us during Summer Bridge about research and how it affects people and he uses this great analogy about AIDS research. Like, being a doctor, you know, going into that aspect of science. You can treat hundreds of AIDS patients or whatever, but actually being a researcher you can develop a cure that might actually, you know, treat millions of people nationwide, so. [LAREUS17]*

> *INTERVEIWER: Would you say that the LA-STEM program has strengthened your interest in going to graduate school?*

> *STUDENT: Definitely. It definitely did that. It solidified it from being, "I could see myself doing that," to "That's really what I want to do and where I want to go!" [LAREUS5]*

*I'm definitely gonna pursue a PhD and I don't think I'd be doing that before just because it's more about, I knew about it, you know, I thought, "Hey, you know, it'd be cool!" But it's more that I know I can do it. I think that's the biggest part. It's given me enough opportunities and enough exposure, enough hands-on experience to know that not only can it be interesting and you'll be doing something that will help, could help, your profession, but I can do it and I know I have the ability to. So I think that's, I don't know, that, to me, is very important. I mean, I've never had, never really questioned whether or not I have the ability to do stuff, but it's just more knowing is even more powerful, you know? [LAREUS7]*

*INTERVIEWER: One of the objectives of LA-STEM is not only to keep you in college, but to have you go on to get a PhD. Would you say that LA-STEM was important in encouraging you to do that?*

*STUDENT: Uh-huh, (YES) definitely. Because I mean, people come talk to us that are, you know, doing research, that are PhD's. Especially engineers. Like a lot of my teachers are PhD's as well. So just seeing the things they do, hear them talk about it, hear just like the benefits of it as well as just knowing the impact that you can have with a PhD degree as opposed to just in the technical field, you know, better gas at Shell or….*

*INTERVIEWER: So it sounds like your thinking about graduate school has changed a little bit and you're leaning towards graduate school a little bit more.*

*SUTDENT: Yes, ma'am.*

*INTERVIEWER: Has LA-STEM influenced that decision?*

*STUDENT: They really have 'cause it, when we came in during the summer we had a couple of lectures on graduate school and what you get out of it, and how it's not what you think it is. And they kinda, those lectures were eye-openers and got you actually thinking, "Maybe this is something that I really should consider." 'Cause I had thought, I was thinking about it when I came in, but I didn't know much about it so I was, it was another one of those intimidation things 'cause I was just thinking "Oh, it's just research all day. That's kinda scary!" (LAUGHS) But as I learned more about it, it just seemed more interesting. [LAREUS23]*

*INTERVIEWER: Has participating in LASTEM strengthened your commitment to going to graduate school in any way?*

*STUDENT: I would say, um, definitely because…I think it was maybe a year ago I had a professor for one of my classes that started flashing salary numbers at us for graduates coming out of LSU and, you know, it sounds great to be making you know, $90,000 or $100,000 dollars right as a 22, 23-year old at a company…. If I heard that without being part of LA-STEM program I would have been like, "Oh*

> *great! I'm gonna graduate. I'm gonna go get a nice job and make some nice money!" …Where I'm going with that is that LA-STEM is giving me knowledge of what everything was involved in the research process and everything like that. And without that program I wouldn't have had that knowledge so it's possible that I would have been like "I don't really know much about these terminal degrees and I don't know if it's something that someone in my field needs," and stuff like that. "If they're making this much money, why do I really need to get a terminal degree now?" and stuff like this. I probably would have gone off with that, but being in the program has geared me, has geared me a lot towards going to graduate school, getting a PhD, and then possibly after that trying to work in academics or, uh, work in a company depending on, I don't know what I'm going to be doing or how I'm feeling at that point in time, but I definitely would not have a problem working in the area, so, as far as academics or for a company somewhere. [LAREUS12]*

For many of the upper-division students (10), participating in LA-STEM had helped them clarify their field of interest and confirm their decision to pursue a STEM career:

> *INTERVIEWER: What lead you to decide to major in electrical and computer engineering?*
>
> *STUDENT: Actually, I knew I wanted to go into engineering 'cause when I was in high school I met one of the, I went to a Jesuit high school in New Orleans and one of the priests there, he just became friends with us out of class. He was a physicist and he had a master's degree in physics. He went to Texas A&M so he went to a big engineering school and stuff like that and I kinda sat down with him one day and we just discussed my interests and things like that and he said that engineering would be a good fit for me. Now it was just for me to decide what kind of engineering I wanted to go into. And at first I kinda felt like, "Ok, maybe I'll go into mechanical." And so that's why I decided to apply for mechanical engineering…. So I actually entered my first year in mechanical engineering. And I guess you could say it wasn't too, I guess the LA-STEM program actually played a factor in me realizing that I fit much more into electrical engineering. So, I guess that was first big personal impact that the program had on me, was kind of guiding me to that major. 'Cause I met people in the LA-STEM program who were in electrical engineering and I kinda realized that from an early age I always had an interest in electronics and things like that, computers. And then I kinda realized, "Why am I in mechanical engineering when I'm much more interested in this other area?" So I made the switch and actually it's been perfect since I made the switch, so. [LAREUS12]*

A number of students (5) told us that LA-STEM was their first exposure to what pursuing a PhD actually entailed and what working as a professional scientist might be like:

> *On the large scale it helped me understand PhD candidates do for research, what's the life of a graduate student like…. And I learned all about graduate*

> *school because I had no idea how the process of graduate school and all that worked. [LAREUS12]*
>
> *INTERVIEWER: If you wouldn't mind, just as a final summary, what are the main benefits that you've gotten out of the LA-STEM Program?*
>
> *STUDENT: I've been given a, a concrete plan, upon which to build my life. I think a lot of what I have wanted to do was abstract. I said I wanted to go to grad school, but I didn't know what I needed to do, you know? But now, three years later, I have a school that already wants me to come for grad school. I have research experience that I can tell people I've had. I have an understanding of what the research process is, and I think for a lot of people who go to grad school, they don't know what that is, and they have to be shown the ropes. We don't. We've been there. We know what it is already. [LAREUS19]*

Other ways that students told us LA-STEM supported their graduate school aspirations included preparation for and information about applying to graduate school, encouragement to pursue opportunities that strengthen a graduate school application—such as research and national competitions—and the opportunity to network with other students and faculty.

We asked graduating seniors their plans for the future:

- 8 of 11 were going to medical school (one intended to take a year off first; one is pursuing an originally-intended MD-PhD)
- 2 of 11 were going to graduate school in a STEM field
- 1 of 11 was unclear about his or her future plans. (This individual originally intended to go to medical school but had recently been offered a fellowship in her current research lab if he or she decided to pursue a PhD.)

Nine of these graduating seniors said that there had been no significant change in their post-college plans because of LA-STEM (i.e., students going on to medical school *entered* college with this goal in mind). Several of the medical school-bound students said they had been introduced to the idea of an MD-PhD by LA-STEM, but almost all gave reasons for not pursuing it or not pursuing it right now.

Overall, the LA-STEM program was largely effective in introducing students to the concept of research and the role played by research in contributing to our collective knowledge and the betterment of society. Though some students resisted the notion of having to do research at first, most were very glad they did. As many students noted, without the LA-STEM program, they would not have known about research at LSU, much less seek out the opportunity to do research themselves. Many students also indicated that participating in LA-STEM had a direct positive impact on their GPAs. Students attributed their academic success to being part of a community of learners that supported a culture of achievement, high expectations set by program staff and the GPA requirement, and awareness of and access to academic support and other resources on

campus. As outcomes of the required weekly classes, students generally reported gains in time management and study skills, and in working collaboratively as a group and said that sessions offering professional development, particularly GRE preparation classes and information on and help with selecting and applying to graduate school, were very useful and supported their academic success.

While most reported that the weekly classes and peer mentoring sessions were very helpful and contributed to building community among LA-STEM students, of all topics raised, IDPs and weekly classes received the highest number of student comments relating mixed or negative views on the value-added of these LA-STEM program elements. These observations came largely from juniors and seniors who felt that, while the classes were helpful the first (and maybe even the second) year, after that, the courses were simply repetitious, redundant and of little or no benefit. These students often spoke with a sense of frustration: they wanted to comply with program requirements, but they no longer derived any value from the classes and couldn't see the sense in "wasting their time," especially in light of difficult and heavy course loads so common in STEM majors. It was commonly known that some students purposely created scheduling conflicts in order to avoid taking the classes. If there were new course content relevant to them, they acknowledged their resistance would be much less.

LA-STEM played a critical role in introducing students to the concept of research, educating students about research as a profession and in helping them to see its significance in building new scientific knowledge that can be directed at bettering society. Based on their own accounts, there is evidence demonstrating that LA-STEM has helped students to persist in their STEM majors and influenced their decision to seek a graduate degree. A number of students told us that strong support from program staff had played an important role in helping them to persist in their major when they might otherwise drop it due to academic or personal difficulties. Several students told us that being a part of LA-STEM had strengthened their interest in going to graduate school, shown them a wider world of career possibilities, and increased their confidence in their ability to do science and to be accepted to and succeed in a PhD program. For many of the upper-division students, participating in LA-STEM had helped them clarify their field of interest and confirm their decision to pursue a STEM career. A number of students also told us that LA-STEM was their first exposure to what pursuing a PhD actually entailed and what working as a professional scientist might be like. Other ways that students told us LA-STEM supported their graduate school aspirations included preparation for and information about applying to graduate school, encouragement to pursue opportunities that strengthen a graduate school application—such as research and national competitions—and the opportunity to network with other students and faculty. The majority of graduating seniors we spoke with planned to go to medical school; two were going on to a STEM PhD program, and another was as yet uncertain whether he or she would go to medical school or pursue a PhD. The majority of graduating seniors we spoke with indicated that they had entered LSU and LA-STEM with the goal of going to medical or graduate school.

## IX. Student Outcomes from Research Experiences

One of the primary ways in which LA-STEM seeks to recruit students to the program, retain them in STEM majors, and encourage their entry to graduate school is through early and sustained engagement in faculty-mentored research experiences. This strategy is a feature of similar formalized programs targeting student retention and recruitment to graduate education, especially for underrepresented groups (i.e., NSF-Louis Stokes Alliances for Minority Participation Program, NIH-Minority Research and Training Programs: SOAR at Xavier University, the Meyerhoff Scholars program at University of Maryland, Baltimore County, the MBRS-RISE and MARC U*Star, California State University, Los Angeles, etc.) That is, undergraduate research is seen as a way to foster students' interest in and ability to successfully pursue education and careers in STEM, and as a means to help them overcome barriers of education and opportunity. They target students early in their college years and admit them as a as a group. Along with other structured elements of support (high-school-to-college bridging programs, academic enrichment, peer mentoring, accessible program staff, financial scholarships, etc.), these programs include research (during both the summer and academic year).

Notwithstanding widespread belief in the value of undergraduate research in helping to achieve higher rates of students' graduating in STEM disciplines and pursuing advanced degrees, only recently have results from research and evaluation studies on these and other UR programs established grounded evidence of the benefits to students and effects on career outcomes, particularly for underrepresented groups (Adhikari, Givant & Nolan, 1997; Foertsch, Alexander, & Penberthy, 1997; Alexander, Foertsch & Daffinrud, 1998; Nagda, Gregerman, Jonides, von Hippel & Lerner, 1998; Maton, Hrabowski & Schmitt, 2000; Hathaway, Nagda & Gregerman, 2002; Barlow & Villarejo, 2004; Seymour, Hunter, Laursen & DeAntoni, 2004; National Research Council, 2005; Clewell, de Cohen, Deterding & Tsui, 2006).

Our research to establish the benefits to students of undergraduate research experiences identified and detailed a comprehensive array of types of gains that fit six categories: personal-professional gains, intellectual gains, gains in professional socialization, gains in skills, enhanced preparation for graduate school and work, and career clarification and confirmation (Seymour, et al, 2004; Hunter, Laursen & Seymour, 2007, 2008). These same categories were used in analyzing and structuring the findings of these qualitative data to determine student outcomes from participating in research and the contribution of research as a program element in helping to attain LA-STEM's stated goals.

As shown in Table 1, students most commonly described personal-professional benefits from participating in research (22% of observations). These benefits included establishing collegial working relationships with their research advisors and with other research group members and increased confidence to carry out research work. Another 18% of students' observations mentioned gains in understanding how science research is done. In this set of comments, students discussed learning through applying their knowledge to hands-on research work, increases in their critical thinking and problem-solving skills, and extending their knowledge (gains in "Thinking and working like a scientist"). In almost equal measures, students also described how research experience

enhanced their preparation to undertake graduate-level work (16%), provided various skills (16%), informed a more realistic understanding of the nature of research work and brought about changes in attitudes and behaviors necessary to do research (15%) (the "Becoming a scientist" category), and clarified and confirm their pre-existing career intentions (14%). These findings indicate that students take away a range of personal, professional, technical and intellectual gains from hands-on research experiences.

In this section of findings, we present students' gains from research based on their own accounts. We provide both the actual *number of students* reporting a particular gain, as well as the *number of comments* offered on the topic, to report students' self-assessed outcomes of research experience. Of 57 interviews conducted with students, 35 focused specifically on the benefits of participating in undergraduate research experiences. Thus, if every student we interviewed specifically about their research experiences reported a gain of some type, the highest possible number of individuals citing a particular benefit from research in this group of interviews would be 35. Of these interviews, 26 were with juniors and seniors, who are the most likely to report gains as a result of multiple experiences and sustained engagement in research (multiple research experiences were reported by nine students; 13 reported sustained engagement on one project). The majority of students described positive experiences, working closely with their advisor on authentic research. However, accounts from seven students detailed poor quality research experiences in which they had little mentoring from their research advisor, found themselves "in over their heads" and academically unprepared to understand the science of the project, felt unable to contribute in any significant way, and/or were assigned menial tasks and "busy work."

## A. Personal-professional gains

In this set of benefits, students discussed establishing a working, collegial relationship with their research advisor (whether a faculty member or a graduate student) and other research peers, increased confidence in their ability to "do research," seeing scientists as regular people working as professionals, gains in personal growth and initial bonding and identification with science research as a profession.

- Establishing a collegial relationship with faculty [25 students; 41 comments]
- Increased professional confidence [19 students; 31 comments]
- Seeing scientists as "real people" [13 students; 18 comments]
- Collegiality with other students, graduate students within the research group [13 students; 14 comments]
- Belonging to a community of learners within their research group [7 students; 9 comments]
- Gains in maturity, self-discovery, taking responsibility [4 students; 4 comments]
- Gains new experiences not linked to career enhancement [3 students; 3 comments]

**Table 1. LA-STEM student observations on the benefits of research experience.**

| Category | N of Obs. | % of Obs. |
|---|---|---|
| **Personal-professional gains**<br>Increased confidence in ability to do research. Establishing collegial, working relationships with faculty advisor and peers. | 120 | 22% |
| **"Thinking and working like a scientist"**<br>Understanding science research through hands-on experience and application of learning (gains in critical thinking, problem-solving, analyzing, and interpreting results); understanding the nature of scientific knowledge (open-ended, constantly constructed); understanding how to approach research problems/design. Increased knowledge and understanding of science and research work (theory, concepts, connections among sciences). Transfer between research and courses; increased relevance of coursework. | 102 | 18% |
| **Enhanced preparation**<br>Opportunities for collaboration/networking with faculty, peers, other scientists; new professional experiences; résumé enhanced. | 88 | 16% |
| **Gains in skills**<br>Laboratory techniques; computer skills; working collaboratively Communication skills: presentation/oral argument; some writing/editing; | 86 | 16% |
| **"Becoming a scientist"**<br>Demonstrated gains in behaviors and attitudes necessary to becoming a researcher (student takes "ownership" of project; shows responsibility, intellectual engagement, initiative; creative and independent approach in decision-making). Greater understanding of the nature of research work and professional practice. Identification with and bonding to science. | 81 | 15% |
| **Career clarification and confirmation**<br>Validation of disciplinary interests and clarification of graduate school intentions (including increased likelihood of going to graduate school); greater knowledge of career/education options; clarification of which field to study. Increased interest/enthusiasm for field. | 76 | 14% |
| **TOTAL** | **553** | **100%** |

A majority of students (25) said that they had had positive working relationships with their research advisor(s) at LSU or at other institutions. They described learning to work collegially with their research advisors and said that their research advisors served as mentors who: cared about their success, asked for and respected their opinions and suggestions, and provided appropriate direction, resources and support to help them achieve their highest potential. The following exchanges and quotations are representative of benefits students' gained from working closely with their research advisors:

Exchange 1:

> *STUDENT 1: Since I was the only person working on it, I went to [my research advisor and the graduate student] a lot to talk to them. Over time, you just—you understand how they work, how they think, so you know what not to ask, and what to ask, and how to just answer it yourself. And then, they kinda know you too, so they know what to tell you, and that kinda thing.*
>
> *STUDENT 2: My mentor and I get along really well. Like, in the summer, we'd always go out to eat on Fridays, and if I ever had a question I'd just call her on the cell phone, so we get along really well.*
>
> *STUDENT 1: Sometimes they'll ask me how to go about doing something, like, they have a question or a problem for a project they're working on, they say "How would you do this?" And if they ask me, they usually go with what I say. [LAREUFG1]*

Exchange 2:

> *STUDENT 1: I love my research. I really do. When I first came to the program, I was thinking about PT school, so I didn't wanna be in bio…. I knew I didn't want to go into the bio type research and programs…. And I got involved with Dr. [X], and he actually works in the lab with me, and so I was able to grow as a researcher. Like, he was the only person that when I talked with him, he gave me a stepping stone: "You're gonna start here and learn the material. Then you're gonna start helping me with my project. You're gonna have your own project. And then maybe you can go present at a conference and have your own paper." And all of that has happened. And so I'm really thankful for my mentor and the opportunity to do research with him.*
>
> *INTERIVEWR: It sounds like Dr. [X] is a good mentor.*
>
> *STUDENT 1: Excellent!*
>
> *INTERVIEWER: What makes him a good mentor?*

*STUDENT 1: Okay. A few weeks ago, like, I hadn't been in the lab in like a week…I had so much going on. He sent me an email. He's, like, "Can we talk?" I was like "Yeeah…."*

*STUDENT 2: You were a little nervous, huh?*

*STUDENT 1: I really was!*

*STUDENT 2: I've gotten those, too.*

*STUDENT 1: The next Monday, I went in, and he was like, "Is everything okay?" and I was like, "Yes, I'm just really stressed and blah blah blah," and he was, like, "Well, we need to get you some help."… And I was just, "I have two tests in one day," and he was like, "Well, I can't help you with that, but you need to just calm down," and just everything. He cares about you on a personal level. I go in there and ask him, "What do you want me to do?" He was like, "What do you think we should do? What's the next step?" or "What do you have time for in your schedule? I think we should write your abstract. And let's see, this conference is on this and so day, so you need to have your abstract written by so and so." He's very detailed. Very organized. He knows exactly who's working in his lab. He knows everything that you're doing, what classes you're taking. It's so personal, yet he has so much stuff going on himself. I have no complaints.*

*STUDENT 2: Yeah. I feel the same way. When I first talked to him, the first meeting we had was like an hour and a half. I was just a little freshman wanting to do research, and he was so impressed with the LA-STEM program, just gearing freshmen towards getting into research. And he said he had high hopes. He wanted to know my level of commitment. We talked about life. We talked about careers. He actually offered me a possible fellowship in his lab to pursue a PhD after I graduate, which I'm still thinking about. He nominated me for a scholarship that I'd never heard about before. And when we, I was able to go to Taiwan this summer with him on a research project, the first international conference I've ever been to. And this is one thing that we talked about in our initial meeting, when I met him for the first time. And just to see it come to pass, and it come through, and how he talks so highly of myself. I would've never thought he thought that about me. He's a pretty demanding professor, but at the same time, you don't feel like he's demanding it from you. You feel like you can do it. He feels like you can do it, so you do it! Working in the lab, working with older people, it's really good experience; the personal skills, the clinical thing, it's really good. I just really like him because he's real down to earth, and he's going to be frank and true, but at the same time, in a loving manner. [LAREUFG2]*

*At UF they have weekly meetings and at the weekly meetings, you know, I figured the grad students would say their things. My grad student would kind of say about what we're doing. But no, I had my day that I had to get up and talk about what I was doing and then she had her day of the week, you know. So I had to*

*stand up and tell everybody what I was doing and then she would be like, the professor would be like "Ok, do you think you should go in this direction or in this direction? What are your ideas? What do you think?" And she pretty much taught us like, treated us like we were a grad student. So, you know, it was really nice to have my input. And then at LSU, um, Dr. [X] was, like, "Oh, here's two projects, which one do you want to do?" and I was like, "I want to do that one but I think we should do this instead," and he'd be, like, "That's a good idea." So I kind of changed the project to do something that I thought was more interesting but also would benefit the overall idea of what we we're trying to do too. So, both of my professors have been really, really good in taking my opinions and not only looking at me as, "Oh, you're just an undergrad," but just being, like, "You're a scientist." So it's been really nice, because I haven't run into any professors that haven't given me respect in that sense. So I could just be lucky, but so far I've, it's been very beneficial. (LAUGHS) [LAREUS16]*

*I brought [an idea] to Dr. [X] and he's kind of that same mindset of he knows it can be done, he's just not quite sure the specific details that would have to go into it to do that, because it's been a learning process for him [too.]. And it's, "Look, I found this paper. Here, you read it." And it's been back and forth, both of us finding papers and giving them to each other. "I thought you might find this interesting," and, "Oh, well I thought you might find this one interesting." [LAREUS5]*

*I had great mentoring experiences and each one brought several different things…. Overall, I am in my sixth year of research total and I've been in five separate labs, all with different research aspects. I've been in the fields of genetics, environmental science, public health, um, inorganic, organic synthesis. And right now I'm doing stem cell biology. So just, never limit yourself or the scope of your research, never limit yourself as a person or a human being and I think that if you push yourself and you try and broaden your own horizons, you will meet people with subsequent values and beliefs and they will guide you along to broaden them even more. And that's what I've had with all of my mentors. They've always pushed me to higher ambitions and higher, you know, viewpoints. Just saying, like, "This could be what you have if you settle. But this, if you push yourself, this is what you really could obtain." And, you know, I've never had any of my mentors put a bar on me or set this, "This is the maximum level that you will achieve." Everyone has always vaulted me up to the upper-echelons of the upper-echelons and that is, that's phenomenal when I think about it. Because when, you know, out of no real trying of yourself to convince other people through your actions and through the things that you accomplish based on sheer drive and sheer pursuit of the accomplishment in and of itself. Other people recognize hard work when they see it and they admire it and they say, "Hey, I appreciate you for that." And that's probably one of the biggest benefits here at LSU is that we've been around a lot of people, a lot of faculty and a lot of mentors that have said, you know, "I see what you're doing. I appreciate it, and I think that you can do this and so much better."… So that limitless attitude that's been adapted here is*

> *definitely a very nurturing and very inspiring environment because, you know, I wasn't afraid to apply to the George Washingtons and the Washington Universities, and the Duke's, you know? When I applied to medical school, because when I went to Duke for my most recent interview, I was there with students from Harvard, Stanford, UC-Berkeley, UCLA, MIT, Yale, Princeton, one guy was from Lebanon. And when they asked me where I came from I said, "LSU." And I'm right there with them! I'm right there with them and I'm just as accomplished. [LAREUS15]*

Another benefit of research experience cited by a majority of students (19) was their increased confidence in their ability to do science research:

> *INTERVIEWER: What's been the hardest or most challenging aspect of your research positions so far?*
>
> *STUDENT: Hmm…I think just getting over the initial intimidation. It's research. It is rocket science! I think that's the main thing. Once you get over that and you see that actually it is something that you can do--maybe not everything. You're not gonna be able to do everything, and they tell us that coming in. "Don't expect to be able to do everything." But as a person you're still, like, "I'm not gonna be able to do anything!" It just seems like it's gonna be too hard. But then, once you get in and you actually see that there is at least something you can do to help out, then you kind of get more into it. You get more excited about doing it and you're not as intimidated, you're not scared to speak your ideas if you have something, if you have a question or if you think something's going on. You're not scared to tell somebody about it. And then you might actually have come up on something that nobody else noticed. So, I think that's, once you get over that initial shock of actually being in the lab, it gets a lot easier. [LAREUS23]*
>
> *At first I was like, "Research? That sounds really like complicated." (LAUGHS) I'm like, "How do they expect us to do that?" I feel more confidence like I can do it now, it's not that hard, but it's just, um, just developing skills and stuff, which is nice to learn early. 'Cause there's, they say there's things I'm doing that most people don't do 'til they go to grad school, so I, I'm like, "Okay, it's possible!" (LAUGHS) So it's nice and, you know, it's getting into it. [LAREUS3]*
>
> *Since [my research advisor] knew Dr. [X], she just expected me to know so much so she just threw me in and she's like "Here's a key. Do this, do this, do this." So it was very much like how it would be on the first day of grad school, you know, you're just kind of thrown in there. I loved it. I'll be honest, as I was driving, I was, like, "Can I do this? But the first day, I was like, "Oh, I got this! This isn't that bad. This is what I do every day!" You know? And I really enjoyed it. The personalities were great the people were nice there. It was an overall great experience. [LAREUS16]*

Many students (13) mentioned that research experience had given them a more realistic view of scientists as people. Many (13) also established positive working relationships with other research group members and student researchers. Some who worked with a group (7) developed a sense of belonging to a community of researchers:

> *It gives you a sense—guess, a sense of a smaller community within the academic community. Classes are pretty huge—especially in the intro classes, maybe, 400-500 people—and the professors don't want to really get to know everyone, because it's just too time-consuming. So you don't get to know your professors just from class. And when you actually go into research and actually see them on a regular basis, you get to talk to them more and you realize that they're not just the kind of stern research-oriented or academic-oriented people that you see in class, that they're actually people and that's sometimes, that's a big jump from seeing a person in class to seeing them outside, and just to, I guess I'm just more comfortable in the whole academia area. [LAREUFG1]*
>
> *I enjoy working there, it's just, it's like bunch of friends. We'll, it feels like we're all just kinda hanging out basically. Sometimes we goof around a little bit when we have time, but we're serious. But, yeah, I mean, he's [my research advisor has] been fine. He's been helpful and stuff, and not mean or anything, so I like working with [the other group members]…. And, definitely, 'cause they help me, especially dealing with my poster, they want me to look, make it look good, and do well and make it look awesome compared to everyone else. So they help me out. It's kind of like a little family almost. [LAREUS3]*
>
> *Over the summer I definitely learned how to work with a partner, which wasn't too hard and both of us were glad that we were paired up on the projects that we were working on, because it gave you somebody that whenever you got stuck you could present what you were doing to and they could look at it, you know, "Oh, well this should be the next step." So the two of us would play off of each other's ideas like that and we got a lot done. So that was another big thing there. I haven't had that experience here just because it's been me and only me on this project. [LAREUS5]*
>
> *Working with the graduate students has been good. One of 'em, I mean, she's wonderful. She treats me kinda like I'm her daughter. She's just always like, "Oh! Let's go to lunch! Let's go to lunch. Let's do this. Let's do that." And, I mean, she's just always there if I need help with school work in general. She's there to help. Like today, she was helping me with organic. And I mean, she's, it's just wonderful. Actually, all of them in there are. They're all helpful. They're all there for you. So, I love it. [LASBPM2]*
>
> *I love sitting around with other people who do, you know, physics research, or other physics majors, just sitting around talking about whatever it is we talk about—physics related all the time, something with math. But I also enjoy sitting around with the others, listening to their research. Because it's completely*

*different, normally, than what I'm talking about. Normally, not so math-related. Sometimes a break is good. (LAUGHS) And any type of science is basically my interest, in the big picture. I enjoy chemistry. Biology…it's a little more memorization than I like, 'cause I like the application. But I can do biology all the same. So, any of those fields, I just enjoy hearing about them, learning anything about it…. Research tends to come up a lot, surprisingly. But it's just the nature of me and my other friends, who—. One of my friends is a math major. He talks about math constantly. So he'll start talking about something, and then somebody else'll bring up something, and it'll always be, "This, the other day, in my research..." and then one of my other friends, he'll talk about, "Oh, I just started doing this today!" and I'm, "Oh! That's pretty interesting! You know, "I was doing this…" So, we kinda go back and forth all the time. [LAREUS1]*

Smaller numbers of students mentioned gains in maturity, noticing their willingness to take responsibility for their work and other changes marking their personal growth. A few noted exposure to new opportunities and experiences as benefits of their research experience:

*In general, I'd consider myself a responsible person. I make sure I get homework done before I go and do this or that or whatever. But with research, it helps me organize things more because, you know, I have to make time for the research. I mean, take care of this now, so I can do research later. And make sure I have enough time for that. And just that, in itself, I'm making myself make time, so I can go do my research. So that in itself just shows I wanna be there. I feel like this is something I need to do. And I can't just let it go undone. [LAREUS1]*

*It's kind of nice right now going to the lab in this huge research center. It really makes you feel professional and like, (LAUGHS) "Oh, goodie! This is what I get to look forward to!" I think it makes me a little bit more mature. [LASBPMS3]*

*I'm spending all my time in lab. I'd go Saturday at 10:00 AM, and leave at 10:00 PM, you know? I went in on the next day, on Sunday. So I was just going in all the time just trying to get all my stuff down, and we came up with, I, I mean I ran experiments that lasted, what, six hours? It's a six-hour experiment and I had to be there for every bit of it. So it's a, it was a really intense process, but it was awesome getting to the end and actually having some solid information, and being able to explain what was going on. [LAREUS19]*

*There are innumerable benefits to doing—, to especially going off, out-of-state and doing research. Going to different places. You learn about different cities, different states in the US. … And, like, my lab, here, half the people are from Russia. So you learn about their life, and what they do, and you hear people talk in Russian all the time. It's like, "What?" The other half of them, a lot of them are Indian. They start talking in their different languages. And I don't know what the dialects are, because they all probably speak a different dialect! And it's just… It's great! [LASBPMS1]*

## B. Gains in skills

Students interviewed about their UR experiences reported gains in various skills:

- Laboratory skills and use of instrumentation [17 students; 20 comments]
- Presentation skills [15 students; 21 comments]
- Collaborative working skills [12 students; 14 comments]
- Writing skills [11 students; 17 comments]
- Computer skills [5 students; 6 comments]
- Communication skills not related to writing or presenting [5 students; 5 comments]
- Ability to defend an oral argument [3 students; 3 comments]

A majority (17) mentioned learning a lot of laboratory skills and gaining familiarity with instrumentation used in their research work:

> *I realized being in organic lab here that what you learn in organic lab is not what you actually use in a research lab. You have a lot more tools and instruments so you can do things more realistically, I guess you could say. So I've learned a lot more skills in that sense. Like how to re-crystalize something, how to filter something the way that people would do in graduate school, not in like your basic organic intro lab. So a lot of techniques, yeah. A lot, a lot of techniques. [LAREUS16]*

> *I've done a lot with cell inventory, so culturing, and…running adhesion assays and I've run a few proliferation assays. This summer I ran a PCR that was pretty cool. Which, I guess isn't cellular, but anyway. I've done live-dead assays. A lot of cell work. Nothing too crazy. Computer imaging, microscope kind of things. [LAREUS27]*

> *I learned tons and tons of techniques, because we were working with neurons, and a protein that helps in neuronal locomotion in embryos when they're developing. And so I'd have to go and do dissections of embryonic mice. So, you know, you have to do dissections under microscopes, in solution. And I'd never done a dissection like that, having to pull out a section of the brain, which is a pretty tiny little thing! And then, the spinal cord and things like that. And it was just really interesting. And then I had my yeast cells. And then we'd do Western Blots over and over and over, confirming things that were going on in the yeast hybrid experiment. [LASBPMS1]*

Many students (15) reported gains in learning to present research: how to put together a poster, being careful to relate the right level of information to a particular audience, and the role of presenting in communicating results to the wider professional scientific community:

*When I was in Wisconsin we had our own little culmination of the summer where everyone in the program did a PowerPoint presentation explaining their research. I gained a ton. I'm a terrible public speaker and practicing, you know, just makes it better (LAUGHS). I think it's good to have practice standing up in front of a crowd and presenting your research to them, especially the people who don't know anything that you're talking about and you have to kind of put it on a basic enough level to explain it. Good, things like that. [LAREUS13]*

*I enjoyed it [presenting the poster]. I was kind of nervous the first time because I know they have professionals and people who knew a lot more than I did walking around asking questions. I just wanted to make sure I could answer the questions the best way possible. So it was cool. It really helped my understanding of the project to do the poster, and my confidence too, being able to stand and defend a poster. I enjoyed it because having to do a poster I had to understand every aspect of it and make sure I knew everything and I would have to think to myself questions that might get asked that were difficult. The experience was really helpful and helped me to improve in that, you know? [LAREUS22]*

*I got to present at lab meeting one time. So I had my PowerPoint. And I explained what all of these people know, that they've been studying, working on for the past eight years or so, for some of 'em that've got their PhD on these things and are doing their post-doc work, it's very intimidating. "I've been working on this for eight weeks, vs. your many years. You have very solid foundations." I was so nervous that I would say things wrong, or whatever. But everybody was very supportive.… And I also presented my research at the end of the summer. We did poster presentations with the whole group, like, everybody, everybody, all the people from all the labs came in. People from around campus came in. If peoples' family were in the area, they came in. I presented there. And then I also took that research to a conference in California, this past November and I presented that to a much greater audience! I mean, I had Deans from Stanford looking at my work, and things like that…. Learning to present and going to conferences, that has been a valuable experience. I'm a terrible, terrible public speaker. So, getting you out there—one, presenting research, having to be very confident about what you're saying and knowing everything about that, it's, you're gonna have to do that for the rest of your life. So, build the skills now. I mean, I'm sure I messed up somewhere along the way in my presentations, but I'd never presented a poster before. I'd never made my own poster before that summer. But this poster was my poster. I worked on it. You had to go through like eight drafts of the poster. When I presented it, I knew everything about that poster. I knew everything about that work. It was mine. And very, very, "Let me teach you about what I've done." And with confidence comes the ability to talk (LAUGHS), So it's definitely helped build my confidence and my communication abilities. One-on one practicing doing presentations—. 'Cause I hate doing presentations. I think it's the most terrible thing ever. But it's, you have to do it. [LASBPMS1]*

A few students said that their communication skills had improved, generally, and a few noted they had learned to defend their research results when questioned during their presentation.

Many of the students who reported working with a research group reported gains in learning to work collaboratively (12). These students appreciated the skills they developed in sharing out tasks, discussing research issues to move the project forward, and working effectively together towards a common goal:

> *I worked in a research team where me and seven or so other people—five of them are here, and two are in Amsterdam—and we're trying to work together to get one common goal…. It's good to figure out how to communicate in time and schedule meetings and everything. …It makes you a better communicator. It brings you up a level from just knowing the basic computer science stuff, applying what you've learned, using the vocabulary, and then discussing it with a group and working together to figure it out. Time management, personal management… It's very useful to learn to collaborate like that. [LAREUS8]*

> *This summer I worked on a team. So it was a team of like five of us, I think. And it's, the, well I, it was through the DEVELOP program and I really liked it because you work in teams the whole summer so you develop a really close bond as well with, like, the DEVELOP program is maybe like 40 students. So you also develop a bond with those 40 students outside of, you know, all the other interns at NASA. And working with them helps us because some of them were older, some of them were younger, so we all kind of got a feel for, like, what we should be doing, you know? Maybe what we can improve on, as well as we were all from different backgrounds. So it was, like, electrical engineering, mechanical, aerospace, civil. And, we just kind of got everyone's kind of knowledge on the subject matter…. Actually, before that, I used to hate working in groups (LAUGHS), like, team projects, in general, because I'm usually always the one that's ended up carrying the weight around…. But this summer was awesome. Like everyone was on point, like they always knew what they were asked to do, anything that was assigned that was due they had no problem doing it and they were just a great group of people to work with. So, they really kind of changed my ideas about teamwork…. The whole team aspect and like the dynamic of everything was just incredible. [LAREU17]*

Some students reported gains in their writing skills, learning to write in a scientific style, and learning the collegial process of review and critique during their research experiences (11). They learned that writing requires practice, but with practice, came greater confidence and self-assurance in taking on large writing projects, such as an honor's thesis, or, eventually, a PhD dissertation:

> *I think I can write a lot better technically. I don't put as much fluff in my writing at all anymore, because a lot of times professor don't want that at all in any technical paper, you know. Get to the facts. Just state the facts. [LAREUS7]*

> *The writing process has been another big thing I really learned over the summer. We had weekly reports that were due and they were revised as if they were submitted to journals, which was sometimes brutal. We'd get back, you know, our three-page report for the week and there'd be very little white space left because it would all be red. And we'd do those revisions and the next week we'd get it back with more revisions, which happened for the first half of the program, at which point our advisor was like, "Ok, ya'll got the taste of that." And after the first week, he brought in a stack of papers, a couple inches thick and it was,"This is something I submitted a year and a half ago to be published. It should be published in November, hopefully. This was the original copy. These were the two that went to, reviewers, all of their comments. See? Just as many as I give you, if not more. Here's the next version, here's those comments. So I went to the editor, he sent me this back." And like, "Ok, this doesn't feel as bad now." It's still kind of brutal but it doesn't feel as bad now. At least we know that it's to be expected. [LAREUS5]*

> *I realized that writing a thesis isn't as scary as it seems, or that you actually do have that much to say! Because I wrote a paper for the Journal of Young Investigators and I started writing it and it ended up being about 35 pages and I wasn't even trying to fluff it at all. I just had 35 pages of stuff to say! And I plan on graduating with honors and you have to write a thesis and everybody's like, "Oh, my gosh! I have to write 30 pages!" I'm, like, I already have a 35-page paper on my computer! And at UF I wrote another paper, just what I did in the summer and I wrote about 20-something pages on that. And it's like, our dissertation in grad school is not going to be anything because you do like five years of work. So I always thought, "What am I going to write about whenever I graduate?" But now I'm just like, "Ok, that's not bad either!" You just realize that everything isn't as unattainable as it seems before. That it's really like right in front of you, you just have to do kind of do it. [LAREUS16]*

Smaller numbers of students reported gains in their computer skills and learning software programs used in modeling and data analysis:

> *I've learned Mathematica, MathLab, and Maple, which are the three really big pieces of software that are used for math work. [LAREUS5]*

> *I've been learning a couple of different languages…. I've learned PERL, just so I can help with the actual programming and writing scripts, and I've been working with XML as well. [LAREU19]*

### C. Enhanced career preparation

Students discussed various ways in which research experience enhanced their preparation for graduate school:

- Opportunities to network with other researchers [14 students; 17 comments]
- Good preparation for graduate school [12 students; 15 comments]
- Research advisor provides career advice and networks for student: provides placement, writes letters of recommendation [11 students; 13 comments]
- Presented at a UR conference [11 students; 12 comments]
- Enhances student's résumé; makes student a more competitive candidate [9 students; 12 comments]
- Student will likely have a publication by the time he or she graduates [9 students; 9 comments]
- Presented at a professional conference [6 students; 6 comments]
- Student is co-author on a publication [4 students; 4 comments]

Most commonly, students said that their research experiences had offered opportunities to network with other researchers (14) and enhanced their preparation to take on graduate-level work (12). Students reported benefiting from their research advisors' help in networking to secure a research position in another lab, advice on graduate schools and advisors, and strong letters of recommendation (11):

> *Another huge benefit for me is just Dr. [X], how well-known he is. I get a letter of recommendation from him going to the field that I want to go into at one of these universities so, undoubtedly the person reading the letter will most likely know who he is so, that helps out. And I've been able to meet some other people in my field through him from other institutions. They know who I am and they know what I'm working on, so…just the people I've met in the field, the connections I've made, things like that. And that's been very, very rewarding itself. To meet these people that I otherwise would never have met. The connections that I've made from Dr. [X] are obviously amazing. [LAREUS12]*
>
> *I'm doing research on what I wanna be doing eventually in grad school. So just knowing that I'm getting the experience now is great, and it lets me learn things that I won't be taking in classes for another year. So I'm definitely glad to be learning it now. [LAREUS1]*
>
> *I'm getting out if it kinda like how graduate school's gonna be. You've gotta figure out everything on your own, and what you wanna do and eveything. So that's what I've gotten out of it. I'm around a whole lot of graduate students all the time, and they're always writing something or doing something on a computer, looking at papers or writing papers. And I'm like, "Do I really wanna do this??" (LAUGHS) I know they have to write their books and papers and journals and everything. I mean, they've really given me a sense of kinda what it's like to be as a graduate student. [LASBPMS2]*
>
> *[My research advisor] helped me to decide if I wanna do the wind engineering stuff 'cause he knows everybody in the field and he knows, even when I say, "Hey, I'm considering Florida." He's, "Oh, yeah? Well, this guy's doing this and this guy's doing this and this guy's doing this really cool thing, but I don't, he's not*

> *the greatest guy to work with. His grad students usually don't like him, but this guy, you know, his grad students love him." So I think that's definitely, that's great advice right there that you can't really get from anybody else, and I trust what he says so…. He's mentioned, you know, "Go wherever you wanna go, but these schools, I have great contacts with. You can get in without a problem and I'll suggest which people to work with and I know you'll have a great time." [LAREUS7]*
>
> *Dr. [X] wrote me a six-page long letter of recommendation and I was, like, "I think this is a whole lot!" …He traced my life back (LAUGHING) to my birth! Dr. [X] wrote a letter of recommendation for me also. You know, that's a very good benefit of having that, is that you get these awesome letters of recommendation, because these people know you personally. It's not just any letter, it's a great letter! [LAREUS18]*

Several students (9) pointed out that research experience strengthened their résumés and enhanced their graduate and medical school applications:

> *It's been good preparation for me, 'cause working at the Cancer Center, I was basically able to work over there 'cause I had some prior knowledge. I probably wouldn't have gotten that opportunity had I not been doing research already…. I definitely think that doing the research is very, very good on a résumé, 'cause when you're applying to some grad school and they have a medical physics program, you can say, "Well, I've been doing this research," and so it definitely gives you a big plus on your résumé when they're looking at it. And just in general, if you have someone applying who hasn't done research and somebody who has, the person with more experience definitely looks like the more favorable candidate. [LAREUS1]*
>
> *Research is a very worthwhile experience to have on your medical school application that a lot of people don't have, so it really can set you apart from other applicants. [LAREUS18]*
>
> *When people apply to graduate school, some people have research experiences, some people don't and then you spend the first six months to a year learning these techniques. Well, if I can walk in with these techniques, I've got some kind of background. I'll be that much more valuable. (LAUGHS) [LAREUS27]*

Students mentioned specific accomplishments they had already achieved, or hoped to achieve, which they saw as enhancing their preparation, including:

- Presenting at a UR conference [11 students]
- Presenting at a professional conference [6 students]
- Being listed as a co-author on a publication [4 students]
- The likelihood of being listed as a co-author on a publication by the time he or she graduates [9 students]

## D. Becoming a scientist

In this benefits category students described types of gains that research advisors view as requisite to working in the profession. By their own accounts, a majority of students gained a clear understanding of the nature of research work (that it is slow, often tedious and fraught with setbacks). Many described gaining an understanding of how scientists practice their profession and detailed changes in their behaviors and attitudes, such as taking an active role in proposing next steps, approaching problems creatively, and demonstrating patience and perseverance—even enthusiasm—when grappling with the inherent difficulties of research. These gains show ways in which research experiences socialize students to the profession of science research and students' growth as young professionals.

Students described gains in "becoming a scientist" in the following ways:

- Gains in understanding the nature of research; what real research is like: it is slow, tedious, frustrating, and full of setbacks [22 students; 31 comments]
- What being a scientist is really like; how scientists practice their profession—collaborative work, professional behavior, grant writing to fund research, practice of peer review, [15 students; 21 comments]
- *Demonstrated gains* in behaving like a scientist: feeling/taking "ownership" of the project; commitment to and intellectual engagement with the project; becomes an active learner, a creative problem-solver; increased willingness and ability to work independently [13 students; 18 comments]
- *Demonstrated gains* in understanding the process of research; increased patience, perseverance, tolerance of setbacks and failure; research work requires these temperamental attributes [10 students; 11 comments]

A majority of students (22) reported coming to a better understanding of the nature of research work, of what real research is like: that it is slow, tedious, frustrating, and full of setbacks:

> *INTERVIEWER: What have you learned about research?*
>
> *STUDENT: It takes a lot of time! Like this project, they've been working on it for…I think two years now…. I learned it take a long time, and since it's research, it's hard to get it right the first time so it requires a lot of communication. We spend a lot of time discussing and guessing and seeing if it'll work. And if it doesn't work, we have to go back and talk again. [LAREUS8]*
>
> *I wrote this program and it kept, like, not working properly at all! And it turns out it was something retardedly stupid that wasn't even my fault. It was some other program's fault we were using. Oh, it was a pain! It took like a week to figure out. I mean, I was doing other stuff on the side while I was, like, oh, I was ignoring it! Sometimes he reminded me. It was like, "Once a year, we get something really bad like this." Like, apparently he was telling me about the year*

*before, some initialization problem that took him like two weeks to figure out. So I wanted to do more, but I couldn't! Because I was stuck! [LAREUS2]*

*After you pull your first 12-hour shift, you learn that research is not like a lab course. And I work in organic, so...for the longest time, we just see "substrate goes to produc" and you're done. But now I know it's not nearly as simple, 'cause I need to see a reaction 12 times to get different percent yields every time. Or sometimes it'll just fail, because that's the nature of chemistry. It's made me realize that it's not so "A becomes B and you're done." …Even though I've only done really my own project for a few months, the repetition was definitely there. And sometimes it's just hard—well, a lot of the times it's hard! But you just find a way. You figure out what you did wrong, and you try to fix that. I think it actually opened my eyes up to how tedious and how difficult research is. [LAREUFG1]*

*I've learned lot of insights into how research goes and the aggravation that can go into it and the hours that you can spend banging your head against the wall going "Why doesn't it work?" [LAREUS5]*

Coming to a clearer understanding of how research works in practice challenged students. They discovered that to work in research required either natural or acquired temperamental attributes—such as patience, perseverance and tolerance—to handle the inherent difficulties of science research. A number of students (10) referenced changes in themselves and learning to cope with the realities of science research:

*INTERVIEWER: What have you gained from doing research?*

*STUDENT: Patience. (LAUGHS) Because it doesn't work the first time. I have never had it work the first time. You have to be patient and consistently try. So I guess determination, also. You know, not giving up. Keep looking for other avenues and different ways to do different things. Just having an open mind to a lot of things. [LAREU13]*

*The summer at UF I did a bunch of runs on some catalysts that they already made, just reanalyzing stuff and running them with different solvents. And we realized afterwards that everything I had done was, the machine wasn't calibrating correctly so all that was not right. So I had to redo everything. But in the end I actually used that as a basis, like, I compared that to the correct stuff, so it actually kind of worked out beneficial. But the only frustrating thing was, you have to run, every run lasts 32 hours. So when one, like, we had one run that worked fine but I accidentally, like, did something, I think I opened something that I wasn't supposed to open and I just, it was late. I wasn't, I was kind of sleepy and I opened it up and air got in and it messed up the run. So I was 18 hours into a run and had to throw it out. I mean, no harm really done, except for time loss. So I had to learn patience in that. (LAUGHS)…. There was maybe one day where I got frustrated so I just took like a two-hour lunch and then came back, because I just had to step away from it for a little bit and think about, "Now, what*

> *am I going to do before I break this glass because I'm so frustrated?" There's no other science that really trumps the frustration chemistry can give you sometimes. But I have a very, very "no quit" attitude. [LSREUS16]*

> *When you kinda think about research, before you really know anything about it, it's like, "Oh, you know, people work on it and they get results and then that's it." But, okay, if you get results. Big deal. You have to do it like five more times, and make sure those results are even real results. …Most of the time, things don't work! And that was probably the biggest thing that I realized, that things just don't work and you have to just try again. Like, especially for what I'm working on at the school here. We're doing a recombinant virus. And about 5% of the time, it works. The other 95% of the time, you just try, try again. And so it's very tedious. Especially when it doesn't work, and you know you're doing everything right, but statistically, it just isn't going to happen. So, it's, that's why it takes some people seven years to get a PhD, because it just doesn't work! There's a lot of times where I would do something, work three or four days on things, it's like, "Okay, well, it didn't work, so you have to start over." It's like, "Are you serious?! I did all of that, and it didn't work at all!? It just disappeared!?" 'Cause I remember one time, our filters were too small. And so we'd go and we'd do all of this work. And then the last step, where you filtered it, it would disappear. And it was like, "Where?! No! NO! Nonono!!!" And we realized, "Ok, the filters are bad." But we did it like three or four times. And it was like, "It's here. It's here!" Now there's like, very, very, very, very, very minute amounts of it here. "Where did it go? Is it getting degraded because-?" …It was like, "Oh, my god! All of this time, wasted! Weeks, weeks, weeks, gone! For nothing!" It teaches you. 'Cause, I mean, obviously, if you're gonna move on after undergraduate and wanna do anything that has to do with research, and you just jump in thinking it's gonna be like flowers and candycanes, it's not. It's terrible! Half the time it's absolutely horrendous and you just wanna, like, throw things! But that's how it goes. That's how you find things out. That's how you make knowledge. You have to suck it up. Work harder. Things don't work. Do it again! Try again! [LASBPMS2]*

A number of students (13) also recognized other changes in themselves as a result of engaging in research. They described types of gains that faculty view as necessary to working in science research; namely, gains in behaving like a scientist: taking ownership of and engaging intellectually with the puzzles of the project, becoming an active learner, working independently and approaching problems creatively:

> *I went to MIT. That was probably, up until that point, that was my absolute favorite. I was one of three undergraduates in the lab, and there were like 10 graduates, post-docs, PhDs—other people who were much, much higher than me. But I had my own lab bench, I had my own pipettes, I had my own solutions, chemicals and things like that. You know, my graduate student would come in and be like, "Okay, well, do this, that, blah blah blah. This is what we're gonna try and do." But it was my project. She was working on other things, and she*

*would help me, but it was like, if things failed, it was mine. I did it again, over and over and over again, and it was my learning experience. It helped her work. It was part of her work. I'd say I have, I realized how much you really can do if you really put time and effort into it. I was like, "Wow, I can do this! This isn't that hard! It's not as bad as I thought!" …I realized that in my day-to-day life I can be very independent. …In lab I'm like, "Ok, I can do this!" When I go to grad school I'll be able to figure out what I want to do without much guidance and it's not unrealistic or that scary. [LAREUS27]*

*INTERVIEWER: How have you grown as a researcher?*

*STUDENT: I'm more independent, definitely. I can develop ideas on my own now, whereas when I was a freshman they were kind of feeding it to me because I had no idea what I was going to do. And now I can kind of come up with a project idea by myself and make sure that it's a good way to do it, develop a valid hypothesis and stuff like that. Working out what to do next and not having to ask all, you know, every time. So, I'd say I've grown a lot. [LAREUS13]*

A number of students (15) also said that they had gained a more realistic view of what being a scientist is "really like" and how scientists practice their profession on a daily basis. These students saw that science is a collaborative process between colleagues and that it requires creative problem-solving. They also came to understand that researchers had to write grants, go through peer review to publish in academic journals, and present their work at professional conferences:

*There were group meetings. I got to see really what the research process was like. And the reason I enjoyed it so much, I think, is because it was a situation where you're bringing together different minds. I was in a physics and chemistry group, because Dr. [X] is a professor of physics and chemistry. Um, he had chemical engineers, physics majors, and chemistry majors in his group. And then he brought me in with the EE background, and it was good, because I learned some different things about how the research process is supposed to work. When I had done research before, that had been nothing but electrical engineering majors, so everybody's thinking in the same mindset, the same mode. But when people get together with different backgrounds, you have a problem that you can approach from several different directions. And I could bring in my ideas about something, because I know what goes on with circuitry, say, and someone else might bring something up about the chemical properties of a material, and things like that…. I was studying the electrical and physical properties of a nanofiber that we were working with. And it was the opportunity to really search for different things with, I guess, a more robust set of specifications, because people were able to look at it from different perspectives and say, "Well this is probably the reason this failed. The material can't stand that kind of pressure!" or, "The material isn't inert with this type of plastic," or something. So it was just a really robust experience, it was really rewarding to see that so many different people to come together on the same problem. [LAREUS19]*

*It takes time. It takes a lot of time. I want results, but you gotta work a lot, and wait a long time for collaboration. And you have to spend a lot of time getting funding, and then making presentations, and just letting everyone know about—. It's a lot of preparation and stuff. I didn't know about that. 'Cause I had to make the poster. That took like a week out of my summer. 'Cause I had to keep, I made it, and then having to revise it, and then send it to five people in the research group. And they all looked at it, and then changed it. It took forever. And then, like, doing it at real work, it takes a long time, 'cause you've gotta write it, make sure it works, and then test it fully, and all this stuff. Takes a long time to get what you want. [LAREUS2]*

*Dr. [X] has to write grants and stuff like that. It's almost like if you have an idea about something, just figure out how you want to do it, and write a grant (LAUGHS) and hopefully you can get it. But it's, it's interesting how it's a lot of work just preparing for an experiment, and just trying to put things together, and how it's very hard, especially with fish. Like, it's important to keep their temperature a certain way, and the pH, and the different chemicals have to be right, 'cause it's a big thing. Like, they say, "If you ever see the trout tank a couple of degrees off, call somebody! It's an emergency!" So it's just, like how important it is just to keep things going the way they should…. So I've learned that. Just how the whole thing works—grants and publication. I didn't even know anything about that until now. So just how all that works. [LAREUS3]*

*I think research really taught me that there's not always gonna be a nine-to-five type job situation. That, most of the time, it's going to be, you might stay 16 hours in the lab and then other days you might leave early because you're actually finished and you're done. And I think that it just kind of taught me how to how to understand that science is not always predictable and can be very frustrating, but at the same time very rewarding. [LASBPMS3]*

### E. Clarification and confirmation of career path intentions

This gains category is comprised of observations on the role of research in clarifying students' pre-existing career intentions, including whether or not going on to graduate school was desirable and appropriate. Their research experiences provided students a first-hand opportunity of what working professionally in research is like and to assess the fit between their interests and temperament and the realities of working in research day-to-day. Students said that research experience:

- Clarified and confirmed their prior interests; provided a concrete understanding of interests and fit within their field; helped determine whether or not 'research is for me', 'graduate school is for me' [20 students; 26 comments]
- Provided direction, career clarification; refined ideas and area of study; gave a sense of what field is like [13 students; 22 comments]

- Hands-on research showed student she or he *does* want a career in research; strengthened interest in and increased probability of going to graduate school [10 students; 12 comments]
- Increased enthusiasm for student's field: 'research is fun!' [8 students; 9 comments]
- Clarified that student does *not* like research, does *not* want a research career [5 students; 6 comments]
- *Introduced* idea of graduate school as a possibility rather than going to medical school; graduate school not previously considered [1 student; 1 comment]

A majority of students (20) said that their research experience had helped to clarify and confirm their prior interests and provided a concrete understanding of how their interests fit within the field. Engaging in hands-on research provided students the chance to assess whether or not "research is for me," and for 10 students, strengthened their intention to go to graduate school. Eight expressed the view that doing research had increased their enthusiasm for their field of study and showed them how much fun it is to do research:

> *Over the summer, I worked with the head of the medical physics department at the Mary Perkins Cancer Center doing research with an REU. So that was me learning even more about something different in medical physics. It wasn't what I had been doing, it was something completely different, that I didn't know much about at all but, once again, I learned over the course of the summer. And I've just been enjoying it thoroughly, because it's exactly what I wanted to be doing…. Medical physics has a lot of different areas you can go into, so I'm not completely sure what exactly I wanna do, but that'll be a grad school concentration. So I've got a little while to think about that. But before it was, "I might kinda want to do a PhD," but now, I know that's what I wanna do…. I'd read about medical physics before coming here, but getting here and seeing what's going on, not necessarily just my research, but all the other research, the high-level research with more complex aspects of, like, radiation therapy and stuff like that, really, that's made me wanna go into it even more. [LAREUS1]*
>
> *It [doing research] really did make me realize how much I do enjoy chemistry and that it's where I should be. [LAREUS16]*
>
> *It has made me more interested in chemistry, just because I know the kind of things you can do. Like, I'd never heard of nanoscale photography until I went to the group that I'm in…. And I was like, "That's really cool! If I get my degree, then I could be doing things like this!" So it's really turned me on in that aspect as well as the math aspect. [LASBPM2]*
>
> *That summer that I worked here, I really enjoyed going into the lab and working and it really, really was fun to see, to see what was going to happen with our reactions. And you know, we failed a couple times (LAUGHS) but it was fun, just to see the process of everything! [LASBPMS3]*

> *LA-STEM brought up the whole concept of research and I'd already been toying with the idea of grad school and it just kind of gave me a means to go, "Well, let me do this and it'll at least put me on the right track and that sounds like something I really would like to do." And after about a semester that was verified and I'm now very happy…. I was split between all of the sciences for a long time. I could have seen myself going into just about any science, except that over time I found that the rest of them didn't hold my attention as much as math did. I could do math and not have that, "Oh, I've been at this for a couple weeks. I want to do something else now." Which I'm prone to with a lot of things, but not so much with math, so I figured it's probably the best direction for me to go and it, it applies to all the sciences…. So grad school was definitely a consideration. But getting into research was definitely the biggest thing, that whole experience of seeing, "Well, this is what it really is all about," and getting that feel for it and wanting to continue doing that. Just, the whole discovery process was kind of amazing. And it was really, it really solidified this past summer when I was involved in an REU at Grand Valley State University. [LAREUS5]*

Thirteen students told us that research experience allowed them to explore their interests and to refine their previous ideas about possible future careers:

> *I've really gotten a good feel for everything because it's given me an opportunity to see how many different ways I can do things with electrical engineering. So it's a good, good experience. I think I've decided what I want to do as far as with my career. My first research experience was on polymers which can be used to create artificial muscles…. But when I went back up to Ohio State in January…someone was designing a mechanical kidney basically…. It could be put in your body to purify your blood…. And when I started college and I was deciding what I wanted to do, "Do I want to be a doctor, or do I want to really go with math and science that I really enjoy, and do engineering?" And I decided on engineering. So for me to see that it's like, "Okay, well I can take my ideas as an electrical engineer and apply them to really help people." So that's something I'm really interested in, just that I think you can accomplish so much more by working in an interdisciplinary fashion. I don't want to be in a situation where I'm working with nothing but EE majors. I would like, when I go to grad school, to be in a biological engineering research group, because I'm pretty sure that my electrical engineering ideas can bring a lot to that. And then also further some of the goals that I have. So it's definitely showed me that I can contribute to projects that are not within just this box of electrical engineering. I don't have to design a new semiconductor basically, just because I'm an electrical engineer. There are so many different things I can do. [LAREUS19]*

> *I was like, "Research? What kind of research can I do???" I always thought of engineering being like a technical field. Like, you design things, you build things, you make plans. And coming into research here and actually going to different places, it's like, just opened up a whole spectrum of things…. Last year I worked in the wind tunnel at LSU. So I worked on wind loads on free-standing walls and*

> *signs. And, at first, of course, I was just like documenting things, taking notes, just kind of getting new to the whole research thing. But once I finished cataloging equipment, things like that, I actually got to build models and go to watch the tests and take measurements…. This past summer I got an internship with NASA and I worked with calculating mass properties for space vehicles, kind of contributing to the plan, the vision, the first exploration plan. That's when I like, I was, "I need to be a mechanical engineer! This is so awesome." So working in the wind tunnel like, everything was so foreign and everything, like, I guess it didn't really spark my fancy, so I was kind of just going with the motions. I mean, I was interested in what I was doing, but it just wasn't enough to where I was, like, "Wow, I want to do this every single day when I get out of class. I want to come to the lab and work!" But this summer, I enjoyed waking up every day and going to work. Like, I loved working 40 hours a week. Like, it, it was just awesome. I couldn't ask for anything better. And now I know mechanical is where I wanna go. [LAREUS17]*

Five students reported that their experience showed them that they did *not* like research. Despite not liking research, students were very glad to have had the opportunity to discover they were unsuited to the work before committing to graduate school:

> *I did summer research for one semester and for one summer. Didn't like it. To me, that's just as important as finding out you do like it. I wouldn't say I wasted my time running off and getting those other jobs because I mean it's still possible, probable that I'll get a graduate degree, maybe not a PhD, but we'll see about that. [LAREUS14]*

> *STUDENT 1: I dunno. I'm kind of... I guess I'm sometimes one way, sometimes the other, but honestly, I don't foresee myself going into research as a career. Just because I don't believe my temperament goes with the nature of the job and that's valuable to learn because, first off, it helps to just really get sort of the reality of science. What's taught in the classrooms is a summary of everything, but you don't really get down to the essence of what happened to get to that point. And no matter how much you read about it, until you actually do it, you won't really know. And the lab courses don't give a very realistic picture of that, either. So, I would—I would definitely urge people to try and get into it now, because if nothing else, it will at least let you know where you stand on research, if you're, you wanted to pursue it more, or if you think you'd like to look into something else. At least you'd know before graduate school.*

> *STUDENT 2: Yeah, I learned I hate straight chemistry research. I'm doing it now, but that's 'cause I'm already there. But I would never do this in graduate school. I think it's interesting, but I don't want to do the same reaction 20 times in a row just to get a lump of something that I then give to someone else to analyze….*

> *STUDENT 3: And seeing a lot of scientists that—well, at least, the ones I've seen, kind of pushes me away from it, 'cause I dunno if they're sincere, or if they're*

*serious in some of the stuff they do and say. But it seems kind of strange. I don't know. That kind of pushes me away.*

*STUDENT 2: I've always want to go into industry for research, because I want to go into pharmaceuticals, but this summer definitely pushed me away whatever little bit I had wanting to go into academics. I don't know if it's just my experience, but I just realized that, once you get into the top, all you do is just work on research proposals, and then the science environment is just really back-stabbing. (LAUGHS) You're like, "They're research isn't good... but I'm gonna steal it." I was just like, "I don't wanna deal with this type of world. I just wanna do my research and not have to fight with other people to get to it first," and I just felt jaded to somewhere, I guess.*

*STUDENT 1: Yeah, it kind of pushes me away from the academic aspect of it, just because, um—maybe, I think, honestly I was really glad that I was actually working because this summer I just felt so isolated from everything outside of the lab. The only real communication I had was using the internet. It was just so time-consuming, and the fact that I just, I just saw the same walls every day and nothing really changed day-to-day, and I just didn't really like it that much, just the atmosphere. [LAREUFG1]*

*[Research], it's very disappointing at times, but at other times it's very rewarding…. I was discouraged. I've gotten discouraged before, especially when you're not interested in something that you're doing. It's very discouraging, 'cause you feel, like, you just don't want to go back. Why go back? All you're doing is failure! But, you know, I continued to do research, because of the LA-STEM program...(BRIEF PAUSE) not because I'm interested in it. …The LA-STEM program definitely gets people interested in research, but I'm not the kind of person that can sit at lab all day—that's why I want to go to medical school to become an MD, not an MD-PhD. [LAREUS14]*

One student told us that though she entered LSU with the idea of going on to medical school, at this point, she was considering a career in science research instead:

*I was completely honest about wanting to go to medical school when I came in. I told them that in the interviews. But it's like, being here and seeing what all research has done for us and what I can do, I'm very interested in it now. So it's definitely a possibility. [LAREUFG2]*

## F. "Thinking and working like a scientist": Intellectual gains

Gains in the "thinking and working like a scientist" category describe growth in students' intellectual and practical understanding of how science research is done, including critical thinking and problem-solving skills, understanding the nature of scientific knowledge, as well as deeper conceptual understanding of science and connections among the different disciplines. In this category, students' described improvement in their ability to bring

their knowledge, critical thinking, and problem-solving skills to bear on real research questions; some developed a clearer understanding of how knowledge is constructed; a few students went further, gaining insights into how to generate and frame research problems so that they can be approached scientifically.

- Increased understanding how research is done; application of learning in practice; understanding experiments must be repeatable and the value of negative results [16 students; 17 comments]
- Increased relevancy of coursework and transfer between research and classes [14 students; 22 comments]
- Increased critical thinking and problem-solving skills, "thinking like a scientist" [14 students; 19 comments]
- Increased understanding how scientific knowledge is built: contributions accumulate over time; understanding the open-endedness of science; the nature of scientific 'fact', theory as a model of reality [11 students; 11 comments]
- Increased understanding theories and concepts, making connections between sciences, seeing the big picture, making interdisciplinary connections [8 students; 15 comments]
- Increased understanding how to design a research experiment [8 students; 10 comments]

Many students (16) described how hands-on research experiences had given them a better understanding of how research is done—learning the process of conducting scientific research—and the opportunity to apply their learning in practice. They realized that experiments must be repeatable and produce similar results multiple times. They appreciated these opportunities to gain experience and expressed a clear understanding that their actions and choices held implications for the outcomes thus generated:

> *I've learned that research takes time and dedication. You can't just be like, "Okay, I'm gonna perform this experiment today," and just not think about it. You have to sit there and actually think your processes through. You have to think about how you're going to go about doing your experiment…. So from research I'd say, just proposing a question and just working your way through to find an answer to your question. [LASBPMS2]*

> *I really enjoy seeing the application start to finish—from the hypothesis to the animal testing to the molecular testing, from the animal testing to writing the paper to how that paper is gonna affect how medicine thinks in a particular subject. To me, that is fascinating. How it started from, like "Let's try this!" and you make the animal model. You test the animal model. You find out what you find out from the animal model. And from there they are able to apply it to help other people. That is something that I did not understand prior to college and doing research. [LAREUS26]*

> *When you think about research, before you really know anything about it, it's like, "Oh, people work on it and they get results and then that's it." But, okay, if you*

*get results, big deal. You have to do it like five more times, and make sure those results are even real results. Make sure all your reagents are right. If they're old, you're gonna get false positives. You're gonna get false negatives. Things are just going to be terrible! [LASBPMS1]*

*I was working with DNA and stuff and you had to be very sterile. Everything's got to be precise, and you can't do one little thing wrong or it could mess everything up. And also, like, just even, you need to be careful with your data, to write notes, and the importance of being precise, like what day, just to make sure that, you know, you want your results to be accurate, and just how important it is to be very precise and keep things sterile, and stuff like that. You can't just, like, fling it in the wind, just be like, "Oh, I'll just...," you know, you can't just do that! You have to be very professional [LAREUS3]*

*[I gained] 40 hours a week of programming experience. I'm a lot more fluent and it's just a lot more natural to me now. I mean, I was good at programming before, but then I switched languages. And then getting used to the environment and stuff. I never worked 40 hours a week before—besides at a library, which didn't count (LAUGHS); I sat around and shelved books all day—but, I mean, in my major and stuff. It was real helpful in understanding what computer science was about. [LAREUS2]*

Many students (14) noted that research experience increased the relevancy of disciplinary course curricula and that their learning transferred between research and their course work:

*As a direct benefit from doing research, I've gotten the ability to be much more comfortable working in these program environments so when a class project is assigned where I have to use one of those coding languages, I'm much more comfortable with it. The programs are much more easy for me to do. For example, I'm in a computer vision class where we take a picture and supplies, we apply an algorithm to the picture, and it's got a lot of noise in the picture and we have to remove the noise, and we use a program called MATLAB…. I learned a lot about MATLAB in the research I'm doing now so this project has been a lot easier to do since I've had that experience. [LAREUS12]*

*The upper-level classes, I am starting to feel more in the swing of things I guess because a lot of the stuff we did over the summer like, I had to do a lot of research to kind of be up to par to actually do the research and like now we're going over a lot of it in class and I'm like "I get it!" Like, it's working for m! And so I think it really helps to get everything enforced once in class and then again, like, in research. And so it's a great learning tool. [LAREUS17]*

*Especially, like, when I took genetics. We had this whole section on PCR amplification and DNA extraction. It was, like, "I've been doing that for the last year!" So I was able to teach people. They're like, "Okay! So…so what*

*happens??" And you're like, "Okay. There are three steps, and it just repeats over and over." "Ohh!" And it's just, things that seemed so simple to me because I'd been doing them, and people were, like, just totally lost. So being in the lab has helped with classes; classes help in the lab, and then, as I learn, I go "Oh! I learned this today in class!" And it's like, "Oh! We used to do that." It's, like, "Oh!" Putting two-and-two together. So it makes things make much more sense. 'Cause, they explain it to you when you do it, but when you don't have the background, it just goes in one ear and out the other. [LASBPMS1]*

Fourteen students discussed the development of their critical thinking and problem-solving skills, derived from grappling with the problems they encountered in their projects. They also had learned to be critical in examining research results and more questioning of how results had been achieved:

*Just having experience that lets me know, you know, if I am presented with this problem, I have some practice method that I use to approach it. So, I definitely go into other projects thinking, "I should be able to do this if I put an effort into it." Not, "Oh, my god! This is sooo much information that I don't know, and I have no idea how this works, how am I ever gonna do this?" I go into it thinking, "If I sit down at this and I work at it and I use everything I know, I should be able to do this." [LAREUS1]*

*INTERVIEWER: Are there particular skills that you've developed as a result of doing research that you think are really valuable or that you'll carry with you?*

*STUDENT: Of course problem-solving and just sitting there and trying to figure, "Why is this not working. I'm doing everything right, I've done everything right three times in a row and it's still not getting the right numbers," and, you know, just a sheer work ethic. [LAREUS7]*

*I was just sitting there, trying all kinds of things. Like, I just had to go through all this stuff to try and figure out what was wrong. And then finally, I figured out what was wrong by accident, when me and a co-worker were working together on it. We changed something, and it worked, and I was like, "What the???" And I didn't even know what we changed, because it was something completely unrelated. And then we found out what it was and we were like, "We fixed it!" I couldn't wait to tell my boss. [LAREUS2]*

*STUDENT 1: I've learned to look at things in a different light…. After a while, you see how everything's not black and white—it's gray, and so "Okay, maybe we could use this to do this, even though it's not ever used." You know, "That piece of equipment to do this." You look at things differently. You see how things can work in another way.*

*STUDENT 2: Yeah. Like, at first I learned to not look at what I get, but why I get what I get. 'Cause in freshman year, I'd always just be concerned with my*

*product. Now I'm worried about why'd I get that product, and how my variables affected my results. [LAREUFG1]*

A number of students (11) commented that research experience had given them a higher-order intellectual benefit: gains in understanding how scientific knowledge his built. These students had come to better appreciate knowledge as an open-ended, ever-growing and evolving body of theories and information. Students often mentioned coming to a more mature understanding about the nature of scientific knowledge in terms of realizing that the 'Truth' set down in their textbooks was not 'fact' as they previously understood it. In these accounts, it's clear that students were excited at the prospect of making a contribution that might "push science along":

*I realized that everything...that's down in the textbook, you know, isn't the gospel truth. I mean, stuff that comes from a textbook is most likely wrong by the time you read it! I have an immunology book that's three years old and half of it is at least false information now…. Research helped me learn that science wasn't memorizing the structures of amino acids and regurgitating them on a test! If that's a...good answer to your question. It helped me learn that science is not what you learn in a classroom; science is what you do after you acquire knowledge in a classroom. Getting a degree in biology does not make you a scientist; (BRIEF PAUSE) it makes you have a degree in biology. Doing research makes you a scientist. [LAREUS18]*

*I didn't have a clue about research. Not a clue. They were like, "Yeah, you have to do it." It was like, "Okay. What do I do? Do I do research? Do I help research? Do I, like, just watch people? What do you do?" And obviously, I had no idea. I go in there and got way excited about splitting cells! (LAUGHS) …I enjoy it. I enjoy it a lot. 'Cause otherwise I would hate my job. I like having to go in and it's not the same thing all the time. … And when you get something right, in a class, it's like, "Well, you did the work, you got it right. Okay, go home. You got an A." Here, you get it right, it's, like, "This is new! This is exciting! This is a paper! This is adding to the scientific knowledge! This is great!" So it's definitely much more profound. And it's exciting to be a part of something like that. And to be very involved in the making of new scientific knowledge. And then knowing how it's going to be applied. Like, we're making vaccines against different viruses right now. That's gonna help a lotta people! [LASBPMS1]*

*INTERVIEWER: What's been the most rewarding thing about doing research?*

*STUDENT: I think just feeling like you actually come to understand something better and…the work you do will help someone else's work, hopefully, I guess, is ultimately the goal. To kinda push science along. (LAUGHS) [LAREUS27]*

*There's so much that we still have to discover and investigate. I think it really kind of put everything into a perspective. [LASBPM3]*

*STUDENT 1: I work in a genetics lab, and as much as we know about genetics all-around, the gene mapping and all that, we don't really know, we just don't know what they're doing. And it was just kind of eye-opening to see that we're working with a small plant that has a relatively small genome, and just to see how much that we don't know, just about a small genome and then to think about how the other genomes that are out there…so a lot of stuff that we don't know and it's eye-opening because you want everything in the textbooks to be what we do know, and it kind of portrays the picture that we do know a lot, but there's so much more we don't.*

*STUDENT 2: For me, it's the same way. Like, my first research project was on Alzheimer's and now any time I hear a teacher say that, for a fact, "Alzheimer's is caused by beta-amyloid plaques," it just pains me! That's a theory, it's not fact, yet. I just hate it when people say things are facts that are still just theory— even if there's a strong, supportive theory, it's still not fact! So I always just go (INHALES) any time a teacher says that, and it's happened two times this year so far.*

*STUDENT 1: Yeah, there's a lot of gray. I think that's all we really have, is gray. We try to make it look black and white, but it's not. So even the stuff we know, we really don't know. [LAREUFG1]*

Some students (8) said that they had learned a lot and that they had a better understanding of the theories and concepts shaping their field. They also noted understanding "the big picture" of the science framing their research and making interdisciplinary connections:

Exchange 1:

*INTERVIEWER: What's been most rewarding about research?*

*STUDENT: Understanding…actually being well-versed in the specifics of computer science as well as a lot more versed in computer science. I think the knowledge is the most rewarding thing. [LAREUS8]*

Exchange 2:

*INTERVIEWER: What's been most rewarding about research?*

*STUDENT: Most rewarding for me? Just, I guess the science and knowledge that I've gained in all these different areas. [LAREUS12]*

*I've just gotten so much knowledge of that kind of computer system. It's been useful in both the research fields I'm in. Because of the uses of the programs and the ways you can run different things on them, I mean, most of what I'm doing transfers to some other aspect of physics. So to get to see how that applies across, you know, what I'm doing. [LAREUS1]*

Several students (8) described gaining another type of higher-order intellectual gain: understanding how to design and carry out a research project:

> *INTERVIEWER: How have you grown as a researcher?*
>
> *STUDENT: I'm more independent, definitely. I can develop ideas on my own now whereas when I was a freshman they were kind of feeding it to me because I had no idea what I was going to do. And now I can come up with a project idea by myself and make sure that it's a good way to do it, develop a valid hypothesis and stuff like that. So, I'd say I've grown a lot. [LAREUS13]*
>
> *I'm at the point now where I can give like a broad, you know, "This is what we need to do next." And what I need help with now is like the experimental setup. Like, "What are the controls going to be? What controls do you need? What do you not need?" you know? "Is this too many variables at one time?" or, "Are we really looking at, is this the best way to look at what we want to see?" And, I mean, I'm taking, I can direct the project but it's more the specifics I have trouble working out by myself. But I'm learning, you know, all the things I need to think about. [LAREUS27]*

## G. Reports of poor research experiences

While the majority of student described quality experiences and working closely with a mentor on authentic research, we did hear accounts of bad research experiences. Seven students detailed (sometimes multiple) poor quality research experiences, often when doing summer research "away" at another institution. Largely, students reporting a poor research experience said that they had had little or no mentoring and that they did not establish a working relationship with their research advisor. Some felt that they were not doing real research, but instead were simply assigned menial tasks and "busy work" or were not allowed to do anything but watch the graduate student do the work (following recommendations from LA-STEM program staff these students were looking for other research positions). Several of the extracts show that a number of students found themselves "in over their heads" and academically unprepared to understand the science of the project and felt their work did not contribute in any significant way. A couple students admitted that they simply didn't like the work they were doing, regardless of the other difficulties with their research positions:

> *I went to do research at Rice. When I was out there my freshman year…. That one wasn't so good. I mean, the people were nice, they're great. But I was a freshman. I didn't know that much about anything and so I pretty much ended up doing like, you know, field work, like regular labor. Like if they needed somebody to be able to do something, like, "Oh, go grind the corn—" we were doing a corn project, "Grind the corn!" So I didn't really learn anything. I just kinda did manual labor. My second summer I went to USC Chapel Hill in University of North Carolina and I guess because I applied later…I decided at the very last minute to do summer research and apply…. I came in and they didn't necessarily*

*have specific research for me so they ended up sticking me in the school of public health, but they stuck me in toxicology and I wanted to do environmental management. Then my professor got sick and so she was gone for about a week and a half. So yeah, it was kind one of those, "Anything that can go wrong, will go wrong." …I was like, "They had me come all the way here and they didn't really even have a project for me!" [LAREUS21]*

*They assigned me someone who first just had me organize their files, and so I asked for a change. And they assigned me to someone else who gave me a project but, you know, theoretical physics and undergraduate, you just really can't do anything and so it was really unfulfilling because I knew what I was working on didn't amount to anything. I was recreating the results of another paper and then while trying to do that I found another paper that went ten times farther than I knew I would ever go with this particular subject so I, I was really disenchanted with the process, like, "What am I doing this for?" And then through summer research, sort of the same sort of thing. Just something about it. I just didn't enjoy it and I didn't see a lot of value in what I was doing and, so…. I went and visited University of Chicago awhile back. And some of their graduate students were working with fluid dynamics and things in a very advanced topic but they said, you know, "We don't really work with quantum mechanics. We don't do this. We don't do this."… Every undergraduate I know who works in physics is more or less a technician. They put in data, they take out data…. They're not really doing authentic work. …But then I moved to the Center for Computation and Technology. It's a, big department here. They get a lot of money. They brought in someone from Einstein Institute of Physics in Germany, I think it is, and they're doing a lot of parallel computing and numerical relativity, but real general relativity. Way over the scope of an undergraduate. And they tried to get me and another undergraduate or two to catch up. They had never worked with undergraduates before. They wanted to attempt this avenue. I didn't know it was their first time doing it. So, we all, I think, more or less felt like failures because what we did in a semester could have been done in a day by anyone who was there. We spent so long trying to learn the mathematics, learn this, learn that, learn the computer system, and there just wasn't a lot of oversight. [LAREUS14]*

*The thing about our electrical engineering department is you're not, undergrads aren't allowed to do anything with the machinery pretty much, so it was very hands-off. And I got to see how everything was working, but I didn't get to do very much, and that was kind of, I guess not ideal because, you know, of course you want to be a part of it. You don't want to just sit back and watch it happen. [LAREUS19]*

Exchange 1:

*STUDENT 1: I worked there this summer and I hated it. And it wasn't that I didn't like what we were doing. It was just way over my head. What we were doing is hydro-formulation, and it's just very intense. You need to have years of*

*experience of chemistry to actually understand what was going on. And I tried so hard to understand. I had a grad student. I would come in with questions every day and he was like, "I can't explain it to you, 'cause I would fill up this whole board with organic. You haven't even had organic, and you wouldn't understand," and I would be like, "Well, I have to present on this and I don't know how to answer a question if I don't understand!" And he was like, "Well, just get a general knowledge." And the machines we were working with, $100,000 machines that I couldn't touch. Most of what I did this summer was just watch what he did. I just followed him around. And that's not what I wanted to do. 'Cause I'd be in a lab all day. There's no windows. You're sitting there. And I'd just be sitting there waiting for him to do something. So my experience this summer wasn't great. But that's why I'm trying to change it. 'Cause I'd like to be in a hospital. I've worked in a hospital before and that's really what I wanna do.*

*STUDENT 2: I'm in the process of changing right now. …I've had some really bad experiences. Like, my first semester, I came in working with hurricane engineering. And my professor was very hard to catch up with. He was always out of town. This is like right after Katrina and they were still trying to figure out all these things. So he's a very busy man, was never in town. I would send him an e-mail, it would take like three weeks to get it back, and like, he had me doing like petty work. I was told I should switch so last spring, I went to chem engineering dept, and I was doing my grad student's dirty work, basically, which is what we basically kinda do. But it was just like, he was like, "Do this. Do this," and he wouldn't explain to me what I was doing…. But now since I'm in a department with my major, and my professor, she's new, she just graduated from [X]. So she's new. I'm new. And so we're starting this project off together. She just got me certified, 'cause we're gonna be working with humans, so we had to be certified. And we're going step-by-step. And she's like, "Okay, we're gonna do this. You read this. And then we're gonna do this." So I actually get to go into the lab next week and kinda get started.*

*INTERVIEWER: So you're on your third project?*

*STUDENT 2: Third one. (LAUGHTER)*

*INTERVIEWER: Okay. But it sounds like this one might-*

*STUDENT 2: I think this one's gonna work. 'cause she told me what I was gonna be doing, and I was very interested in it. And she's gonna walk me through it. [LAREUFG2]*

Exchange 2:

*INTERVIEWER: And with the second experience, you said that you went away for that? How did you choose that REU?*

*STUDENT: I didn't apply to very many, and it's the only one that accepted me, so there was no choice. I didn't really know anything about what they were doing. Very heavily experimental things. And I was also, even though I'm not a physics major anymore, I'm taking quantum right now, and at the time I hadn't taken quantum. So I didn't really understand what was going on, I was just pushing buttons.*

*INTERVIEWER: So if you'd had a better concept of what was going on, it might have been more of interest, or if you'd had it this next summer after quantum?*

*STUDENT: I don't think I would have liked it anyway. But, yeah, but I would have understood it better maybe.*

*INTERVIEWER: You said it was just pushing buttons. Was it a fairly menial job then? You weren't really engaged in the research or...?*

*STUDENT: The most fun I had was writing a little program to fit some data points for fitting, you know, a peak, an absorption peak with some polynomial. That was the most fun I had.*

*INTERVIEWER: Uh huh, (YES). But otherwise, was it that it didn't require much skill? Or it was just boring to you? Or you just weren't interested?*

*STUDENT: At one point I had to build a detecting device thing which was, to me it was just putting some pipes together. I mean it required more than that, but I didn't really like it. I don't think I'm very good at that kind of like task, like ordering bolts and screws. You know, and like making sure everything's fitting together. I didn't really like that. [LAREUS9]*

In sum, over half the students we interviewed (17-25 of 35 students) reported gains in:

- Establishing a collegial relationship with faculty [25 students]
- Understanding the nature of research [22 students]
- Clarification and confirmation of their prior interests; provided a concrete understanding of interests and fit within their field; helped determine whether or not 'research is for me', 'graduate school is for me'; increased interest in graduate school [20 students]
- Increased professional confidence [19 students]
- Laboratory skills and use of instrumentation [17 students]

Thus a majority of students described positive research experiences in which they developed quality working relationships with their research advisor. In the process of doing research, students gained familiarity and facility with technical laboratory skills and instrumentation needed to carry out the research. These opportunities helped students to feel more confident in their ability to do research. In addition, as a result of engaging in authentic research, a majority of students developed a clear understanding of

the nature of research work—that it is slow, repetitive, and that setbacks and failure are par for the course.

In this sample of talented, highly-motivated students, a majority said that their research experiences had served to clarify, confirm and strengthen their incoming interest in going to graduate or medical school. Five told us that they had discovered they were not temperamentally suited to research work and were enabled to determine "research is not for me." They counted this realization as a gain and were glad to know this as an undergraduate rather than as a graduate student. The only student to report being introduced to the idea of graduate school was a student who had intended to go to medical school prior to college entry and was now considering a graduate program instead.

Between 25%-50% (8-17 students) reported a majority of gains across the six benefits categories.

- Laboratory skills and use of instrumentation [17 students]
- Understanding how research is done; application of learning in practice; understanding experiments must be repeatable and the value of negative results [16 students]
- Presentation skills [15 students]
- What being a scientist is really like; how scientists practice their profession—collaborative work, professional behavior, grant writing to fund research, practice of peer review, [15 students]
- Opportunities to network with other researchers [14 students]
- Increased relevancy of coursework and transfer between research and classes [14 students]
- Critical thinking and problem-solving skills, thinking like a scientist [14 students]
- Seeing scientists as "real people" [13 students]
- Collegiality with other students, graduate students within the research group [13 students]
- *Demonstrated gains* in behaving like a scientist: "ownership" of project; commitment to and intellectual engagement with the project; becomes an active learner, a creative problem-solver; increased willingness and ability to work independently [13 students]
- Career clarification; refined ideas and area of study; gave a sense of what field is like [13 students]
- Collaborative working skills [12 students]
- Good preparation for graduate school [12 students]
- Writing skills [11 students]
- Research advisor provides career advice and networks for student: provides placement, writes letters of recommendation [11 students]
- Presented at a UR conference [11 students]

- Increased understanding of how scientific knowledge is built: contributions accumulate over time; understanding the open-endedness of science, nature of scientific 'fact', theory as a model of reality [11 students]
- *Demonstrated gains* in understanding the process of research; increased patience, perseverance, tolerance of setbacks and failure; research work requires these temperamental attributes [10 students]
- Hands-on research showed student she or he *does* want a career in research; strengthened interest in and increased probability of going to graduate school [10 students]
- Enhances student's résumé; makes student a more competitive candidate [9 students]
- Student will likely have a publication by the time he or she graduates [9 students]
- Increased enthusiasm for student's field: research is fun! [8 students]
- Increased understanding of theories and concepts, making connections between sciences, seeing the big picture, making interdisciplinary connections [8 students]
- Increased understanding how to design a research experiment [8 students]

Thus one-quarter to half of students detailed a broad range of personal, professional, intellectual and technical benefits that they take away from research experience.

A small number of benefits were reported by about a quarter of the students interviewed about their research experiences. These benefits can be expected to be reported by a minority of students as they reflect particular differences in research experiences, such as whether or not a student worked in a group setting (not commonly reported), disciplinary field, or had enough sustained engagement for the student to achieve longer-term outcomes, such as learning to defend one’s research results during questioning in a presentation, presenting at a professional conference, and being listed as a co-author on a publication.

- Belonging to a community of learners within their research group [7 students]
- Presented at a professional conference [6 students]
- Computer skills [5 students]
- Communication skills not related to writing or presenting [5 students]
- Gains in maturity, self-discovery, responsibility [4 students]
- Student is co-author on a publication [4 students]
- Gains new experiences not linked to career enhancement [3 students]
- Ability to defend an oral argument [3 students]

Seven students reported instances of poor quality research experiences, mostly occurring in research positions at a host institution. Common elements of poor research experiences included little or no guidance and mentoring from the research advisor, being assigned only menial work tasks, being academically underprepared to understand or meaningfully contribute and finding one self better suited to other interests and work tasks.

# X. Research Advisors Views on LA-STEM and Mentoring Undergraduate Researchers

We interviewed a sample of 15 faculty research advisors associated with LA-STEM to explore their experiences with and views about the program (descriptions of faculty sample characteristics, i.e., discipline, gender, race, etc. are listed in Appendix D).

We asked research advisors:

- to describe their engagement with LA-STEM (i.e., their role and how long they had been involved, how many students they typically work with, whether they conduct research with students during the summer, the academic year, or both, etc.)
- about their knowledge of LA-STEM's objectives and of the program, generally
- how they selected students to work with
- to describe the types of projects students work on
- how they typically worked with students
- what they observed students gain from doing research, and
- about the benefits and costs of directing LA-STEM students, to themselves, their department, or to LSU

Here we present findings from the qualitative analysis of our interviews with these faculty members.

## A. Research advisors' engagement with LA-STEM

Research advisors with whom we spoke had been involved with LA-STEM different lengths of time, though the range of their participation, overall, is balanced across the four-year history of the LA-STEM program (see Figure 1). Several research advisors had started more recently, while others had directed LA-STEM students since the beginning of the program. One research advisor couldn't recall when he started participating: he was involved in so many undergraduate research programs, he couldn't distinguish them. One faculty member who directed undergraduate research reported that he had no prior experience with the LA-STEM program, though he had heard of it. Finally, two of the research advisors we interviewed said that they were not currently working with a LA-STEM student.

Beyond directing LA-STEM students in research experiences, a few research advisors (3) mentioned other ways in which they had participated in LA-STEM, such as giving a presentation of their research to students during Summer Bridge, and serving on a panel about graduate school and STEM career options, among other types of involvement.

**Figure 1. Length of time research advisors' have been engaged with LA-STEM**

| *Time engaged with LA-STEM* | *# of Res. Advs.* |
|---|---|
| Less than one year | 1 |
| One to two years | 4 |
| Two to three years | 4 |
| Four years; since LA-STEM began | 4 |
| Does not know how many years he's been involved in LA-STEM; has worked with many students from multiple programs over the years | 1 |
| No involvement with LA-STEM, but has heard of it | 1 |
| **Total** | **15** |

All research advisors reported working with students during the summer as well as the academic school year. About half of research advisors (7) reported working with one or two students per semester; four said that they routinely worked with groups of students of three or more. While one reported working in a very small lab, without a lab technician, eight directed larger research groups with graduate students and paid hourly workers. One research advisor estimated that the research center he worked at currently employed 12 LA-STEM students on various projects. Eight research advisors said that, typically, their students had sustained engagement on the same research project both during the summer and the academic year and longer-term student involvement of two or more years.

## B. Knowledge of LA-STEM's objective and general knowledge of the program

A majority of the faculty research advisors with whom we spoke (13) were aware of LA-STEM's objectives to recruit talented students to STEM majors, retain them, and encourage their entry to STEM graduate degree programs.

Six research advisors said simply that LA-STEM's objective is to recruit the "best and brightest" of a diversity of students to STEM fields, regardless of race and ethnicity:

> *I understand it's a special way of getting students into science and technology, and I understand it's not just minority students, it's all talented students. [LAFACS5]*

> *I gather that this is for very motivated, talented students and that's about all I know. [LAFACS8]*

*INTERVIEWER: Do you know anything about the goals of the program or the mission of the program?*

*RESEARCH ADVISOR: No, but I can I probably could give a pretty good guess.*

*INTERVIEWER: What would your guess be?*

*RESEARCH ADVISOR: My guess would be to promote particularly underrepresented groups in the sciences and math, though they do have plenty of white males in there. But they want to recruit the best students. [LAFACS10]*

Four characterized LA-STEM's objective as recruiting students from underrepresented groups to enter STEM majors, retaining them, and encouraging them to pursue a PhD in the STEM fields:

*INTERVIEWER: Tell me, what do you understand to be the objectives of the LA-STEM Research Scholars program?*

*RESEARCH ADVISOR: Oh, to interest minority students in the STEM areas, the science, technology, and math areas and having them go on to PhDs. [LAFACS15]*

Three specifically mentioned the use of undergraduate research experiences in retaining students in STEM fields and as a means to encourage their entry to STEM PhDs and career pathways:

*INTERVIEWER: What is your understanding is of the LA-STEM's objectives?*

*RESEARCH ADVISOR: It's to get students more engaged in research, particularly more in the physical sciences and encourage them to go into PhD work in the physical sciences. Because we're trying to increase the number of underrepresented students getting PhDs and potentially going into research intensive university positions to address the woeful state of underrepresented minorities and women in physical science faculty positions. [LAFACS6]*

*INTERVIEWER: What do you understand to be the goals of the LA-STEM program?*

*RESEARCH ADVISOR: My understanding is to try to convince students, or maybe open their opportunities to the possibilities that exist if they go to graduate school…. I know in [my discipline] we have an issue where some of our undergrads this year are getting job offers in the high $70's to low $80,000 dollar range so it's hard to convince someone to go to grad school. I think that one of the ways you get students involved in grad school is you have them doing undergraduate research. So my impression is if you're in LA-STEM is you have the chance to do some undergraduate research and to have more kind of a*

> *personal relationship with a faculty member who can serve as a mentor or advisor to you. And then you get exposed to what it might be like to go to grad school or a post-graduate degree, then they have the opportunity to decide, you know, "Do I really want to go work in industry or did I enjoy the lab work enough that maybe I want to pursue that further?" [LAFACS11]*

One research advisor mentioned offering research experiences to students early on, as freshman, as an objective of LA-STEM. One noted that the emphasis of LA-STEM was to support students in the physical sciences and to promote careers in these fields, and was less directed at degrees in the biological sciences or for students interested in pursuing a medical career. Three mentioned that they knew the LA-STEM program was supported by funding from the National Science Foundation (NSF) to promote research experiences for undergraduates, particularly for students from underrepresented groups.

In discussing more general knowledge of the program, 10 faculty offered one or two comments each on a range of LA-STEM elements, including financial scholarships, Summer Bridge, classes, or program requirements:

> *These students receive, if I understand correctly, they receive a tuition waiver, a tuition scholarship. In exchange for that scholarship they commit about four hours a week to lab work. So, basically it's a win-win situation for them because they get live experience and they also get tuition covered. [LAFACS11]*

> *The Summer Bridge, they bring the freshman in, to live on campus over the summer, prior to the start of their freshman year and give them some courses to get a head start. And also they bring faculty in to present, give demonstrations of their research to show students what's available. And they'll also provide students with some time management workshops, study skills sessions to prepare them for college coursework. [LAFACS15]*

> *I know that she's kind of required to do so many hours of work during the summer. And she was making pretty good money to do it. So the very least, people were expected to treat it like a job. [LAFACS2]*

While it is encouraging that a majority of research advisors understood the primary objectives of LA-STEM to recruit and retain students in STEM majors and encourage entry to STEM PhD programs, they knew little about the LA-STEM program overall. Over two-thirds of the research advisors (11) stated they actually knew very little about the LA-STEM program:

> *INTERVIEWER: What is your knowledge of the LASTEM program?*

> *RESEARCH ADVISOR: Well, um, to be honest, very little knowledge. I figured out what the acronym stood for. [LAFACS10]*

> *The only thing I know about the program is that a student approached me and said they wanted to work for me. Otherwise I would have been unaware of the program. [LAFACS8]*
>
> *INTERVIEWER: What do you know about the LA-STEM program?*
>
> *RESEARCH ADVISOR: Um, not a lot actually. To be frank, I'd like to know a little bit more about the program. LSU has some very good undergraduate programs, but not all of them communicate to the same extent…. I'd like to know more about it. [LAFACS2]*

Though it is clear that research advisors could use and would appreciate more information about the LA-STEM program and its requirements, the last speaker identifies another issue raised by 12 of the 15: that, as a large research university, LSU had multiple, overlapping undergraduate research programs operating across the campus, and including several large research centers. Given the "alphabet soup" of program names (LABRIN, LSAMP, NSF REU, HHMI, etc.) many acknowledged it was nearly impossible to keep them all straight. In fact, several research advisors were not entirely clear which programs sponsored which of their student researchers:

> *I don't actually pay much attention to what program students come to me through. It seems like the programs have kept changing names, which actually has confused me. I would kind of like it if they didn't keep starting up new programs with new names, because I just don't know which one is which. [LAFACS8]*
>
> *INTERVIEWER: Did you work with a student this past summer?*
>
> *RESEARCH ADVISOR: Yes, but I don't, I, I don't think it was one of the LA-STEM programs. It was a minority program, but not a LA-STEM program. But it's unclear to me, because I work with so many different programs.... I'm not quite sure which students are LA-STEM students and which students might belong to other research programs. The student I'm working with now, well there's a couple of students, but one of the students, I think she may be in one of the programs that's under the LA-STEM program. [LAFACS15]*

## C. How research advisors select students to work with

Two-thirds of the research advisors told us that students had approached them and requested to work on their research. One of the research centers had hired a director to manage student researchers and those interested in a position at the center applied to him initially. Two research advisors said students from their classes approached them for work and two said that colleagues had recommended students seeking research positions. One advisor, who in the past had grant monies supporting UR opportunities for students from underrepresented groups, told us that he recalled approaching particular students to ask whether they would be interested in working on his research. In all cases, the research

advisor and student discussed the project to see if there was a good match between the student's interest and the project.

## D. Defining a student research project

Research advisors were in common agreement about the types of research projects they had their students work on. On the whole, research advisors developed projects related to some facet of their own work with the goal that results would inform their research. When asked to describe the types of projects they assign to students, two-thirds of the research advisors said that they were careful to structure the project to accommodate students at their level and to meet students' own objectives. Working with first-year students as novice researchers required advisors to carefully scaffold students' learning and level of participation. Many (8) were also concerned to structure a project likely to produce results in the limited time available while taking into account students' abilities (and constraints):

> *At the beginning of the summer I had her working closely with my research assistant and he was showing her various techniques just within the lab, just so she could become familiar with it…. That was before I set her on her own to do stuff…. But the project [my student] is working on is based on what she came in wanting to do. It was working with embryos. It's something that she can come in, in an hour, a couple hours in the day, monitor them, do some kind of basic observations on them…. It's kind of, the project's being somewhat tailored and it's also a project that's sort of something I've been wanting to do. [LAFACS2]*

> *He had his own little project, um...but related to the larger goals of the lab…. It has to be something that's reasonable for them to do. It has to be something that's truly useful for the lab. I think those are the primary things. And then I think it has to be a relatively straightforward, simple thing to do. Um...you know more than that and you just guarantee frustration, just complete frustration, and that's just pointless all the way around. [LAFACS12]*

> *Projects that I choose have well defined goals and something that has a realistic time table…. I want to have a well defined project that I know exactly what needs to be done experiment-wise in the next semester, and they know exactly what they need to be working on, and they know when they can expect results by. [LAFACS11]*

> *I know enough to give students projects that are doable and where they can get some results, and as the student gets more and more experienced, they get more involved in the real cutting-edge research, where they will occasionally encounter more failures, but it also has a higher probability of success. …Almost anyone who comes in my group, including new grads, starts off by making this chemical. And it takes them a semester to learn all the techniques and how to do it. …Most of my students never do a whole lot of brand new innovative stuff… And we do try to get involved in some of the cutting-edge stuff after they've gone past this*

> *intro stuff. It also depends on how long they've been in my group. A student who only spends a semester doing research isn't gonna do a whole lot of brand new stuff, although they'll see all sorts of new things. [LAFACS6]*

In reviewing advisors accounts of the types of projects they had students work on and of the activities in which students were engaged, it is clear that, to the extent possible and appropriate, students were engaged in authentic, original research. There was only one account in which an advisor described a student doing "slave labor." In this instance, the advisor moved the student onto a "real research project" once he saw her initiative and talent:

> *I had her come into my lab and really acting more like a technician. A lot of what she was doing was a lot of inventory and just a lot of rock labor stuff. Kinda learned how to do certain techniques and I was showing her things, but it was stuff that was not necessarily leading to results. And I saw that she was capable and I know she was showing initiative and so I put her on her own little project that was leading to results, versus just helping out others in the lab. [LAFACS2]*

## E. How research advisors work with students

Research advisors described various ways in which they managed research with students.

Four said that they worked with student researchers "one-on-one."

> *I work directly with him. And I try to explain things to him, although it's more time consuming on my part. But maybe better for him. But I cannot rely on my grad student to really mentor an undergrad. I don't think it would be good for the undergrad. [LAFACS3]*

Eight told us that they kept tabs on students' progress and were generally available when problems arose, but that they relied upon their graduate students to train the undergraduate researchers and guide them on a daily basis.

> *So a lot of my undergraduates, I have them working with graduate students and the expectation is the graduate student will really be responsible for the day-to-day monitoring and then I'm sort of over there, sort of doing my thing—getting the money, creating lectures and that type of thing—and I just sort of leave it up to them. If they have a problem, they can come and see me. [LAFACS2]*

Most commonly, research advisors (11) began (or had their graduate students begin) by familiarizing students to the laboratory, training them on equipment, and showing them how to do basic techniques. Whether working with a student one-on-one, in pairs, or in groups, a majority of research advisors (11) described engaging students in conversations about the research, giving "mini-lectures" when necessary, and providing appropriate instructions and direction so that students could carry out the work:

> *I ask how things are going. "So where are you at with these? I'll need you to put the data together." Or "I'd like to see the data for this" and that type of thing. And when they get the data back it's, "Ok, normally this is how you'd do it." Or I would show them, "Okay, this is how you do a mean of standard deviation. This is what it means." And that's kinda the interactions I've been having with [my LA-STEM student]. [LAFACS2]*

> *Often what I will do is, we will reach some point in the experiment, we'll see something, and I'll say, "Okay, let's go discuss this." And we get away from the experimental set up, we all sit down in my office and we start to discuss, "Where are we now? What's good? What's bad? What should we do? What are the problems?" and try to form a consensus, then based on that, then we proceed. [LAFACS15]*

> *I work with the students at more of their level. I'll talk about what's going on here and I'll see glassed-over eyes, and, "All right. Step back." And I'll re-explain it, or ask, "What does this mean?" And try to explain pieces. And that's how I run the lab. I ask for independence in that they have to start thinking, they have to use it, but I'll be there to, you can keep coming to me and keep asking me and there is no problem. [LAFACS14]*

Some research advisors (4) working with multiple students or a lab group utilized peer learning, where more experienced, senior student researchers trained and mentored incoming, novice students:

> *Right now in my lab, [Student 1] came first from LA-STEM. After [Student 1] had been in my lab for a year then [Student 2] came. So the first thing I told [Student 2] was, "You work with [Student 1]. Whatever she does. I give you one semester to get familiar with what we do, to get familiar with the lab, with everybody in the lab. Whatever [Student 1] is doing, just watch her, help her, and if you have questions ask her. If she can't answer, go ask my doctoral student. And if all three of you can't answer the question, then come to me." And I feel like it's really important for them to realize research is always teamwork. It's not an individual project. And the bouncing ideas around with people is always helpful. So in that way, student mentors, it's not just for them to mentor the incoming new students, it's for them to realize the teamwork, the collegiality, the research-team concept. [LAFACS1]*

> *Some of the undergrads, like [my student], she's advanced to the point now where she supervises a new undergrad…. I feel she's advanced enough that she can help, and teaching is a very powerful way of learning. And it also gives her a sense of authority and that she's growing up and advancing and that type of thing. [LAFACS6]*

Six research advisors said they met with students weekly and another three mentioned that they held group meetings on a weekly basis so that members could check in with one

another and report progress, and also to make sure that everyone was on track and heading in the right direction.

Beyond directing and overseeing students' research, four advisors discussed helping their students put together a poster for an end-of-summer undergraduate research symposium and three reported spending time to develop students' professional writing skills, critiquing, editing and working with the student through multiple drafts (two for student project proposals and one for a final project report being sent to funders).

## F. Faculty research advisors views on students' gains from research experience

We asked faculty research advisors to comment on what they saw their LA-STEM students gain from research experience. Their responses, however, were directed at gains to students, generally, rather than at LA-STEM students, specifically. Nonetheless, the gains they mentioned matched the types of benefits identified in recent research and evaluation studies exploring the benefits to students of undergraduate research experiences and we can reasonably expect that LA-STEM students also make these types of gains. Indeed, LA-STEM students whom we interviewed provided much more comment and detail on their gains from research experience compared to the research advisors (see section IX, "Student Outcomes from Research Experiences," above).

As with our analysis of students' assessments of their benefits, we used the gains categories developed in our research to analyze and structure faculty research advisors' observations. While research advisors' addressed the range of benefits, the number of comments offered is relatively low (N=153). Because the number of observations is small, it is difficult to draw meaningful conclusions from advisors' observations, other than that they support the view that research experiences contribute to students' personal, intellectual and professional growth.

Research advisors offered nearly equal numbers of comments about student gains across the benefits categories, with one exception (see Table 2). In almost equal measures, advisors described how research experience enhanced students' preparation to undertake graduate-level work (20% of observations), gave them various skills (20%), informed a more realistic understanding of the nature of research work and brought about changes in attitudes and behaviors necessary to research (19%) (the "Becoming a scientist" category), provided various personal/professional gains, such as establishing collegial working relationships with their advisors and with other research group members (17%), and gave students hands-on experience of what it was like to "think and work like a scientist" (15%). However, only 9% of advisors' comments mentioned ways in which research experience served to clarify students' thinking about their career intentions.
In this section of findings, we present faculty research advisors' perceptions of students' gains from research experience based on their own accounts. We provide both the actual *number of advisors* reporting a particular gain, as well as the *number of comments* offered on the topic.

1. Enhanced career preparation

Research advisors discussed various ways in which research experience enhanced students' preparation for graduate school or a future career in science:

- Good preparation for graduate school [8 research advisors; 13 comments]
- Student presented at a UR symposium [4 research advisors; 10 comments]
- Research advisor provides graduate school, career advice; writes letters of recommendation [3 research advisors; 3 comments]
- Student will likely have a publication by the time he or she graduates [2 research advisors; 2 comments]
- Enhances student's résumé; makes student a more competitive candidate [1 research advisor; 2 comments]
- Student attended a professional conference [1 research advisor; 1 comment]

Just over half of the research advisors with whom we spoke (8) mentioned that research experience was good preparation for graduate school. They were agreed that doing research as an undergraduate gave students an idea of what graduate school would be like:

> *There's no question research prepares you for graduate school…. It gives you an idea of what life's gonna be like as a grad student because you know you're working in a lab and you're getting a feel for what it's like. Definitely prepares you for grad school…. [LAFACS11]*

> *The way they work, the way they learn, the skills, it all sets them up to succeed in graduate school. [LAFACS4]*

A few advisors (3) reported that talking to students about graduate school, providing career advice, and writing strong letters of recommendation were benefits of research experience that enhanced students' preparation for graduate school or the workforce. As the second speaker also points out, research experience gave students an advantage when applying to graduate school:

> *I talk to my students about, you know, different aspects between medical school and graduate school and what not…. I give them advice in terms of what they can do to set themselves aside from other people. And I think like the people that are taking this kind of research avenue, I think it's ultimately, I think it's one of the thing that strengthens them, if they've worked in a research. [LAFACS3]*

> *Many grad schools will preferentially admit students that already have research experience…. I think for many students that's a very important point, that they have research experience. And that they can get a good recommendation letter from their advisor. [LAFACS5]*

**Table 2. LA-STEM research advisors' observations on the benefits to students of research experience.**

| *Category* | *N of Obs.* | *% of Obs.* |
|---|---|---|
| **Enhanced preparation**<br>Good graduate school/job preparation; opportunities for collaboration with faculty, peers, other scientists; résumé enhanced. | 31 | 20% |
| **Gains in skills**<br>Laboratory techniques; time management; working collaboratively; presentation/communication skills; some writing/editing | 30 | 20% |
| **"Becoming a scientist"**<br>Demonstrated gains in behaviors and attitudes necessary to becoming a researcher (student takes "ownership" of project; shows responsibility, intellectual engagement, initiative; creative and independent approach in decision-making; increased patience). Greater understanding of the nature of research work and professional practice. | 29 | 19% |
| **Personal-professional gains**<br>Increased confidence in ability to do research. Establishing collegial, working relationships with research advisors and peers; belonging to a community. | 26 | 17% |
| **"Thinking and working like a scientist"**<br>Understanding science research through hands-on experience and application of learning (gains in critical thinking, problem-solving skills); understanding the nature of scientific knowledge (open-ended, constantly constructed). Increased knowledge and understanding of science and research work (theory, concepts, connections among sciences). Transfer between research and courses; increased relevance of coursework. | 23 | 15% |
| **Career clarification and confirmation**<br>Validation of disciplinary interests and clarification of graduate school intentions (including increased likelihood of going to graduate school); study. Clarifies that a research career is *not* what student wants. Increased interest/enthusiasm for field. | 14 | 9% |
| **TOTAL** | **153** | **100%** |

Finally, some of the research advisors said that presenting research at a UR symposium (4) or professional conference (1) enhanced students' preparation, as did being listed as a co-author on a publication (2):

> *The undergrads, if you can somehow manage to kind of get a body of work done that can be published, you really put yourself in a good position for whatever it is you want to do. [LAFACS2]*
>
> *The conference presentation, he did it. He put it together, he wrote it out, he made the poster. He went there and presented, talked to people about it, and people were interested and liked it. So I think that's, you know, very good preparation for grad school, or whatever he may want to do. [LAFACS4]*
>
> *Two of the more successful students in recent times have been medical students—want to go to medical school. [Student 1] is gonna get her name on two papers, and she worked just really very hard and had a close relationship with a lot of people in the lab, and really did a lot of work. So that will help her. That will give her a leg up. [LAFACS8]*

2. Gains in skills

Research advisors reported that students gained various skills from their UR experience:

- Presentation/communication skills [7 research advisors; 10 comments]
- Writing skills [5 research advisors; 8 comments]
- Laboratory skills and use of instrumentation [5 research advisors; 10 comments]
- Time-management skills [2 research advisors; 2 comments]

Almost half of the research advisors (7) said that students' improved their communication skills through presenting and discussing their research:

> *They learn how to communicate the results of the research to somebody, through a presentation, through a poster, or, you know, something like that. And I think they get, learn a lot from that especially. [LAFACS4]*
>
> *I think it's good for general communication skills. They design their poster, with help from the grad students. I usually check over it. And talking about their research to people walking around. They have a judging thing, sometimes give out little prizes, stuff like that. It depends on the exact event. So they're motivated to learn their stuff, not look like an idiot. Most of 'em really do a good job on it. [LAFACS6]*
>
> *We did have an external review of this project where we needed to make posters and give a PowerPoint presentation…. So [my students] made the posters and they stood next to the posters and people came around and asked questions. And [one of the students] is a very personable individual, and she was the one who*

*was explaining her poster, not the graduate student. (LAUGHS) And she was doing a damn good job of explaining it! [LAFACS15]*

Five advisors mentioned that they had seen improvement in students' writing skills:

*She had to write a real report. It was serious. It went to the funding agency. And I kept making her go back for more revisions so she got a feel for what it's like to write a thesis in some ways, though not quite as demanding…. There was about five months that she was working on the final report, which she had to write. The source of funding was specifically for undergraduates and it had to be their report. So she really worked on it, and when it was done, it was a good report and I think she learned a lot about how to write. [LAFACS10]*

*They give me a first draft first and I work with them on that. I try to teach them some technical writing but I don't want to say— especially as I only have another year until I'm up for tenure—that I can afford to endlessly prolong that process. But I actually had a student who basically wrote a paper and she's an undergrad, and she was in a summer program here. At the end, after several drafts, I said, "You already have all the skills that are necessary for somebody who has a PhD." It was satisfying to see how her writing had improved and really how she had progressed, overall. [LAFACS5]*

Five advisors also commented that students learned laboratory techniques and how to operate instrumentation during their research experiences:

*They learn all the various technical things, be it synthesis or instrumentation or various techniques that they gain, that they generally would not gain in a standard undergrad lab. [LAFACS6]*

*He learned lots of techniques. He did basic tissue cultures, cell culture techniques, which are important. He learned how to do isolation of DNA and RNA and Western-blotting. Lots of techniques. [LAFACS12]*

The last skill gain that research advisors mentioned as a benefit of research experience was that students learned better how to manage their time:

*I think they also learn time management. Because this, for them, is an added activity. And so they have to learn how to manage their time. They can go to a party, go drinking, but then they also have to go to classes and study and they have to come to work. (LAUGHS) [LAFACS1]*

3. Becoming a scientist

In this benefits category research advisors described types of student gains viewed as requisite to working in the profession. In advisors' views, students developed a clear understanding of the nature of research work—that it is slow, often tedious and fraught

with setbacks. A number of advisors described how research helped students gain a better understanding of how scientists practice their profession and noted changes in students' behaviors and attitudes, such as taking an active role in proposing next steps, approaching problems creatively, and demonstrating patience and perseverance when confronting difficulties inherent to research work. These gains show ways in which research experiences socialize students to the profession of science research and students' growth as young scientists.

Advisors described gains in "becoming a scientist" in the following ways:

- Gains in understanding the nature of research; what real research is like: it is slow, tedious, frustrating, and full of setbacks [7 research advisors; 15 comments]
- *Demonstrated gains* in behaving like a scientist: taking "ownership" of the project; commitment to and intellectual engagement with the project; becomes an active learner, a creative problem-solver; increased willingness and ability to work independently [5 research advisors; 6 comments]
- What being a scientist is really like; how scientists practice their profession—collaborative work, professional behavior, grant writing to fund research, practice of peer review, [4 research advisors; 5 comments]
- *Demonstrated gains* in understanding the process of research; increased patience, perseverance, tolerance of setbacks and failure; research work requires these temperamental attributes [3 research advisors; 3 comments]

About half of the research advisors (7) said that students gain a more realistic view of the nature of research work—that research is fraught with setbacks, that repeating procedures is par for the course, and that it can be slow, tedious and frustrating. Three advisors noted that they had seen students show tolerance, patience and perseverance in confronting difficulties encountered in their work:

> *I had one student work in my lab for two years. Right now he's in the master's program at the University of Florida at Gainsville. Through his involvement in research, he gradually realized research is not a smooth sail. You get into unknown territory and you tread water. Sometimes, you have a hypothesis. You test your hypothesis. Sometimes the result is positive. Sometimes your result is negative. Sometimes your hypothesis is entirely wrong! I keep telling them, "This is why we do research! Because we don't really know this. If we know this, then we don't have to do experiments anymore!" So they start gaining an appreciation of the complexity of the research…. But, you know, gradually, they start appreciating that process. They start enjoying that process. At first, they're a little frustrated. It's not like you read this book, you get an A tomorrow (LAUGHS). So things are not that straight-forward anymore. [LAFACS1]*
>
> *You have these kids, they're excited. They want to do stuff. But remember, they don't have a lot of the courses and therefore they have, you know, some limits. So we have to try to figure out their limits before we actually start them in the wrong direction. So [my student], he started in a good, very good direction. He did a*

*lot of work, a lot of development. He got to a point where he started doing research. I mean, just basically repeating a lot of experiments with different kinds of set-ups. And it got to a point where he was doing that, but there were also small details that were, "This one doesn't work. The equipment breaks down all the time." You know, "The pipes burst!" or, you know, melt or something, whatever. And I knew that he had this problem…. It didn't work the way he expected. So he went back and changed the design. He did another whole set of experiments. It didn't work. He went back again, changed the design, tried again…. He kept at it. We're on the right track now. [LAFACS4]*

*INTERVIEWER: Are there specific gains that you see students making from undergraduate research?*

*RESEARCH ADVISOR: It's just really learning what research is. I don't think they have any idea of what research is when they first come in. You can talk about it, but until you're in the lab doing it yourself and having those reactions that don't work, or don't work as well as they should—and once again, we usually protect the undergrads by giving them projects that are more likely to work—but even though it's basically almost a cookbook reaction, it's things they've never done. They're not gonna do as well the first time they go through it. These aren't like freshman chem labs. It's quite the challenge for an undergrad to do it. So they don't get the kind of yield, or they run into problems, and they have to do it several times before they succeed. And that's actually quite different from an undergrad lab. You don't have time to do it several times. It's designed to work—if you're at all competent—the first time. In my group, there's a host of mistakes you can make where it's not gonna work at all and you have to go back and do it again. They know it's gonna work right if they develop the right technique. And it's learning the technique that's actually, for my research group, more the challenge…. So going through that process, I think, they learn that research can be frustrating, that it's not easy and you have to try, try again! Some students can handle that, but some find out they just don't have the patience for it. [LAFACS6]*

*I would guess probably all of them realize that research takes a lot of perseverance or, you know, that research can be tedious. I think there's a spectrum. Students react differently. [LAFACS15]*

One third of the research advisors talked about students' attitudes and behaviors toward their research work, such as taking "ownership" of their project—putting in extra hours and taking the initiative to make sure the work gets done. These changes indicated to advisors the making of a good scientist:

*She takes research seriously. She would come in on the weekends when she had to and that type of thing, work late, you know? If she had to do some stuff she would work late, like 7:30pm or 8:00pm and that's good because you don't always get that. A lot of time you get a lot students who are, "Oh, it's 4:00pm and it's*

*gonna take me two hours. I guess I'll just go home now," versus, "I'll stick around till 6:00pm and do it." [LAFACS2]*

*My lab is really small. We don't have a tech. So every student has to take full responsibility for everything that goes on in that lab. That means maintenance, ordering, cleaning, whatever. I think this is also part of it, where I can clearly distinguish between students who really feel they belong and like to do it and those that wanna feel like guests. The ones that belong, they just without being asked or anything, they will take responsibility. And I think this is an extremely important thing to learn or develop also. Somebody who just takes responsibility and takes the lead. And I can see all these characteristics developing. [LAFACS5]*

*When they take some initiative and they come to you with some other ideas…. If they are working and they're thinking—if they're thinking about their project away from, outside of the lab and they, you know, stumble across or go to the library and look up a paper and bring it to me—then I know, "Oh, my goodness! We have something here!" There's, you know, somebody has clued in. [LAFACS10]*

*I like to see independence. That's actually what I look for…. Can they go in, set it up, and do it? You know, work on their own. Are they willing? If they take that initiative, then that's a student I can carry through, and they can be productive fast. It's one that is willing to go put their hands in, and if they goof, we dump that set of samples, or that supply, you know, it's what I can risk in their hands, and, and we start over. No problem, I'm not upset with them, I don't, you know, that's exactly, that's learning. If they're willing to do that, wow, um, those students I love! [LAFACS14]*

Finally, several advisors (4) noted that students gained a better understanding of what being a scientist is really like and how scientists practice their profession through interacting with role models. Students who attended or presented at conferences saw the broader professional significance of meeting and talking with other scientists:

*They understand that they don't know everything. That there's always more to learn. But the students are working with people that know they have to read papers every day. You know, the grad students, they're gonna read a professional paper instead of the newspaper at breakfast. So the undergrads, they come out knowing the ways these people who are top in their field right now, how they learn and keep up. [LAFACS7]*

*Most of my UR students, I take them to some regional, national or international conferences to go present there. A few of them actually write a paper up of the research. If they finish a complete project. Then that'll be their choice…. They get to see how it compares with other people presenting at the conference, if it's a pretty good project. And they get interaction with people. Like, this last summer,*

*they interacted with people from all over the world. You see that what we do in the lab is not an isolated phenomenon. It's part of a greater force. We're all driven to better this world. So I think they learn the appreciation of the research subject, the research field, the discipline, a lot more if they can go participate in those kinds of exchanges. Compared to if they only work in the lab and collect the data and hand me the data. [LAFACS1]*

4. Personal-professional gains

In this set of benefits advisors discussed personal gains that students make in the context of authentic, professional research work, including establishing a collegial relationship with their advisor, graduate students and other research peers, increased confidence in their ability to "do research," becoming more mature and feelings of belonging to a community.

- Collegiality with other students, graduate students within the research group [7 research advisors; 7 comments]
- Increased confidence in their ability to do research [6 research advisors; 6 comments]
- Establishing a collegial relationship with faculty [5 research advisors; 8 comments]
- Gains in maturity, self-discovery [3 research advisors; 3 comments]
- Belonging to a community of learners within their research group [2 research advisors; 2 comments]

About half of the research advisors (7) emphasized the benefits to students of establishing collegial relationships with others in their research group, including graduate students. Research advisors commonly noted that group members drew upon each other as a resource, asking a quick question or for help in figuring something out, and as a sounding board to "bounce ideas off of":

*I really encourage students to discuss things among themselves. The collegiality formed in the lab through the process, it's great. They all get along fine. They help each other. They go out on limbs to help each other. Every single one of them has their own project, but when the other one needs help, they all converge. They all help with each other…. I feel like it's really important for them to realize research requires teamwork, it's not an individual project, and the bouncing around of ideas with people is always helpful. [LAFACS1]*

*Our labs are this open lab format, so there are five independent labs in the same area that's open. So there are undergraduates with other PI's who are close by so they all got to interact over the summer. It really works out well for them, I think. They can go to anyone and ask questions. I mean, they generally ask questions of their peers, you know? That's how they go about it, but that works out fine because then they come back and they have some ideas, which may or may not be reasonable, but that's fine because, you know, they are talking about it. And they're trying not to be so dependent on me (LAUGHS). So you can see the*

> *interest in what they're doing and they get to talk about it with one another, and that's great, that's just fine. [LAFACS12]*

A number or advisors (5) also commented on the benefits to students of working closely with a research mentor—but cautioned that this gain was realized by students with long-term engagement on a research project:

> *In ideal circumstance you develop a fair degree of trust with a student over a number of years. And, and there've been a number, I mean there've been, actually a number of students that I've had really strong bonds with like that and that happens really with the students who are around—who stay, who actually show up and put the work in and put in the time in and then you find yourself here at 7:00pm at night and somebody's unhappy and you ask them why or somebody says I'm really stressed and you start talking about why they're really stressed. [LAFACS8]*

A couple advisors commented that, as a result of long term involvement in research, students had developed a deeper sense of collegiality, one of belonging to a community working in common interest:

> *One of the big advantages is that it brings them together and they have a real sense of community and they sort of invest in each others' success whereas they might not be able to come together as easily otherwise. So I think that sort of group thing is a very powerful, it's what I would call very positive peer influence. A majority of them are doing well in their coursework and they wanna, they tend to help their group-mates and there's a sense of, "I can succeed if I work hard." Whereas if you're sitting alone in a class and having troubles, you can feel like you're alone in the universe. So I think that's really one of the powerful things, getting them involved with some faculty and research. But I think at the early stage, it's the structured activities and keeping them on track with respect to the coursework, and I think the real advantage of research comes later, in the second, and particularly the third year, when they've been in the lab for a while and get to know the other students, know the grads. There's a sense of family there. [LAFACS6]*

Several faculty members (6) noted that students' confidence in their ability to do research increased as a result of their hands-on experiences.

> *What I see really clearly is that their confidence is just increasing incredibly—that success that they see. And I can totally relate to this, because before I became a scientist, I was always in awe of what science is, and I thought, "I'm probably not good enough to ever do it right and well." Then when I actually did it I realized, "I can do it!" It's actually something that is possible to do. And I see this in my students. Sometimes I tell them, especially also my grad students, "You're gonna be one of the smartest people in the world when you get your PhD. In this area, especially in your specific area, you know more than anybody in this world." And this is also something again, I don't make any differences between*

> *undergrads and grads, this is also something that, especially when they get into it, know what they are doing, develop their own ideas, that I really feel their self-esteem and their confidence increases a great deal. Even if they don't want to be scientists, even if they want to be medical doctors, it's the same mechanism. They just feel, "I can do it." [LAFACS5]*
>
> *From the undergraduates that work with me on the research, I guess it makes them more confident in what they can do. [LAFACS9]*

A few advisors (3) also noted that, over time, they had seen students mature and "grow up":

> *I think it's really exciting and, you know, time consuming. But, you know, I think it helps them. It helps them grow and mature. [LAFACS4]*
>
> *One of the students I got was an extremely immature kid—really, extremely immature. Very gifted, very intelligent, loves attention, but he's unbelievably immature. You have to deal with that. And it took about two years, almost two and a half years, and finally, you know, I see a different person. You know, the whole, how he behaves, how he looks, how he dresses, how he speaks and so on. So I think what you need to be aware of, it's almost always two years until we have reached a level of personal integration where their private life, their attitude, and their academic preparation is at the level where they have grown up and we can now start to do real work. [LAFACS13]*

5. "Thinking and working like a scientist": Intellectual Gains

Gains in the "thinking and working like a scientist" category are comprised of research advisors descriptions in students' intellectual growth and practical understanding of how science research is done, including their application of critical thinking and problem-solving skills to research work, as well as deeper conceptual understanding of science and connections among the different disciplines. A couple advisors noted higher-order intellectual gains, such as students' learning how to choose, frame and test a research question, and coming to a more mature understanding of the open-ended nature of science.

- Increased understanding of how research is done; application of learning in practice [5 research advisors; 7 comments]
- Increased understanding of theories and concepts, making connections between sciences, seeing the big picture, making interdisciplinary connections [3 research advisors; 5 comments]
- Increased critical thinking and problem-solving skills, thinking like a scientist [3 research advisors; 4 comments]
- Increased relevancy of coursework and transfer between research and classes [3 research advisors; 3 comments]

- Increased understanding of how to design a research experiment [2 research advisors; 3 comments]
- Increased understanding of how scientific knowledge is built: contributions accumulate over time; understanding the open-endedness of science, nature of scientific 'fact', theory as a model of reality [1 research advisor; 1 comment]

One third of the research advisors with whom we spoke pointed out that the advantage to students of research experience is that it teaches them how research is done. Several of their comments offer observations of other intellectual gains, such as increased knowledge and transfer of knowledge between research and course work, as well as the opportunity to apply critical thinking and problem-solving skills to the actual practice of research:

> *They learn how to do research…. He does learn a lot of things from me and we talk about a lot of stuff, not necessarily related strictly to his project, but you know, some other things that he has learned. We had a discussion related to his project. We started with some of the problems that he had, but we went backward to some of the fundamental stuff that he learned in some of his classes. And he told me, and he goes, "Yeah, I learned that, you know, but I didn't know that's what I would use it for." And especially for engineering students, "How does something that you learned in a math class, or in a calculus class, how does that apply in engineering?" So to make that bridge or transition between, you know, the abstract versus the application. And that's not necessarily something that comes out in classes. But they come into research and they see, they can apply what they have learned and see how it works in practice. [LAFACS5]*

> *They're learning how research is done. It's very good in testing critical thinking and problem-solving skills, and making interdisciplinary connections. Most research is interdisciplinary nowadays—crosses boundaries and involves other areas—so they're learning a lot in new and different areas and learning how to apply it. [LAFACS8]*

> *I believe they have a better depth of knowledge specific to their area. [LAFACS7]*

> *You know, we would get them to start putting their data together relatively early and have them keep telling us what they thought about it. Did it mean anything to them? And at first it really didn't. It really didn't at all. But by the time they had to do their poster it did. It was meaningful to them. And they knew what they were saying, what they were talking about. So sort of nice to see. It was good growth over a short period of time in the summer. [LAFACS12]*

A couple of advisors said that students struggled with the complexity of choosing a research question and designing an experiment, but that this type of higher-order intellectual gain was not expected of undergraduate students. Only one advisor commented on students' gaining a more mature understanding of the open-ended nature of scientific knowledge and how it builds over time.

6. Clarification and confirmation of career path intentions

Research advisors offered the fewest observations (14 comments) concerning ways in which research experience helps students to clarify their career intentions. The majority of advisors' comments described how research experiences provided students a first-hand opportunity of what research is like and to assess the fit between their interests and temperament and the realities of day-to-day work. Students, advisors observed, discovered whether or not "research is for me." A few advisors said that research had increased students' interest in and enthusiasm for science.

- UR provided a concrete understanding of interests and fit within their field; clarified that student does or does *not* like research [6 research advisors; 7 comments]
- Hands-on research strengthened interest in and increased probability of going to graduate school; clarified and confirmed their prior interests; [3 research advisors; 5 comments]
- UR increased enthusiasm for student's field [2 research advisors; 2 comments]

Half of advisors' comments related experiences with students in which some had discovered a love for research and others who had discovered "research is *not* for me":

> *I've seen it go both ways. I've seen students get turned off research when things didn't go well. Not all have the same ability. [LAFACS6]*

> *Most of the student's I've had in the lab, undergrads and grad students, just everybody finds, the vast majority are becoming really interested in research…. There's one or two that, you know, "No, I don't want to do this for a living." [LAFACS14]*

Advisors appreciated that research experience gave students the chance to figure out whether going to graduate school would be an appropriate choice and the right next-step:

> *Some of them figure out if they want to go into research. Or the type, you know, more science-oriented research, or more engineering-oriented research. Or if they want to do graduate school research at all. They say, "Well this is a lot of fun, but I'm not up to this." So they figure out early in the process if they don't want to do research, then they don't go to graduate school. Maybe they find that they are best suited to their personality is just go into the work force…. It seems that this helps them make better career choices, I guess, from my perspective. [LAFACS4]*

> *I think research helps in the long term because you're less likely, in my opinion, if you go to grad school and you've done undergraduate research ,you're less likely to be dissatisfied with the graduate school experience. I don't think everyone's gonna love graduate school and I don't think it's for everyone. So I think if you get a small taste of research as an undergrad and you like it, you're more likely to*

> *enjoy grad school. What we don't want is, I don't' want to have somebody come in as a grad student, I take a year, year and half to train them and then they come to you one day and say, "I don't like grad school. I wish I hadn't come here." And then they leave. So I think it helps to do undergraduate research in giving you a good idea whether you'll enjoy grad school. [LAFACS11]*

> *People react differently. Some people can take an enormous amount of data, work on it, you know, enormously tedious. And they end up saying, "Well this is really interesting because I did something that nobody else ever did before, and I have some understanding that no one else did." But other people can go through that and say, "What a pain in the neck!" (LAUGHS) You know, "I'll do it because I'm here, but that, that's not the way I want to spend the rest of my life." And that's okay if that's a knowledgeable decision. I don't have any problem with it. [LAFACS15]*

Three advisors said they had seen students learn that they liked research work and that research experience had strengthened their intention to go to graduate school:

> *So she learned a lot from that and really enjoyed the summer…. She learned all sorts of new stuff this summer. So I see that as her confidence. And she's pretty much committed to going to grad school. She was sorta sure when she joined the program. She's one of these, she was probably gonna go to grad school anyway, but this has really cemented it for her. [LAFACS6]*

Two said that they had seen students become more interested in and enthusiastic about science and research:

> *I don't really know what happened to them, but they were both very, they showed a lot of excitement about the science they were working on and in the research they were doing. [LAFACS5]*

In sum, just over one-third to about half of the research advisors with whom we spoke mentioned gains that form a set of prime benefits from research experience (N=48, about one-third of all gains observations):

- Good preparation for graduate school [8 research advisors]
- Gains in understanding the nature of research; what real research is like: it is slow, tedious, frustrating, and full of setbacks [7 research advisors}
- Presentation/communication skills [7 research advisors]
- Collegiality with other students, graduate students within the research group [7 research advisors]
- Provided a concrete understanding of interests and fit within their field; clarified that student does or does *not* like research [6 research advisors]
- Increased confidence in their ability to do research [6 research advisors]

Thus research advisors most commonly described ways in which research experience prepared students for graduate school and taught them the nature of research work—that research work is slow and often frustrating and that setbacks are par for the course. Nearly half commented on the benefits to students of improved communication skills (including presentation and writing skills), establishing collegial relationships with group members, increased confidence to do research, and the opportunity to assess whether or not they like and are suited to a career in science research.

Over two-thirds of advisors' observations across the range of benefits (N=105) were offered by one-third, or fewer, of the advisors with whom we spoke, showing that advisors are aware of a wide variety of benefits are generated by research experiences:

- Writing skills [5 research advisors]
- Laboratory skills and use of instrumentation [5 research advisors]
- Establishing a collegial relationship with faculty [5 research advisors]
- Increased understanding of how research is done; application of learning in practice [5 research advisors]
- *Demonstrated gains* in behaving like a scientist: "ownership" of project; commitment to and intellectual engagement with the project; becomes an active learner, a creative problem-solver; increased willingness and ability to work independently [5 research advisors]
- Student presented at a UR symposium [4 research advisors]
- What being a scientist is really like; how scientists practice their profession - collaborative work, professional behavior, grant writing to fund research, practice of peer review [4 research advisors]
- Research advisor provides graduate school, career advice; writes letters of recommendation [3 research advisors]
- Increased understanding of theories and concepts, making connections between sciences, seeing the big picture, making interdisciplinary connections [3 research advisors]
- Hands-on research strengthened interest in and increased probability of going to graduate school; clarified and confirmed their prior interests; [3 research advisors]
- Increased critical thinking and problem-solving skills, thinking like a scientist [3 research advisors]
- *Demonstrated gains* in understanding the process of research; increased patience, perseverance, tolerance of setbacks and failure; research work requires these temperamental attributes [3 research advisors]
- Increased relevancy of coursework and transfer between research and classes [3 research advisors]
- Gains in maturity, self-discovery [3 research advisors]
- Increased understanding of how to design a research experiment [2 research advisors]
- Student will likely have a publication by the time he or she graduates [2 research advisors]
- Time-management skills [2 research advisors]

- Belonging to a community of learners within their research group [2 research advisors]
- Increased enthusiasm for student's field [2 research advisors]
- Enhances student's résumé; makes student a more competitive candidate [1 research advisor]
- Student attended a professional conference [1 research advisor]
- Increased understanding of how scientific knowledge is built: contributions accumulate over time; understanding the open-endedness of science, nature of scientific 'fact', theory as a model of reality [1 research advisor]

In summary, research advisors' observations on the benefits to students of research experiences referenced gains they had seen among students they had worked with generally, rather than for specific LA-STEM students. The benefits they described matched those described by students and also identified in recent research and evaluation studies. Overall, research advisors offered nearly equal numbers of comments about student gains across the benefits categories, with one exception. In almost equal measures, advisors described how research experience: enhanced students' preparation to undertake graduate-level work; gave them various skills; informed a more realistic understanding of the nature of research work and brought about changes in attitudes and behaviors necessary to do research; provided various personal/professional gains, such as establishing collegial working relationships with their advisors and with other research group members; and gave students hands-on experience of what it was like to "think and work like a scientist." Only a few advisors commented on ways in which research experience served to clarify students' thinking about their career intentions. Due to the low number of observations, it is difficult to draw meaningful conclusions from advisors' comments, other than that they support the view that students gains a broad range of benefits contributing to their personal, intellectual and professional growth.

## G. Reports of poor research experiences with students

Advisors recalled more and less successful experiences of directing students in research. A majority of advisors (11) mentioned problematic research experiences working with students who lacked interest in and motivation to do research. Two-thirds of advisors also reported instances where students were underprepared to take on the science of the research and advisors struggled to re-structure projects to better fit students' knowledge and skill levels. Two advisors noted times when they ran into problems with the way graduate students had directed students. One advisor reported directing a student in a research project outside his area of expertise as problematic. One other advisor reported a poor research experience not related to problems with students—a summer plagued by technical difficulties.

- Students who lack interest in research/are not motivated to do research are a pain to work with [11 advisors; 16 comments]
- Other problems with student attitudes: students don't think critically, 'A' students as poor researchers, research to build résumé [10 advisors; 20 comments]

- Issues of students being underprepared for research work/scaffolding the project to student's level [10 advisors; 20 comments]
- Problems with graduate students direction of student researchers [2 advisors; 5 comments]
- Problems with directing research project outside own area of research [1 advisor; 3 comments]
- Problems of technical difficulties cause serious setbacks in the research [1 advisor; 2 comments]

Advisors agreed that working with students who lacked interest in and motivation to do research detracted from the experience.

> *I've had some students in the past who I think were just going through the motions. They probably got minimal benefit from the program. [LAFACS15]*

> *My expectation is that, at the end of the day, they've at least been worth my effort and time. And initially I put in a fair bit of effort… And when I feel like they're wasting my time, I deal with them. Like my one, one student was just a pain. I should've got ridden of him because it wasn't worth the aggravation. I was really blunt. I just said, "Look. You come in here. You look disinterested. You're wasting my time." He just didn't ever seem to do anything. He had no interest whatsoever. [LAFACS2]*

> *Either a student really wants to do it or I don't think it's going to work. [LAFACS6]*

Advisors accounts of poor experiences included instances of working with students who refused to or were reluctant to think and work independently. These students required more of their time and energy and made directing students in research problematic:

> *They are used to being told what to do exactly. They are spoon-fed all the time. In high school they never worked. And now they are being spoon-fed as an undergraduate. And if you don't tell them exactly what to do, they will just sit there! You have to push them. Pull them. Lead them constantly. It's so tiring. [LAFACS9]*

These accounts typically included instances of working with 'A' students who, it turned out, lacked critical thinking skills and the willingness to take initiative. Working with these students also contributed to less-than satisfying experiences of directing students in research:

> *It isn't always that top 3% that are the best students. Sometimes they're the worst students to have in fact, because they have either a sense of entitlement, which is completely impossible to work with and I'd just as soon throw all of them out (LAUGHS), or they have, everything has come to them so easily that they don't*

> *know how to work. It's not that they aren't willing, but they have no clue how to sit down and think things through. [LAFACS10]*

In addition to lack of motivation and interest, a number of advisors mentioned other attitudes that made directing students in research less than satisfying, for instance, students who pursued research in order to list it on his or her résumé:

> *It was almost perfunctory the way she approached the research and she was waiting for me to tell her the next step and I think it was because she felt compelled, she wanted it on her résumé. That's the way it was. And so she didn't get much out of it. [LAFACS3]*

Other descriptions of problematic student research experiences mentioned difficulties with students' preparedness to take on the research work:

> *The student I had, he's really good at some things, and he actually is outstanding in some things. But there were some other things, you know, he just, I guess he just doesn't know it. And since he did so well on some of the things, I was sort of expecting he'd, you know, do very well on all the other things. [LAFACS4]*

> *If the kids don't know math, there's very little they can do. They cannot even talk to us sometimes. It's like they're illiterate. The research doesn't involve laboratories, and in that case, finding a significant activity for the mentee to do is hard. [LAFACS9]*

A few advisors discussed other problems related to directing students in research work: instances in which graduate students failed to oversee students' work appropriately; directing a student research project outside of one's area of research, and one account of technical difficulties that caused serious setbacks in the research (and, in this case, notably unrelated to problems with students).

In sum, a majority of advisors recalled times when directing students in research work was problematic. Most commonly, research advisors reported that working with students who lacked interest in and motivation to do research were "no fun to work with." A majority of advisors also reported instances where students were underprepared to take on the science of the research and advisors struggled to re-structure projects. A few advisors raised other issues, such as problems with graduate students directing student researchers and overseeing a project outside of one's research area.

## H. Advisors' views on the benefits and costs of directing students in research

We asked research advisors their views about the benefits and costs of directing students in research. Table 3 provides an overview of their observations on these topics. In discussing the benefits of directing students in research, a majority of advisors focused their comments on the ways in which students' work pushed their research forward and

thus contributed to their professional scholarship and career advancement. A majority also mentioned intrinsic gains—benefits derived from working with students that they personally valued. When talking about the costs of directing students in research, a majority of advisors, and almost all of their comments, described the increased time and effort it required of them. For many, the cost of time placed greater strains on already oversubscribed schedules and professional commitments. In this section of the report we illustrate the benefits and costs of directing undergraduate research based on advisors' own accounts. We begin with advisors' views on the benefits of directing students in research.

1. The benefits of directing students in research

    a. *Student contributions to advisor's professional scholarship and career advancement*

A majority of advisors (12) agreed that student researchers' contributed to their professional scholarship and career advancement. Two-thirds of their benefits' observations described how capable student researchers helped to push their research forward, which, in turn, increased the likelihood of future publications, grants, and tenure and promotion in their department. The following quotations are representative:

> *What I get out of it is I get work done. So for me to get tenure I need to have a certain amount of publications and a certain amount of research grants and that kind of stuff and an undergrad can help me with that. I mean, they can help me get publications. They can help me to get preliminary data to apply for funding.*

> *Certainly, the good students, you do get data that can be used for publications. The reality is it's you do it more for the fact that it advances your research program.... You get publications out of it (LAUGHS). Ultimately, everything comes down to publications and grants, which go kind of hand-in-hand. [LAFACS2]*

> *This one student who has been in my lab continuously for the second year, I really would say, yes, she is doing very well and she will actually contribute, at the end, to the progress of my research…. She's gonna graduate next year. I think by that time she probably will have a small publication so…of course, it will help my tenure, also. [LAFACS5]*

Some (6 advisors) cited as a benefit student research help that came with a paid stipend. After all, who could say no to "free help"? This was especially important to new and junior faculty members:

> *I got a good student. I don't have to pay any money. How can I complain? [LAFACS2]*

**Table 3. Advisors' observations on the benefits and costs of directing students in research.**

| *Type of observation* | *# of Obs.* |
|---|---|
| **Benefits** | |
| Student contributions to advisor's professional scholarship and career advancement | 41 |
| Capable student help pushes advisors' research forward and leads to publications/tenure; funded help is always good; student awards a good thing for advisor's portfolio; junior faculty member expects to publish co-authored article with student in future: hopes it will help tenure review; student research participation helps secure funding; students provide fresh points of view, new ideas; working professionally, collegially as scientists, has the benefit of bringing together different perspectives and ideas | |
| Intrinsic gains to advisor from directing students in research | 23 |
| Reward of students' growth is what motivates advisor (despite the time and effort required): working with students is fun, interesting; longer-term relations with former research students; directing research is intensive and leads to bonds with students; advisor gives life, personal advice; does not view participation as helping own research: directing students in research is seen as more of a personal contribution | |
| *Subtotal* | *64* |
| **Costs** | |
| Issues of time | 27 |
| Could get own research done faster without students; undergraduates slow down graduate students too; mentoring is very time-consuming, a large personal commitment; getting started is time consuming; new faculty starting-up research program and research with students: "a lot of work"; Because advisor is not an expert in student's choice of project, he or she had to put in extra effort/time to learn more about it; trade-off: time doing UR vs. time writing grants, attending to other professional commitments; it is difficult to balance a personal and a professional life when directing UR | |
| Other issues | 4 |
| Advisor devotes monetary resources to students | |
| *Subtotal* | *31* |
| **TOTAL** | **95** |

> *A student knocks on my door and says they want to do research, and I say, "I don't have money for you," and they say they bring money with them. At the end, I don't really care why they want to do research. I am starting, I need the help, I don't have the money, and here they are offering! [LFACS5]*

Beyond building a portfolio of grants and publications, a few advisors (3) also recognized that student awards or honors theses and co-authored publications generated through undergraduate research activities counted favorably, though not formally, in tenure and promotion decisions. Two advisors also cited their ability to secure further funding from the National Science Foundation based on grants requiring student researchers (in one case, specifically with students from underrepresented groups) and evidence of broader impacts (including students' professional development, such as earning an award, giving a presentation, or co-authoring an article).

Half of advisors said that working collegially and collaboratively with students on research strengthened their professional scholarship. Advisors recounted how they had benefited from students' "crazy ideas," fresh perspectives, and being challenged by "questions from out of left field."

> *I always look for different points of view. And maybe I'm used to looking at something just one direction, and I'm making the same mistake all the time because I don't realize there's another direction that I can look. So I always ask a student to just let me know when you think that it could be done any other way. Better way. That is something that I try to encourage. [LAFACS3]*

> *They keep me excited about the research that I do. Especially that they usually come up with some of the craziest ideas that we can ever think of, and, you know, some of them are actually pretty good, and they help me set up future research projects. So from that perspective, I think it's really good for me, because they do have, and this, especially this one, he came up with a list of, you know, six great ideas that everybody is trying out…. They do come up with … you know, they keep me young, I guess. [LAFACS4]*

> *I have seen breakthroughs, in projects, because in attempting to explain things to the undergraduate students, as a group or as individuals, all of a sudden the researcher will think of something, or they will see it from a different viewpoint, and they'll find a way to go to the next level. [LAFACS7]*

> *They keep you on your toes, because you have to be, whenever, you know, they ask a question from the far left field, and you're like, "Uhhhhh, I have to think about that." So they, so they do… I did learn a lot. I think it benefits me both, you know, personally and professionally. [LAFACS12]*

A couple of advisors valued the opportunity to work professionally as colleagues and described how the process of working collaboratively with students created better thinking and better science:

> *It's a group of people that works together. And that actually is important. We can discuss things in a group in a knowledgeable way. We all work in the same area at least and can really see what the other person is doing because we have an understanding of our own work. The students—it's really good if there is a critical mass, which is like 3, 4 people—they can discuss the research that we are doing together. I think that's another big benefit, that it's actually a group, a collaboration. If I was there all by myself, it would probably be much, much less fruitful in that regard. You are more creative within a group. 'Cause especially the questions asked by undergrads who are interested, but that don't know that much yet, are often the really interesting ones, because they really get to the bottom of things, if there's a flaw in something. [LAFACS5]*

*b. Intrinsic gains to the advisor from directing students in research*

In addition to descriptions of ways in which advisors' professional scholarship and career advancement benefited from students' help, advisors also talked about intrinsic gains from directing research. One-third of advisors' comments about the benefits of directing students in research related personal gains, such as enjoying interacting with students. A majority (12) said that while directing students in research was time consuming, it was worth the effort:

> *They are a lot of fun to be around. [LAFACS12]*

> *One reason I wanted to do this job is because I enjoy interacting with people and interacting with undergraduates. So, I mean, I like teaching and I think that there's some personal satisfaction for me to just have the interactions with the undergrads and I enjoy that personally. So that's one thing I'd get out of it. [LAFACS11]*

> *I like to see students learn. I like to help. If there is an ounce of curiosity, I would like to nurture it and make sure it flourishes, to maximize their opportunity, their capacity to learn, to help them grow. So in that capacity, well, yeah, it is time-consuming, but you get your satisfaction from watching a student grow. [LAFACS1]*

A couple advisors saw directing students in research as more of a personal contribution:

> *I don't view it as directly helping my research. Rather I view it as me helping research in a broader sense of the word. So I don't think they've helped my research a lot, although I think it's been really good…. I don't think it's directly helped my career very much, but I do it anyway, 'cause I do lots of things that don't directly help my career. I do it because I think it's important. [LAFACS6]*

A couple advisors described the personal satisfaction they gained from contributing to the development of the next generation of scientists:

> *I regard myself, as a faculty member, not only as somebody who was hired to bring in research funding and related activity, but also as a professor in the traditional sense, that my role is also to mentor young people and to provide a good supply, future supply, of bright minds. So, I think this time is invested into the future…. That's what I gain out of it. [LAFACS3]*

One advisor mentioned the benefit of establishing long-term friendships with former research students:

> *I think that eventually you build up a personal relationship with students in terms of…of there've been many students, who, you know, we had long mentoring discussions…. We had some really deep discussions. I mean, sometimes the bond can be really deep where you, you really find yourself giving sort of lifetime advice that goes beyond, like, "What career should I be?" you know? ….In the ideal circumstance, you develop a fair degree of trust with a student over a number of years. [LAFACS8]*

We now discuss advisors' observations on the costs of directing students in research.

2. The costs of directing students in research

   *a. Issues of time*

A majority of research advisors (11) said that directing students in research required a good deal of their time and attention. Nearly half (7) said that they could get their research done faster *without* students' help. A few (3) advisors commented that it not only slowed them down, it slowed down their graduate students' progress too:

> *If you've got a freshman then you have to find papers that a freshman can understand or maybe you have to provide little mini-lessons once a week that brings them up to the speed for the project…. And that's the big thing, you have to spend a lot of time with them. [LAFACS7]*

> *It slows down the research, that's the cost. It does. I mean, it would be much easier over a summer for me to work in the lab, you know, just with another research associate, to work in the lab and collaborate with other PI's and just turn out the work. You know...so it [working with students] slows the work down. In reality, it does. [LAFACS12]*

> *I could save time and money if I just did it myself. [LAFACS5]*

> *INTERVIEWER: What does it take to be a good research mentor to undergraduates?*

> *ADVISOR: Time would be the biggest thing, and it's probably the thing we have the least of because, just like at the undergraduate level, the university is*

> *achievement oriented…. The amount of time it takes, that's the biggest. Because they have so little knowledge of everything and they're less sure of themselves and so they're not, you know, it's a little bit harder. [LAFACS10]*
>
> *It can suck up too much of your time and the grads' time, 'cause it does slow down the grads. And it can really have a negative impact on your research in that sense, even though it's good in a broader sense. [LAFACS6]*

Four advisors noted that directing students in research was an investment of time that may or may not pay off: some students required more help than others; some stuck with the research, and others left the lab before the advisor received any benefit:

> *It becomes a very large time commitment when things don't go well. When things go well, you know, I'm fine with it because they do their work, I don't have to spend the time with them. If they don't do their work or something goes wrong and they don't know it's gone wrong, or I can't find the answer and I have to help them, then it becomes a large time commitment. [LAFACS4]*
>
> *One word of advice for those who start to do anything like this is the time commitment. A great deal of time investment, especially initially. A tremendous amount of time that you have to teach somebody one-on-one without knowing whether or not this will be fruitful. It's a shot in the dark. It's a tremendous amount of work, and then you hope for the best…. [LAFACS3]*

In addition to comments about the time-intensive nature of working with students, advisors offered a handful of comments related to other issues of time and directing students in research: new faculty found starting-up research programs and working with research students "a lot of work" (3 advisors); time became a trade-off between working with students and writing grants or attending to other professional commitments (2 advisors); one reported having to put in extra time and effort to learn about the science of the student's project because it was in an area unrelated to his own research work; one also said that it could be challenging to balance one's personal and professional lives when working with students on research.

*b. Other issues*

Finally, advisors mentioned money-related issues as costs of directing students in research. A couple advisors said that they had had to spend their own resources to cover student research-related costs:

> *It's a little harder to get a decently funded project for them. I mean they do a very nice job with their little undergraduate research program [not the LA-STEM program] but it pays less than $3000 and it only pays a student's stipend. It doesn't really pay for if you wanted to do a project, like, even on Fault's River, which is about 45 minutes from here, you're still going to need to rent a university vehicle and pay gas and they don't pay for those kinds of expenses. So that's the,*

> *you know, having a pot of money that you could apply to for that would be nice. [LAFACS10]*

Two advisors noted the extra expenses associated with working with students who had "bad lab hands" and broke (sometimes expensive) laboratory equipment which, then, had to be replaced:

> *The amount of money I spend is in direct relationship to how good they [the students] are. And for the students that were not so good…a few hundred dollars here, a few hundred dollars there…. It adds up. [LAFACS2]*

In sum, in describing the benefits of directing students in research a majority of advisors said that they benefited from students' help and that students' work contributed positively to their professional scholarship and career advancement. In addition, a majority of advisors reported intrinsic gains from directing students in research: students were fun to interact with, and despite the time and effort it required, seeing students grow as researchers and as young adults was described as very rewarding; a couple of advisors gained satisfaction in the knowledge that they were helping to "bring up" the next generation of scientists. One commented on long-term friendships he had enjoyed with former research students.

Overall, a majority of research advisors, and their comments, described the costs of directing students in research in terms of the time and effort it required: student research is time-intensive. Getting students set up, giving them information, directing them, answering their questions—namely, educating students—requires a large time commitment. Almost all advisors agreed that working with students slowed them down, and several felt they could get their work done faster *without* students' help. The time spent setting up the research and training the students might not pay off. Directing students in research required advisors' extra time and effort and added to the pressures of balancing other professional commitments, such as writing up research results for publication or putting together grant proposals to secure further research funding. One advisor acknowledged that directing students in research also made it difficult to balance his personal with his professional life. For a few advisors, covering expenses associated with the students' research was a real cost of directing students in research.

## XI. The Faculty Rewards System

In talking with advisors about the benefits and costs of directing students in research work, we asked whether the department or institution rewarded them in any way for this out-of-classroom work with students. All advisors reported that there was no formal reward for working with students on research:

Exchange 1:

> *INTERVIEWER: Are you rewarded in any way by your department or the institution for working with undergraduates?*

*ADVISOR: Oh, goodness no. I don't. I, we barely get an "Attaboy!" (LAUGHS)*

Exchange 2:

*INTERVIEWER: Do you feel that your work with students in research has been rewarded by the department and by the center?*

*ADVISOR: No. But that's ok (LAUGHS). The other rewards are worth it. [LAFACS7]*

Exchange 3:

*ADVISOR: It doesn't advance my career at all. It simply, I do it because I like to do it. I think it's necessary to do it. It doesn't contribute to anything, it's not appreciated.*

*INTERVIEWER: Yes. So what are the benefits to you of working with undergraduates?*

*ADVISOR: Satisfaction of having a kid that is bright, that he continues and goes to grad school. [LAFAC9]*

Six advisors said that while working with students on research was not rewarded, neither was it required by departments and institutions. Faculty members were free to do as they pleased:

*You don't do it, nobody really minds. You don't do it, you don't get punished. You do it, you don't get encouraged. You don't get awarded. Right? I'm doing it just because I like it, just because I think it's the right thing to do. It's not because there are consequences if I don't do it. Like I said, I'm the only one in my department doing the LA-STEM program. I think, by and large, there are probably just a few people in our department who actually get undergrads involved in research. I get undergrads, not only the LA-STEM students, I get others involved in research too. [LAFACS1]*

However, one of the research centers had recently instituted a policy that required its researchers to work with students.

In discussing the faculty rewards system, nearly two-thirds of advisors (9) emphasized the competitive, "publish-or-perish" imperative that drove research and tenure at a large research university like Louisiana State University (LSU):

*INTERVIEWER: Is your work with undergraduate students, is it rewarded in the department or the institutional structure?*

*ADVISOR: Not- I don't know that it's, I don't know that it's valued really deeply. I mean, tenure and promotion decisions clearly count, well- tenure and promotion decisions per se depend on grants and papers and, in a fairly quantitative way. … It's always something that's mentioned by the person who presents their tenure case to the senior faculty, but it's also really clear that if you don't have, you know, five papers and a grant or something like that, you don't have a whole lot of chance to make it. [LAFACS8]*

*The working conditions for faculty members have been deteriorating. And you have, you know, assistant professors coming in under tremendous pressure, little support, you know, maybe they get the start up money, but then it's "Do your own thing." And under tremendous emotional stress, they are squeezed for time. They are given tasks that you cannot reasonably achieve today, you know, kind of bringing in a major national grant, at a time when the success rate is between 10% and 15%. I mean it's insane. In our department, very few assistant professors get tenure on a regular fashion. They usually don't make it the first time. Sometimes they make it the second time. Sometimes they even can't make it because the requirements have become so unrealistic. And so you have these people who are totally under stress. If they are mid-level they are under stress because they have to make full-professor…. So everybody is under stress, everybody is overworked…. Today as a faculty member, whatever you do it is always, "Yes, but..." So if you are a good teacher, "Yes, but how many publications do you have?" Then you say, "I have so many publications." "Yes, but how many grants did you get?" "Well I got a grant." "Yes, but it is not the big one." So whatever you do it is this, "Yes, but..." It is always this, "Yes, but..." People work, try and do the things, it's never enough. [LAFACS13]*

*ADVISOR: The only thing they care about is research productivity. So if you want to make sure people notice you, you have to publish. And now I understand why my supervisors used to bug me. I have a good publication record, but he's still bugging me about a couple articles and I know that they have to get done. Just time, right? You have to kind of make it part of your schedule. And then the undergrads, the same thing, you know, if you can somehow manage to kind of get a body of work done that can be published, you really put yourself in a good position for whatever it is you want to do.*

*INTERVIEWER: Is working with undergraduates rewarded in your department in any way? Any kind of formal recognition in the tenure process?*

*ADVISOR: You get publications out of it (LAUGHS). Ultimately everything comes down to publications and grants…. That's the main stressful part…. You deal with it (LAUGHS). [LAFACS2]*

*Faculty are not judged on how much time they spend with students, how well they teach. They're judged by grants and publications in most departments. [LAFACS7]*

New and junior faculty recognized that there was a trade-off between time and productivity in working with students in research. These advisors appreciated the extra help students provided, but the investment of time in students was viewed as risky to achieving tenure. Senior colleagues counseled against working with students until after receiving tenure:

> *As an assistant professor, working with students maybe not be the wisest thing to do. Especially for my own experience. I'm going see how this year goes I guess, see how these new students are working. But I'm probably going to limit myself in being a mentor to, you know, one or two students at a time, because I have other things, I mean, I don't have the luxury of trying four years for a project until we get it right. I need results and publications sooner than that. [LAFACS4]*

> *I think it's pretty typical for junior faculty that we all want to make our own experiences and think we know better. So I often got the, "You shouldn't take undergrads." But since I so very much enjoy that, I didn't want to really listen. [LAFACS5]*

As with their observations about the ways in which directing students consumed their time, advisors observations about meeting tenure requirements mentioned stresses of time. Half of advisors referenced difficulties in trying to balance their various professional commitments. Time was a universal pressure for all faculty members:

> *I consistently come home late. Right now, it's busy 'cause if I want to get anything other than teaching done I have to work long hours, because I'm teaching the two courses and modifying the courses a lot but, yeah I spend a lot of time. I, I try to kinda at least give a few hours a day where, you know, before the kids go to bed, even if I'm doing work I can interact with them and spend time. My sons are like on my shoulders or something and doing nasty things to me or that type of thing or, you know, even if I'm on the computer on the coffee table and they're all around me and I just do stuff like, on weekends I kinda spend time. Definitely, everyone says that, "We're all busy." I think that the thing that makes things stressful is funding. It's by far the most important thing to getting tenure. It's actually very stressful. [LAFACS2]*

> *I think it's actually very difficult to be a good mentor because the reality of this job is that I already have three hats. I'm teaching, doing research, and then I have administrative responsibilities both to my lab and to the department. And, so it depends, but sometimes I go quite a while without really talking to the students so much. [LAFACS8]*

> *A lot of the people right now have tasks competing for their time. I work 60 - 80 hours a week, I still can't finish my to-do list. (LAUGHS) I'm still trying to write up an article, two years later. That's not a joke. I had an editor from a publisher call me, "You promised a book two years ago!" I said, "I will start it!" (LAUGHS) [LAFACS1]*

When asked whether directing students in research work was rewarded, several advisors (6) said that it would be nice to receive some acknowledgement for their efforts:

> *INTERVIEWER: Does your department reward you? Is there a specific reward in the department merit structure?*
>
> *ADVISOR: Nope! I wish they did! Would you suggest that to my department chair? (LAUGHS) Hey, if Dr. Warner wanted to call my department chair, that would be great! (LAUGHS) [LAFACS1]*
>
> *INTERVIEWER: Do you receive any type of reward from the merit system for your engagement in research?*
>
> *ADVISOR: Nope, not a bit. It would be good if it did, but it's just not the way it works. It's not the way it works. (LONG PAUSE) Doing research all the time is great, but for me, I really like teaching, so it's just a personal thing. You know, yeah, it would be great for it too, to count for something in my yearly evaluation, but it really doesn't. [LAFACS12]*
>
> *It's upsetting to me that it's really not recognized at all. It should be. [LAFACS9]*

Four advisors said no recognition was necessary for their work directing students in research:

> *INTERVIEWER: Are you formally rewarded for your work with UR, either by the department, in the merit rewards system, or by the university?*
>
> *ADVISOR: No. I've never been. I'm not sure if I should be. It is part of my job. It is part of my due. At least in my philosophy and in my up-bringing. It certainly would be nice, but I don't hold the university to it. It's okay. Well, the only thing is maybe to recognize, "Well, this guy's spending a little bit of his time on that." Maybe. But other than that, I don't think it's-, at least for me, it's not necessary. [LAFACS3]*
>
> *Both UR and teaching, is something where I draw my strength for the rest of it. Because that's something I deeply enjoy. So I do it. And this is basically the balance to the things I don't enjoy too much, which is writing grants…. Dealing with the undergrads, that's where I actually get the necessary reward. I don't really care about other rewards. [LAFACS5]*

One advisor said that directing students in research should not be rewarded. He argued that only those faculty members who are interested in and motivated to direct students in research should do so; recognizing research work in with students in the reward system could end up bringing in faculty members for the wrong reasons:

*INTERVIEWER: Do you think it would be a good idea to institute a formal recognition of work with undergraduates?*

*ADVISOR: Uh, actually probably not. Because people should do it because they want to do it, not because of some benefit. You'd end up with a lot of people playing games, who aren't really interested. [LAFACS15]*

In sum, advisors were clear that they received no departmental or institutional reward for directing students in research work. By advisors' own accounts, directing students was largely seen as directly benefiting their research productivity, which increased the likelihood of publishing results and securing grants, and thereby their tenure and promotion. A majority of advisors emphasized that a strong "publish-or-perish" imperative governed the rewards system at LSU. Half of advisors' mentioned being stressed for time in trying to get everything done, not only on a daily basis, but also in terms of tenure and promotion. A number of advisors (6) said it would be nice to receive some recognition for their work directing students in research, but others (4) said no reward was necessary for their work. One advisor recommended against any formal award saying research with students has to be something the faculty member wants to do and instituting a reward of some kind would change that.

## XII. Formative Feedback

In our interviews we asked students and faculty to offer their advice on how to improve the program. We note that in following up with program staff on issues raised by students, that they were all well aware of students' views and that they were in ongoing conversations among staff, students and program directors. Indeed in the time between of our first and second site visit, a LA-STEM student volunteer council had been assembled to work with program staff to come up with solutions. Students were glad to have a voice in the process and felt program staff were open to their input.

Advice offered by student and faculty interview participants to improve the LA-STEM program includes:

*Formative feedback on the Summer Bridge program:*
We heard from many of the students that we spoke with that diversity activities within the Summer Bridge program felt "forced." They did not want to be "forced" to talk to particular people. They felt that they would have made an effort to get to know the other students given more time and that the emphasis on diversity activities was too heavy-handed and thus became tiresome to students. Most of the students expressed positive views on appreciating diversity, remarking that diversity was not simply an issue of race or ethnicity, but was much broader: appreciating differences in past experiences, interests, and talents were at least equally as important. Many students expressed the belief that they already held a healthy appreciation for diversity and that the over-emphasis on diversity activities was unnecessary. Generally, students voiced a preference for diversity activities to be scaled back.

As mentioned earlier in this report, some of the faculty research presentations given during the Summer Bridge program were "over the heads" of some of the students, particularly those for mathematics and physics, as well as some presented during field trips to local research laboratories. Faculty members and laboratory researchers might review their presentations to LA-STEM students and better "sign post" for students the real-world relevance and applications of their research objectives in order to meet students at a more appropriate knowledge level.

*Formative feedback on program-structured peer mentoring:*
Several experienced peer mentors mentioned that they do not like the current arrangement of the formal peer mentoring sessions. These students feel that the sessions were not as effective as in the past. The auditorium-type setting made it difficult for small groups of students to interact and the space can become noisy, making it hard to hear what another is saying. Also, in an auditorium, they do not have privacy to discuss personal issues with their peer mentors. Students compared the current setting with "how it used to be." Previously, students had the option of meeting outdoors or in other places with their peer mentoring groups. These less formal and optional settings reportedly fostered a stronger sense of community and openness within the group. Students suggested offering alternative settings for peer group sessions, outside of the auditorium/classroom. (For a report of the participant observation conducted on one of these peer mentoring sessions see Appendix C.)

*Formative feedback on required weekly LA-STEM classes:*
While most reported that the weekly classes and peer mentoring sessions were very helpful and contributed to building community among LA-STEM students, of all topics raised, IDPs and weekly classes received the highest number of student comments relating mixed or negative views on the value-added of these LA-STEM program elements. These observations came largely from juniors and seniors who felt that, while the classes were helpful the first (and maybe even the second) year, after that, the courses were simply repetitious, redundant and of little or no benefit. These students often spoke with a sense of frustration: they wanted to comply with program requirements, but they no longer derived any value from the classes and couldn't see the sense in "wasting their time," especially in light of difficult and heavy course loads so common in STEM majors. It was commonly known that some students purposely created scheduling conflicts in order to avoid taking the classes. If there were new course content relevant to them, they acknowledged their resistance would be much less.

*Formative feedback on the faculty-student research matching process:*
Students reported differing levels of faculty awareness of the LA-STEM program within their departments. Some said that faculty members in their department were very aware of LA-STEM while others said that faculty in their department were not familiar with the program at all. Likewise, faculty we spoke with knew little about the program and expressed an interest in knowing more about it.

The process of finding a research position was not smooth for all students. Most students reported that it was not difficult for them to secure an appointment, while a few reported

that it was difficult for them to find a position. Some students reported that faculty members were responsive to their efforts to contact them for a position, while others said that they sent multiple emails that were never returned. Faculty we spoke with said that students had contacted them about working as an undergraduate researcher: none had approached LA-STEM with inquiries about the availability of students to work in their lab. Faculty members, themselves, were uncertain as to how to find and hire a LA-STEM student for their lab. A few students were not appointed a faculty mentor until the end of the first year and this impacted their ability to secure a research position.

In other colleges where UR is active, it is common for departments and programs to compile an online, accessible database containing descriptions of faculty members' research and listing available positions. A similar resource available to LA-STEM students and faculty research mentors would greatly facilitate both advertisement of available UR experiences and placement of interested LA-STEM students.

*Formative feedback on faculty research mentors' needs for program information and professional development:*
Junior faculty members were also uncertain as to how to best mentor a student. They were learning through trial and error. These faculty, in particular, could benefit from a mentoring workshop that would help them to identify effective ways to work with undergraduates and to select research projects that have an appropriate level of complexity and challenge for undergraduates, particularly freshmen and sophomores. Good resources addressing these topics are available from the Council on Undergraduate Research (http://www.cur.org/publications.html). Also "Entering Mentoring: A Seminar to Train a New Generation of Scientists" (2005) by Jo Handelsman and her colleagues is becoming widely used by UR programs offering professional development for faculty research advisors. A one- or two-page handout with tips on mentoring would likely be useful for new faculty research mentors.

Most faculty members were also uncertain about the requirements of working with a LA-STEM student. For instance, one faculty member had a LA-STEM student over the summer but did not know that a poster presentation was a requirement for LA-STEM. Knowing this would have been helpful so that he could have placed the student on an appropriate project from the beginning of her appointment. Providing faculty research mentors with a list of requirements for working with LA-STEM students (e.g., number of hours required per week, providing an authentic research project, producing a poster presentation at the end of the summer, etc.) would be useful.

*Formative feedback on raising the profile of the LA-STEM program on the LSU campus:*
We were provided a list of faculty member who had been identified by program staff as having mentored a LA-STEM student. However, when we contacted faculty by email requesting an interview, a large proportion replied that they had had no association with the program. Given that LA-STEM students are the "best and brightest of LSU," LA-STEM may want to consider a publicity campaign that advertises the distinguished awards and accomplishments of LA-STEM students to raise the profile of the program on campus.

*Formative feedback on growth of the LA-STEM program and the LA-STEM program staff:*
Some students who are now juniors and seniors commented on "how big" the LA-STEM program had become. As members of the first and second LA-STEM cohorts, it seems natural that these students would be surprised at the expansion of the program and contrast it to their own experience of smaller group sizes. Some of these students voiced concern about the viability of maintaining strong community with such a large group. Several students suggested organizing activities that brought all LA-STEM students together at least a couple of times per year.

Related to growth of the LA-STEM program, a number of students observed that the LA-STEM program was short-staffed and suggested more help be hired. They noticed that required paperwork was slower to be processed than in the past, and that staff members were apt to be busy with others and unavailable when needed. One student suggested that it would be really helpful to have a program staff member who could be contacted "after 4pm" for questions and needs that came up outside of OSI's regular office hours. From students' descriptions, program staff clearly served as mentors to students. A few older students mentioned turnover of LA-STEM program staff. Having built supportive relationships with the staff members, it was difficult for these students to have staff members move on. Students voiced the hope that LA-STEM could find managers who were interested in staying in their position in the longer-term.

## XIII. Interviews with Program Staff

As part of this external evaluation we interviewed LA-STEM program staff (7) to gain their views about the program and explore how things were going. In our interviews we asked staff to provide a brief history of the LA-STEM program to better understand its context within the institution. We asked staff to talk to us about their work within LA-STEM and how they saw the program working to support students and their success. We also used our time with staff to discuss issues raised by students and to learn staff's perspectives.

We found program staff knowledgeable and professional in all respects. They all clearly understood LA-STEM's program objectives, described their work responsibilities in detail, and offered evidence of and insights into the ways in which the LA-STEM program helped support students' success.

As there is a small number of interviews with staff members and staff expressed a consensus on all issues we raised, we do not report numbers of staff members reporting an observation, nor total numbers of observations on any topic. As well, in this section of the report we do not provide identifiers to quotations to best protect anonymity of the speaker.

Here we present findings from the qualitative analysis of interviews with LA-STEM program staff.

## A. Program improvements based on formative feedback

Over the four-year history of the program, the LA-STEM has grown from approximately 25 students to over 100. Developing a program requires a scale-up period, posing any number of challenges as growing pains necessitate changes and adjustments.

As discussed earlier in this report, some in the first LA-STEM cohorts found this foundational period of the program difficult in terms of growth in program size, but particularly in relation to turnover in staff members, shifts in staff positions, and new hires. Staff members were aware that changes in program management had been difficult for students. In inquiring whether internal difficulties had been the cause for staff changes, we found that turnover was due to individuals' own personal decisions (largely to pursue PhDs) and unrelated to questions of job performance.

Staff members were aware of all of the issues that had been raised by students and were eager to tell us about improvements that were in the works. For instance, we talked to program staff about students' concerns and confusion regarding recent changes in the grade point required for program participation (from 3.5 to 3.2). In our conversations, it was clear that change in the grade point requirement had been decided upon only after careful review of policy, expectations of student performance, and a desire to mediate the variability of GPAs across disciplines and from semester-to-semester. Engineering students, particularly, were seen as disadvantaged in maintaining a 3.5 GPA given strong evidence of engineering faculty members' traditional weed-out grading methods. Staff also described strong students who hit a bad semester, and suddenly their GPAs had dropped below the requirement level.

Staff members understood that changes in the GPA requirement was a source of confusion for students and took pains to tell us that, like with the Individual Development Plan (IDP), they had put a new policy in place vis à vis a written contract: staff made it a point to sit down and talk with each of the 100+ students individually to make sure program expectations were entirely clear and to seek verbal feedback from the student that he or she understood these expectations fully before signing the document:

> *We have certain standards, and we will abide by that across the board. If you have special circumstances, then we can certainly discuss that. However, the standard will be written, it will be known, and it will be communicated to the students. So that was the one, big issue. Because a lot of them just had no idea as to what was expected. And then, the expectations, if they weren't met, they weren't held accountable for that. And so that was the one area that we definitely changed just on the onset of coming in. So now we have written contracts. We read over the contracts in class, and when they come in, we go over it again, and they have to sign it.*

Clarifying and enforcing program requirements was seen as a positive development:

> *There were some things that weren't happening that they were not required to do. It was in the grant but it wasn't happening. Students weren't forced to do some things. And now with these new managers, they're taking on the attitude, "You don't do it, you're gonna suffer." Now if that means financially, too bad. And then they start to hear that. And with our turnover, sadly but true, every time we've hired someone new, they've been better. They've been better.*

Following our first trip to LSU in the fall, we provided a site visit report offering formative feedback we heard from students and faculty during our interviews. Based on this feedback, staff members were already actively working on program improvements when we returned in the spring.

In between our first and second site visits, the staff had instituted a student advisory board to help address difficulties raised by students. Students also reported to us that this had occurred. Through this forum, program staff and students were working with each other to develop solutions. For instance, staff told us that they were talking with students about ways in which required weekly LA-STEM classes might be revised to provide more useful content for juniors and seniors, who complained that they no longer derived any benefit from attending them and that this was not a good use of their time. Staff said that they were also brainstorming with students activities to build a stronger sense of community around LA-STEM as a whole which reflected the bonds that were clearly established among each of the cohorts and to ameliorate the effects for students of LA-STEM's quick growth from a small to a large program. Improving matching of peer mentors and monitoring the quality of peer mentoring were also being discussed.

In addition to their responsiveness to students' issues, LA-STEM program staff had also offered a faculty mentoring training session for research advisors working with LA-STEM students as a means to strengthen communication between the LA-STEM program and better inform faculty. Three staff mentioned development of a LA-STEM research advisor's handbook to provide program information, information on student requirements, and tips on mentoring students in research work. While both the mentor training session and the research advisor's handbook address the issue raised by advisors in our interviews that they generally lacked information about the LA-STEM program, they are also activities that program staff had been planning for. However, given larger priorities necessitated by the start-up of the LA-STEM program, staff had not had time to accomplish these tasks previously.

Given the progress in addressing formative feedback provided concerning the LA-STEM program, it is apparent that the program staff are responsive and working proactively with students to make improvements to the LA-STEM program.

## B. Program staff's assessments of program elements.

We asked program staff their views about what was working in the LA-STEM program. While individual staff mentioned particular program elements, taking staff interviews collectively, all program elements were described as important. That is, various program

elements were well articulated and, as a whole, provided the elements necessary to support students' success. Program staff described the multiple ways in which LA-STEM was structured to promote student retention and encourage students' interest in pursuing—and preparedness to undertake—advanced degrees (as these elements articulate with and support other program elements, there is no rank order to their listing):

- Summer Bridge: mentoring by peers and program staff eases students' transition to college; critical in building community and creating a "sense of family"
- Training in diversity awareness, diversity of LA-STEM program, and program support particularly for students from underrepresented groups
- Ongoing peer mentoring and strong support from program staff keeps students on track and also from falling through the cracks
- Academic enrichment and leadership development
- Introduction to what research is and exposure to wider career possibilities (especially outside of medicine)
- Engagement in authentic research
- Strong leadership from Dr. Warner
- Committed, well-qualified, professional, action-oriented program staff
- Strong financial support of talented LA-STEM students: "the best of LSU"

Staff members described LA-STEM's program elements as addressing multiple student needs in a holistic manner. To counter problems of students who come in underprepared in a number of ways, LA-STEM has worked to build a comprehensive support system aimed at encouraging students' success, beginning with the Summer Bridge program.

1. The Summer Bridge program

Staff members clearly stated the importance of the Summer Bridge program in building community among students and staff, in helping to create a welcoming, supportive climate, and in easing students' transition to college:

> *INTERVIEWER: Tell me, do you have your own evidence of the effectiveness of the Summer Bridge program? What are you seeing as signs of success?*
>
> *STAFF MEMBER: Well, first of all, the bonding of the students. They really bond doing this activity, and this is really important. In bonding they have—they form a community, a learning community, in fact. They can now—as they walk in as freshmen —rely on that community to help them navigate the entire system. And I think those are the key components that make it a successful aspect of our program. We really need these students to get to know each other, to rely on each other, and all this peer mentoring that we talk about, it actually starts and is established during Summer Bridge.*
>
> *I think that the Summer Bridge program has been one of the most successful parts of the program, that students do come out of that program every year feeling satisfied, feeling ready for the semester. And even if you ask them a year later,*

*they will say that Summer Bridge is the thing that made the difference. My experience with students has been that they generally feel like Summer Bridge has been an incredibly valuable experience. That first couple of years we did get a lot of complaints. The last couple of years have almost been strange because I've talked to students and they say like, "Yeah, I'm having a great time. It's been great." Like, "Really? Is there anything you want to tell me because you can tell me, it's ok." And they have really just been having a good time. I think Summer Bridge is a key part of building that community, putting students in this environment where they are in cooperation with each other rather than competition, is just very different from how the sciences are usually, sort of constructed as a field of student life. I think having that sense of multiple sources of support that if a student runs into a problem there are people on this campus who care about that. And it sounds like a small thing, but it really has made a huge difference for a number of our students just to have somewhere that they can take that too.*

2. Diversity training, diversity within LA-STEM, and program support for students particularly from underrepresented groups

Program staff were aware that one aspect of the Summer Bridge program—diversity training—was problematic for some students. This was one area, however, in which staff were less willing to negotiate changes: students might complain, but from staff members' perspectives and experiences, students benefited from these activities. Putting diversity right out on the table for everyone to talk about directly was necessary given the history of race in the South, that many students in the LA-STEM program were in racial and ethnic minorities on campus, and that some students may have had little experience interacting routinely with others outside their own race or ethnicity. A majority of program staff agreed that diversity training activities were important to Summer Bridge and to the LA-STEM program overall:

*I remember there was a lot of discussion in the first few days of class this fall about some of the students feeling like the diversity activities were heavy-handed, were focused more on race than anything else, and were specifically focused on African-Americans, which...(LAUGHS), to some extent, you know, I think there certainly needs to be an attempt to be balanced, but I also feel like some of the discussions of diversity get so far away from race, get so far into the idea of like, "Diversity is opinion!" and "Diversity is all of these other things!" and I certainly believe in diversity in the broader sense, but I don't want to just have sort of a multicultural carnival. I feel like this program is here to address very real structural differences and this is an opportunity. We can't get so far away from talking about things as they are. Some of the students, particularly, I think some of the Caucasian students who feel like any discussion of race puts them in a difficult position are really desperate not to talk about those things and so I would like to see them pushed to talk about it more…. Some of our older students very quickly sort of were able to bring that other perspective and ensure that it didn't get totally away from race as a category of diversity and as something that*

*matters to the program—not necessarily over all of these other things, but it's not like race and opinion are the same thing when we're talking about diversity. Particularly not in a program like this, so…. They're like, "Well, yeah, it's about diversity and who plays the cello versus who plays the guitar." I mean that's important, but that's not really what we're talking about here…. Every year I know they have complained, but every year when they first come in, they always break themselves into groups that are broken up by race and gender. They just do it automatically like that. It's something that they do every year and every year we try and disrupt that. We have always tried to say, "Ok, you sit over here. Don't sit next to somebody that you sat next to yesterday." So, every year they do resist, to some extent, those changes.*

*We want them to have diversity. We think that's important to LSU and Louisiana in general, where many of the students go to segregated schools—still. Many of our students are not accustomed to being in a diverse environment. And so we want them to embrace diversity, because that will certainly be the real world that they'll be working in.*

*STAFF MEMBER: I think the most outstanding thing this program does is the Summer Bridge…. I think they increase their understanding of diversity because so many students throughout Louisiana go to private schools now. The public school system throughout the state is almost completely avoided by anyone except African-Americans. And so I think it opens the door to diversity for some students. Even though they think they're diverse, their thought processes are, they find out that they're not once they get here.*

*INTERVIEWER: And how does the Summer Bridge program address that?*

*STAFF MEMBER: Well, one, it makes a team out of them. I think they learn how to depend on each other and like each other personally and understand that there are not, there really aren't that many differences in their lifestyles. Even though they've gone to different schools, their family backgrounds are different, etc. I think they start to realize, especially the white students start to realize, that the minority students really aren't that different.*

Racial and ethnic diversity within the program was seen as a strength by staff members and was viewed as important in raising the presence of students from underrepresented groups on the LSU campus. Generating a comfortable climate where minority students saw people "like themselves" was also seen as important in supporting their success:

*Sometimes they say, "I don't see many women in engineering," or "I don't see many minority students." But now within this group, you can see minorities. And being among a strong group like this, they can say, "Oh, okay! This is common." And with more minority students, it does become more common. So with this program, they think it's natural, common, it really doesn't matter. It's also greater diversity. We have some students from China, from India, from Vietnam.*

> *So that is very unusual, in terms of diversity. I think that it is very successful…. We encourage more minorities, but we do have many people from all the different backgrounds.*
>
> *In some situations students of color or women are not well-represented in their disciplines and I think they benefit more from this type of support system, you know? For example, our females who are chemical engineering—or any engineering major for that matter—they're usually the only female in their classes when they get to their upper-level courses, and professors—and just sometimes men—aren't used to handling situations where women are, you know, just as smart as them and those dynamics can be a little bit difficult. And just to see that they have a family of other people who can relate, "So, okay, yeah, I'm also the only girl in the class," or, "Yeah, I'm also having to be the leader of all these guys who don't want to listen to me and I have important things to say." So, I see how women can definitely—and for minorities too—being the only minority and having others like themselves around to help them see…. Sometimes listening to some these students, they haven't seen or been around other women who have been successful, seen that other minorities are successful. So when they come here and see people actually doing great things and they're just like them, it gives them a little bit more encouragement to do well…. I think just by the program being here the faculty, as well, are starting to see that you should expect more from these students and not just count them out. Because, just the dynamic of being in a large university with minorities, however you want to define minorities, you know, sometimes they're taken less seriously than other students. But by seeing how these students, as a group, are excelling and they're competing and sometimes out-performing many other students, I think the program is very beneficial.*

Staff were agreed that they were recruiting the right students to the program. When confronted with the query whether students selected as the "best and the brightest" would succeed regardless, program staff cautioned that though students recruited and accepted by LA-STEM had tremendous potential, this program was critical in addressing the common problem of students who come in "over-confident and under-prepared"—students likely to come from rural Louisiana or to have done well in the public school system:

> *We are in a unique position, in that the Louisiana education system—a third of our students in the state actually go to private and parochial schools. There is a low investment in the public school system. And, as a result of that, the public school systems suffer. So you have students coming into LSU that might have reasonably high ACT scores. Very high GPAs. But they hit a brick wall when they realize what college life is really like. And so, those kinds of things that you're talking about, the success course, the study skills, the time management, all of those things are designed to prepare them for real college life, because they're not really prepared. They think that because they're a 4.0 student, have a*

*reasonable ACT score, that they are prepared, but they're not really prepared. And so we try to prepare them in advance for what they're going to encounter.*

An administrator we interviewed had this to say:

*We do find that, believe it or not, many of the very bright students are the first ones that tend to fall off the wagon because they are the students who really think that everything should come very easily to them because it always has. And as soon as they hit a stumbling block then they just decide, "Well, this is not for me. If I can't make A's the way I normally would, then I evidently can't succeed in this area."*

Aside from academic enrichment and courses developed particularly for LA-STEM students, staff were continuing to seek ways to better support students early on. For instance, faculty in the mathematics and physics were working with LA-STEM to address problems with preparedness:

*We're constantly looking at what we're doing and why. What we're not doing. And one of the things that we've identified—a lot of our students come into calculus and physics and they hit this brick wall. And so we've had conversations with the math department and the physics department. And, particularly math, they're going to design a special course for us this summer, to try and address the needs and deficits of our students as they come in. And physics will do something similar. And so we're trying to address problems as we see them.*

3. Strong program staff support and peer mentoring

Providing students with support included mentoring from program staff. Getting to know students personally, keeping track of their progress, talking with them one-on-one, were priorities for several staff. They saw their job as serving as a resource for students, including providing students' emotional and social support. Students' success was program staff's central concern and, as such, a critical element in helping students to succeed in their college career:

*During the meetings, we talk about a little bit of everything. It just depends on the needs of the students. We've had some just come in and need to cry, need a hug, just, "Class is bad. Help me schedule for next time," or "My parents are stressing me out." Some of them have been really sick, or mom or dad died, most with a terminal illness—I mean, you name it—money, everything. So I will help them, you know, set up a budget, schedule a class (LAUGHING). Whatever is needed. A little bit of everything. And some of them come in and are kinda quiet, like, 4.0, "Oh, everything's great," you know? So we just talk. Talk about research, talk about life.*

*INTERVIEWER: Tell me what you see as being a critical component of the LA-STEM program. What's important?*

*STAFF MEMBER: I think the critical component is the individual meeting with the students. Based on my experience, a lot of students, they may be the top in the high school, but the environment is so different. And many top students, no matter where they go—not necessarily LSU, but Ivy League and elsewhere—if they don't have the counselor or advisor or whatever to keep an eye on them, once they get lost, then they will be done. That means they may not finish their degree. I think students have to go through a lot of adjustment. I mean, it's very common that a high school student will think that they are so good. They are 4.0 in the high school. That is not really the case. And it's not that they cannot do it, but on the other hand, if they never got a C on an exam, and suddenly when they get a C, some students think it's so extreme, and it certainly is a big shock. And if no one can tell them the reality, and tell them, "That's okay" and come up with a plan, then they may not be successful at all.*

*They have to come in for at least two mentoring meetings. Some students choose to come in fairly often and just sit and talk to us about problems they might be having with their personal life, or academically. So I personally do my very best to guide them, and if I'm unable to, I certainly point them in the right direction. For instance, Miss Holmes, our counselor, she knows a lot of stuff that I just can't deal with, so I schedule an appointment with her if it's a personal matter that is more than I can handle. So the students definitely get mentoring from us as well.*

*If you're getting that B, if you need tutoring, we're going to help you with. If you also need to go to the Center for Academic Success, if it's a time management thing, we're going to sit down and assess with you here. Maybe refer out to Center for Academic Success and follow up with Center for Academic Success. And maybe mental health issues, and then possibly do counseling, or refer out. It can be a whole slew of other things!*

Peer mentoring was also seen as an important element of the LA-STEM program. Like program staff, students could turn to their peer mentor or others in the program for the support they needed:

*Younger students don't necessarily know about research, or just being a student here at LSU, in general. So their peer mentors serve a great function, in that they can go to these older students with problems and typically they get advice and help resolving them.*

*I hear things and I see things that I think are working. I think that peer mentoring has brought them together. I think they're more of a team than program participants, because I think that they look out for each other. When someone gets in trouble, they all take it personally, you know? It's a personal responsibility that they feel for each other.*

> *The students, knowing that they have someone there to coach them through and to walk them through the process, be it choosing a class or which faculty to take. I think that's something that the students feel is very important to have, the very close relationship with someone that can help them through the process.*

Like students, program staff described support that felt like "family":

> *The feeling of a family atmosphere. There's often talk of a big university, like just being a number. And being in LA-STEM, you're no longer a number, you're part of a small, tightly-knit group.*

4. Academic enrichment and professional development

As noted earlier, program staff described the LA-STEM program as being designed to support students in a holistic fashion. The weekly LA-STEM classes and workshops on professional development were cited as providing needed support to talented, high-achieving students who nonetheless come into college underprepared. Thus the weekly classes were seen as an important element of the LA-STEM program:

> *Study skills. Just the basic study skills. Teaching them how to learn how to learn. Teaching you about your learning style. Just that alone. And then dissecting actually how you, "How're you doing homeworks? Are you doing it properly?" Time management skills. "Are you using your planner?" Just some basic skills that make such a difference.*

> *The courses, the study skills, the time management, all of those things are designed to prepare them for real college life, because they're not really prepared.*

5. Introducing students to research and wider career possibilities

Staff members were in agreement that LA-STEM offered a valuable program that introduced students to broader career possibilities and, particularly, to the possibility of a career in science. Quite commonly, students entering science majors in college express high interest in pursuing a medical degree, largely because they lack any knowledge of alternative degrees and the medical profession promises a secure and lucrative career, is viewed as prestigious, and garners parental support. Student interest in pursuing a medical degree was reportedly quite high at LSU. Staff recognized that introducing students to research and educating students on career possibilities beyond medicine was an important function of the LA-STEM program:

> *Exposing students to research, I think, is a very central part of what we do. We bring in guest speakers to talk about their research and it really sparks interest in the students to do research. I've known a number of students who, after they've spoken—or listened to a lecture about one of these guest speakers—have approached them about doing research in their lab.*

*A lot of what they get are just the opportunities that we throw at them. Most— a lot of the students—don't even know what the PhD is. All they know is, "I'm going to be a doctor." And most of them will actively pursue research once they're in this program, once they have the opportunity to see what that means.*

Exchange 1:

*STAFF MEMBER: I like to see students who are inspired to keep doing work in their disciplines. Who will come in and say that they love research, that research makes their academic work easier, students who do decide that they don't want to go to medical school and that they want to get a PhD, is always an exciting conversation to have (LAUGHS).*

*INTERVIEWER: Does that happen often?*

*STAFF MEMBER: Yes. It's happened several times at least. We had—one of our students who was one of the very first students and one of the most sort of gung-ho medical-school people, ended up having a summer research experience. She had already applied to medical school. And she came back from summer research the summer before her senior year and said that she was going to get a PhD. That was wonderful…. I know we've gotten some criticism from NSF that we are accepting too many students who initially want to go to medical school and that students are persisting in their desires to want to go to medical school, and certainly, we are going to have students who go to medical school. That's what it is. But what we have found is that there's such a high portion of those students who are so successful in the sciences, they do have a medical school focus and they don't really know that there are other possibilities, other things that they can do with that science ability. And so we try and limit the number of students that we will accept whose stated focus is medical school and who we think we can convince otherwise—who we have some reason to believe that research is going to be an important part of their lives. But that's, in terms of our selection process, like, probably, I'd say, at least a third of our total applicants are pre-med applicants. At least.*

Exchange 2:

*STAFF MEMBER: Even myself being in high school, I remember my parents were pushing me towards medicine. I mean, it's just something that parents do. They want the very best, and they see medical school as the way to go. Doctors make oodles of money. This past weekend was selection weekend. We've had students who after they hear Dr. Warner's opening address admit that they never knew what research was and that it excites them. So some students, as die-hard as they are about med school, when they get into research, that's all they can imagine themselves doing.*

*INTERVIEWER: So you have seen this program change students' minds?*

*STAFF MEMBER: Yes. The two students that I know of, who graduated early, are pursuing graduate school right now. One in math, and I forget what the other one was. But we are just now coming to our first full graduating class, so I guess we'll have a better indication after the semester.*

6. Engagement in authentic research

Research experience for students, early and often, was viewed by staff as a critical program component. In seeking to encourage student retention and recruitment to graduate STEM degrees, the LA-STEM program sees involving students in the hands-on learning of how research is done as the best way to accomplish these objectives. Getting students involved in research as freshmen built skills from the start:

*The research focus—lots of students don't expect the research when they get here—the heavy emphasis on research. But I think that's something that all of the students need early on, and not waiting until they're juniors and seniors. Start from the beginning. Let them know, if you want a PhD this is what's expected of you. This is what you're going to have to do. It's the only way students are going to find out for themselves whether research is something they really want to do.*

*Definitely the research component is critical. The mentoring component. All of the elements are crucial to me. Mentoring with the faculty, with the staff, with each other. Research. Just being taught how to secure research. How to do research. And getting that hands-on exposure as an undergraduate.*

*Getting students into research early on is really an important part of what we are doing. Building their skills, building their confidence, building their competencies—this is what research does for students. If they are going to get a PhD, they should know what that means and getting students involved in research shows them.*

7. Strong leadership from Dr. Warner

Program staff emphasized the highly positive ways in which Dr. Warner influenced the LA-STEM program. His leadership was seen as an important element in supporting students' success. Dr. Warner was described as "passionate"; many also added that he carried a lot of prestige:

*I don't know how they can find another person like Dr. Warner. Because it truly is his passion that drives this program. When people work with us, the first thing they recognize is how passionate Dr. Warner is about this. And you can't help but believe in something if someone is standing up and advocating so strongly for it.*

*Dr. Warner provides some very strong leadership, a lot of credibility. I mean, he'll make a phone call, "I need you to talk with so-and-so about working in your*

*lab. A great, bright student." I mean, this is a Boyd Professor. This is the President's Award for Mentoring. I mean, come on! You know? So I think that's certainly a big part of it. And he really inspires the students.*

8. Committed, well-qualified, professional, action-oriented program staff

From our interviews with program staff, it was clear that they were dedicated, well-qualified and action-oriented. We found them knowledgeable and professional in all respects. Like Dr. Warner, they tended to express passion for their work. They were committed to making LA-STEM the best program possible, and worked proactively in accordance with program goals:

*I wake up in the morning looking forward to coming to work, which was pretty rare for me until I got this job. I actually don't mind putting in extra hours. Selection week, obviously, that Friday was a 13-hour workday for me. Saturday I had to work for another three hours, and I had absolutely no problem with it, I enjoy it. I absolutely enjoy it.*

*Just me, from a managerial point of view, I want everything to perform at 100%.*

*We try to catch it. Like, right now, midterm grades. We have to check everyone's midterm grades this week just to see if there's something we need to be concerned about. And then, we're going to have whoever's a red flag, have them come in and see if there's something we can do to prevent a serious problem from occurring.*

Despite difficulties caused by turnover, it appears that LA-STEM has in place an effective program staff:

*I think the managers we currently have, have come in with a lot of spirit to create teamwork. And they've taken more of an interest in fulfilling the goals and objectives of the program as they were written in the proposal. They've really worked hard, defined objectives and gone full steam ahead!*

9. Strong financial support of talented LA-STEM students: "the best of LSU"

Program staff said that strong financial support was critical in helping students to succeed, and as such, saw it as an important program element:

*LA-STEM students are the top within LSU, and their scholarship program is the best at LSU. Not coming from state money, not coming from university money. This is the best package. We get the best students within LSU. And financial support is kind of critical in keeping students from, you know, having to work at a part-time job or something, which can really affect their grades and overall performance. And they're the best. They really deserve it, and they work hard for it.*

In sum, interviews with program staff showed that they were they were actively working to implement improvements to the program based on formative feedback and with students' input. They described LA-STEM as a program providing multiple elements of support with the objective of meeting student needs at every level. The Summer Bridge program eased students' transition to college life and built a sense of community among LA-STEM members. Training in diversity awareness, diversity within the LA-STEM program, and program support, particularly for students from underrepresented groups, were described as important program elements that addressed students' needs. Given the history of race in the South, that many students in the LA-STEM program were in racial and ethnic minorities on campus, and that some students had little experience interacting routinely with others outside their own race or ethnicity, diversity training was developed to address issues unique to LSU's context. Ongoing peer mentoring and strong support from program staff directed at keeping students on track—and from falling through the cracks—were elements also seen as playing important roles in promoting students' success. Academic enrichment and professional development ameliorated difficulties students encountered due to under-preparedness. Introduction to what research is and exposure to wider career possibilities (especially outside of medicine) and opportunities to engage in authentic research were considered central to achieving program objectives to retain students in STEM majors, and encourage and prepare them to go on to STEM PhDs. Program staff acknowledged that strong leadership from Dr. Warner—his passion and dedication—was a driving force behind LA-STEM and, as a role model, inspired students to succeed. From our interviews with program staff it is clear that they are committed, well-qualified, professional and action-oriented: certainly important elements contributing to program success. Finally, program staff recognized that strong financial support of "the best of LSU" attracted talented, high-achieving students who might otherwise go elsewhere. Strong financial support was also critical for students who otherwise would have to work to supplement their educational costs and, therefore, detract from students' academic performance. Overall, program elements operated as a network of student supports. Multiple elements were structured into the LA-STEM program, and staff's accounts demonstrate the ways in which, collectively, and as an articulated whole, program elements support students' success in STEM majors and encourage their interest in pursuing STEM PhDs.

## XIV. Benefits to Louisiana State University from the LA-STEM program

Across interviews with program staff (7) and administrators (5), we asked how LA-STEM fit into the institutional context of Louisiana State University (LSU) and whether LSU derived benefits from the LA-STEM program. In responding to our questions, program staff and administrators noted several benefits associated with the LA-STEM program. Aside from benefits to faculty productivity, LA-STEM was seen as benefitting the institution by attracting top-qualified science students to study at LSU and by raising the national prominence of LSU through LA-STEM's growing reputation as a highly-competitive and prestigious program. In exploring the LA-STEM program and its context within the university, we found that LA-STEM's program objectives were remarkably well aligned with those of LSU's "Flagship Agenda."

As there is a small number of interviews with staff members and administrators and that there was consensus on all issues we raised, we do not report numbers of individuals reporting an observation, nor total numbers of observations on any topic. As well, in this section of the report we do not provide identifiers to quotations to best protect anonymity of the speaker.

Program staff said that the LA-STEM program, even within its short history, was already gaining a prestigious reputation. For instance, we were told that applications to LA-STEM were now coming from across the US and that the program was attracting students considering top-ranking research universities:

> *I think you'll find that talking to many of the students, they'll say that they never would've come here, had it not been for the LA-STEM program. So we're attracting a lot of students that would not normally look toward LSU. And the program is becoming better and better now and more and more students are very interested in getting into the program.*
>
> *We recruit the top-notch students. They choose to come here, instead of an Ivy League, Stanford or Berkeley, or so on. That is good, because we did hear many people, they said yes because of the mentoring environment plus the financial scholarship, and they decided not to go to the Ivy League.*
>
> *We have a student who came in from Kentucky last year, so, the word about this program is beginning to spread. We have a young woman from New York who heard about our program…. It's beginning to attract a lot of national attention, but initially, for the first year or so, it was just a Louisiana program. But now the word is beginning to spread.*

Program staff also told us that faculty were actively seeking out LA-STEM students to work with. They also reported that research faculty at campus and nearby research centers where LA-STEM students had conducted research were routinely reporting back that they were impressed with the students they had worked with and described them as having graduate-level skills and abilities:

> *The program's reputation is growing nationally. It's also growing campus-wide. We have many people who come in and want to work with our students because those who have worked with our students have said they're as good as their graduate students.*
>
> *LA-STEM has become a jewel of LSU. Lots of people know us. They talk about the students, and they all know that these are the best-of-the-best. The Center for Computation in Technology is absolutely in love with our students, because the professors love having good students doing their research. And they don't have to pay them. (LAUGHS) So they're very fond of us.*

Being known for having high-caliber science students was seen as helpful in supporting LSU's mission to attract talented science faculty. The LA-STEM program also exemplified LSU's goal to strengthen undergraduate education. One administrator had this to say:

> *Our goal—which is the goal of most very high research institutions—to achieve national prominence requires that our faculty are engaged, obviously, in research that can garner the attention of their disciplines at a national level. So we're trying to hire exceptionally good faculty. And those faculty are attracted not just to a place where you have excellent graduate students, but also where there are really exceptional undergraduates with whom you can do research. So LA-STEM provides a link for our faculty in terms of helping them to be more productive. Now separate and apart from that, we also want to provide exceptional quality in our undergraduate programs. That's also a part of that agenda. And so this also is a critical link in terms of providing a really exceptional experience.*

Recently, LSU had implemented a new mission policy, codified as the "Flagship Agenda.' An administrator described it this way:

> *The Flagship Agenda is basically a strategic plan. It sets out a series of objectives and milestones that we hope to reach by the sesquicentennial of the University in 2010. It's very structured like most strategic plans would be in terms of increasing numbers of faculty, increasing numbers of graduate students, increasing research space, funding for research, etc…. It has a lot of buy-in with both the faculty and administration here, so it's more than just a document. It actually becomes…we try to focus everything we do around that.*

In talking with program staff and administrators it was clear that LA-STEM program was seen as a central support to LSU's mission to fulfill the objectives set out in the Flagship Agenda. Administrators, particularly, were clear in expressing the many ways in which the LA-STEM program supported LSU's institutional goals. By attracting the "best and the brightest," the LA-STEM program was seem as helping achieve the goal of raising the national prominence of LSU through a strengthened commitment to institutional excellence (both faculty hiring and student admission standards had recently been raised).

However, with its objective to promote the success of students from underrepresented groups, the LA-STEM program was also seen as supporting LSU's mission to redress historic racial inequalities in higher education in the South by increasing the representation of diversity on its campus and encouraging a racial climate and providing the resources necessary to supporting the success of students from underrepresented groups:

> *It fits in very well in terms of increasing student enrollment. But in a larger context it, fits in with the overall mission of the university in trying to encourage minority and underrepresented individuals to go into the sciences. I don't think you'll find those words actually in the Flagship Agenda itself, but that's an*

*underlying mission that affects everything we do here… Now separate and apart from other goals, I also think there is a moral imperative on this campus, especially given where we are in the South and given the history that we have in terms of the relationships, especially between race and gender and what we do as an institution. We have a legacy, one that we obviously are not proud of, that we have to be very proactive in terms of trying to move forward. So there are certain goals and agendas to this, but there's also our history, and I think our moral responsibility to address that. We were for years under the court ordered desegregation plan, and we've over the last several years moved from that, not being under that plan. And how do you transition to something that can still work toward the goals that you're no longer being required legally to do, but you still are morally—and not just obligated—but committed and appreciative of what it is we're supposed to do? So I think we have that goal. Now apart from that there's also, just in general in this country (LAUGHS)—we are not alone in facing that obstacle. We just simply happen to have a particularly egregious past associated with ours. So I think you can't just say "Rah, rah, cheer, cheer," I think you have to really be purposive about it. And this sort of LA-STEM program in a place like LSU, it is critical for us to bring in people of color and women to these disciplines. And the program is not entirely comprised of people of color and of women, but it has a core group. And providing a core group so that you look around a table and you see people who look like you, is important. It really is important that there is a core. So it provides that, and then it also provides the structure and the mentoring to help those people succeed, and then of course the ultimate goal is they move from the undergraduate to the graduate programs, and ultimately enter the disciplines.*

*LA-STEM is really geared towards increasing the excellence of the university, geared at attracting a higher-quality faculty, a higher-quality student. And a diverse student body as well as faculty. And I think in this part of the world, in the South, our consent decree and desegregation and the realignment of the universities within Louisiana—as between those that are historically black and those that are open to all—it's only a recent phenomenon. And so I think we have an added expectation and an added obligation to be sure that diversity in all of its rich and positive dimensions is what we practice and what we celebrate.*

*The Flagship Agenda looks to increase campus climate, particularly for underrepresented populations. So just in terms of efforts around increasing diversity, the program certainly helps in that regard for recruitment and retention of students of color and women in the STEM areas. As well, attracting high-caliber students, in terms of the Flagship Agenda and moving us up on the national rankings of the US News & World Report. It has to be, you know, a calculation of high-ability students. So they have really done a good job of attracting top-notch scholars.*

*The Flagship Agenda is certainly to increase diversity. And if there's any one component among the students—there's a lack of diversity particularly in*

> *successful students and role models within the STEM disciplines. You have probably 9%-10% African-Americans, 10%-12% underrepresented minorities, in general. But that number is significantly lower in the STEM areas. And so here we have a program which has 40% underrepresented minorities and 60% percent women. That is sort of a microcosm of what the overall objective of what the university is going towards in terms of the Flagship Agenda, and that is to diversify the entire campus. And here we're making that effort happen within the STEM disciplines.*

Program staff and administrator's appreciated that the LA-STEM program was critical in attracting students from underrepresented groups to LSU, especially given the number of neighbor institutions which are Historically Black Colleges and Universities:

> *One of the things that's really important to a campus like ours, is to increase the diversity. And we have a particular challenge because we have—and it's wonderful that we have the large numbers of Historically Black Institutions that we do—but those institutions also create challenges for us in terms of attracting students of color here. So these sorts of programs are vital for us to be able to explain why those students should come here. I mean, I can't imagine having to finally have an opportunity where you are a majority. And I would think that highly attractive. So we have to convince those students that there are real opportunities for them here, and that it's important that they're here, but there's a real competition for us with Xavier, and Dillard and Southern, among a number of them. So these sorts of programs are really critical.*

Insofar as LA-STEM program objectives were well aligned with LSU's Flagship Agenda, positive program and student outcomes from LA-STEM were seen as directly benefitting LSU. Our final site visit occurred in the spring, approximately two months prior to the graduation of the first LA-STEM cohort: the LA-STEM program's first opportunity to demonstrate hard outcomes for student retention and recruitment to graduate school:

> *This year is the first year we have a large group of students that started the program from the beginning, and who are going to be graduating and going on to graduate school. I am so excited to see that, and to see where they actually go for graduate school!*

Overall, the LA-STEM program was viewed by program staff and administrators as beneficial to LSU. In attracting talented and highly-motivated students to the STEM disciplines, LA-STEM directly contributed to LSU's commitment to raising the status of the institution and thereby helped to recruit desirable faculty to LSU as well. More importantly, however, LA-STEM's objective to promote the greater representation of students of color and women in the STEM disciplines matches LSU's goals to promote diversity and a welcoming climate on campus supportive to students from underrepresented groups. For a number of administrators, promoting diversity at LSU was described as a moral commitment to help redress racial inequality due to the region's historic past.

## XV. Program sustainability

Faculty, program staff and administrators were asked to comment on those factors they saw affecting the sustainability of the LA-STEM program.

When asked if they thought they would continue their participation in LA-STEM, ten research advisors offered an unqualified, "Yes." Another two said they wanted to *increase* their involvement in LA-STEM. Another two said they would continue to be involved, but would not actively seek out students to work with. One said that, due to tenure pressures, he would likely limit his involvement.

In commenting on the extent that other faculty in departments mentored students in research, it was evident that there was a quite a range. Two faculty said that they were the only members of their department working with undergraduates. Six said that one or two of the faculty in their departments directed students in research. Three said that their departments supported research with students. One of the research centers on campus required its faculty to work with undergraduates. In general, it was thought that there were enough STEM faculty at LSU to sustain undergraduate research.

Not surprisingly, however, sustainability of the LA-STEM program was quite largely predicated upon the success of acquiring adequate and ongoing funding. Senior program staff had taken the initiative to write proposals to secure funding to establish LA-STEM, and writing grant proposals remained a primary strategy for sustaining it. However, given the inability to guarantee that a proposal will be funded, the sustainability of LA-STEM on this basis alone remains an open question. We raised the issues of institutional support and sustainability of the LA-STEM program with LSU administrators with whom we spoke. They expressed strong support for the LA-STEM program. They reiterated the ways in which LA-STEM's program objectives aligned with those of the institution and said that funding invested in the Flagship Agenda and other STEM initiatives on campus demonstrated institutional support of and commitment to the success of the LA-STEM program.

Staff and administrators acknowledged that Dr. Warner and his colleagues were responsible not only for promoting undergraduate research, but critical agents in securing the funding to make it and the LA-STEM program happen. Indeed, senior LA-STEM program staff were Principle Investigators (PIs) on more than 12 large grants supporting graduate and undergraduate research at LSU, i.e., NSF-REU, HHMI, McNair, LSAMP, etc. (hence the "alphabet soup" of research programs on campus):

> *This is something that Dr. Warner is passionate about. He went after the funding. And it really can be daunting to have to go after the money every year when the program is about to run out of funding. So he has just doggedly pursued getting resources to make sure that this program stays in place. And, I mean, that's not to say that there's nobody else who's working very hard to do this. Dr. Pang works relentlessly to bring in money.*

Multiple sources of funding were required to get LA-STEM up and running. Primarily funded by the NSF, monies for program staffing had been provided by Research Corporation, and the Board of Regents had also contributed some funding for scholarships. While program staff and administrators were optimistic about the likelihood of receiving future funding for LA-STEM, some cautioned that such funding was never guaranteed:

> *I believe it's sustainable. I mean, it's an excellent program. There's no reason they wouldn't continue it. I would like to think that NSF will continue funding…. It's a great program and we certainly, when it's time to renew, we do our very best. I'd like to think that we'll continue being funded, but you never know.*

> *I think that it's unpredictable. This is kind of the nature of the grant environment in sciences. There are so many people who are frustrated because the funding continues to decrease. I sit on NSF review panels and I see the number of very worthy projects that would be funded if the money had not run out. But it did. So they can't fund it. And so this is a fairly fickle environment. And sometimes they decide, "Well, no, the emphasis this year will be on starting new initiatives and not continuing initiatives that have been operating for awhile." I just think that it's tenuous just depending on how the environment changes, what funds may be available. It would be great if success was pretty much guaranteed, but I don't see that. I see Dr. Warner fighting year after year to try to get funding and make sure the program continues.*

We asked administrators their thoughts about the level of LSU's commitment to sustaining the program. All administrators with whom we talked expressed strong support for LA-STEM. Their responses restated the ways in which the LA-STEM program and its objectives were linked to the institution's Flagship Agenda and state funding. That the LA-STEM program was situated within the Office of Strategic Initiatives, itself, signaled its importance to the institution. Again, a moral commitment to improve diversity at LSU underpinned support for LA-STEM:

> *There are multiple initiatives that will benefit LA-STEM from the state. They are putting up tremendous amounts of money into the networking and computing side of what we're doing on this campus. And some of the money that the state invested in us, we are putting into multi-disciplinary hiring initiatives in some of the STEM disciplines. So we've got major investments going into material sciences, engineering, and computing, and then a long history in terms of chemistry and some of the other areas there. And then these newer initiatives that bring in some of the other disciplines, that I think have probably not had the sort of investment that was needed. And the way that plays in for these students, is that we now are hiring the faculty for them to work with. It doesn't help us to bring these students in and they don't have really top-notch faculty to work with. They have to have those mentors. And the faculty with the research that's exciting and cutting edge, and getting national prominence. Those students then are going to filter into exceptional graduate programs obviously. And the state is investing*

> *in that…. The other area where we're, where I think the longevity of the program is really critical is that we're building in both merit-based and need-based scholarships that we've not had before. I think that's also a critical component because you're not going to get them here just by saying, "Come." These are students that had multiple offers. So we have to be able to be competitive. And so we're recognizing that.*
>
> *It seems to me that an initiative like this, if it was simply an administrative pronouncement, would not penetrate the rank and file of departments and programs. Faculty have embraced this. It's become a part of the culture. It's not simply an administrative pronouncement. It has a champion who is highly regarded for his own scholastic achievements and who himself is a minority. That gives the initiative a kind of clout. Secondly, it is lodged at the highest levels of the university to both symbolically and substantively convey the importance that we attach to it. I think it really does penetrate the culture. It's not simply an administrative pronouncement, nor is it a fad. It really has gotten grafted into the culture of the relevant colleges and departments and something that they, in many ways, are starting to mirror. For example, the College of Engineering now has an Associate Dean whose principle functions are to focus on diversity and the recruitment of women and minorities into a field that nationally is historically underrepresented…. Mathematics has undertaken a major curriculum reform initiative in their department. These initiatives reinforce one another.*
>
> *INTERVIEWER: From your experience, does there seem to be some good support for LA-STEM? For bringing in the funding and scholarships that are necessary to keep the program going?*
>
> *ADMINSTRATOR: Absolutely. And let me assure you that nobody wants Dr. Warner sitting across from a table, (LAUGHS), saying, "Why are you not funding this?" Nobody wants that! And let me go back to the fact that we recognize our responsibility to this group as a university. That can't be far…I mean, in the long-term history of things, that court order ended just a few years ago. That's pretty sad actually, that you even had to be under one, but that's, that's the history that we have in this state, the history that we have in this country. So that support is there.*

An administrator also added that, given the industry base of Louisiana, and national concerns to build a scientific workforce that includes greater diversity, it made it fundamentally easier to substantiate their requests for funding when approaching the state legislature:

> *It's much easier to sell to a legislature when you're talking economic development…. It's much easier to say to a legislator, "We're going to graduate these engineers and scientists, and they're the best and the brightest. And we can graduate them here, or they can go someplace else." So they are investing and*

> *they have given us some scholarship dollars that are going to be supporting these students.*

A LA-STEM staff member was hopeful that LSU and the state step forward and play a significant role in sustaining its future:

> *I'm hoping that the university, and by extension the state, will think about making this a sustainable program. It's important that we invest in our students, invest in their future. These are the best and we have to support them. And a program like this has proven to be successful. The funding agencies aren't going to continue to fund this forever, I mean, it's LSU's responsibility to educate their students. So hopefully LSU, the legislature, will come through and help in this effort.*

The possibility of raising an endowment was also raised by program staff as a strategy for sustaining the LA-STEM program. This remained an option for the future if other types of funding could be secured in the meantime.

Overall, the majority of research advisors planned to continue their participation in the LA-STEM program. Though department and faculty buy-in of directing undergraduates in research was reported to vary considerably, the general view was that there were enough STEM faculty at LSU to support LA-STEM and other undergraduate research programs. Rather, acquiring future funding was seen as the primary factor affecting sustainability of the LA-STEM program. It was clear to several program staff and administrators that NSF funding would not continue indefinitely and that the labor- and time-intensive effort of proposal writing was an inherently risky way to raise funding. Louisiana State University administrators voiced strong support of and commitment to the LA-STEM program. The alignment of LA-STEM's program goals with LSU's Flagship Agenda was seen as assuring ongoing commitment to both initiatives.

## XVI. Reproducibility of the LA-STEM program

Program staff and administrators were asked to offer their insights on whether and how LA-STEM, as a model program, might be reproduced at other campuses with similar objectives. Staff and administrators agreed it could be reproduced (and adapted) elsewhere. However, they emphasized one factor as particularly critical to program success: highly dedicated and distinguished leadership, such as that provided by Dr. Warner.

Program staff were agreed that the various elements comprising the LA-STEM program—Summer Bridge, peer mentoring, strong staff support, academic enrichment, professional development, early research opportunities, etc.—could be successfully replicated at other institutions provided sufficient awareness of local contextual influences. Elements may need to be adapted or developed to address issues specific to institutional and student needs:

> *There's lots of things within the program that can be transferred to other programs, but it all has to be done within the context of that particular state, that particular university.*
>
> *It's definitely replicable. If I'm not mistaken, we were largely based on the Meyerhoff program. But we developed the diversity training, because that's an issue particular to this campus and to the students here.*

Program staff and administrators cautioned that one factor critical to the program success was difficult to replicate: the strong and distinguished leadership of Dr. Warner. His passion and prestige were described as key to the program's success:

> *They would just have to have someone over it who's was just as passionate about it…. . You'd have to have someone like Dr. Warner behind it. He just gives it that extra element of "Wow!" It would succeed without him, but I wouldn't want to try.*
>
> *Dr Warner has established an unparalleled reputation and you can't purchase that. It takes decades to build that. He's phenomenal. He is a force to be reckoned with in a very good way. He's the exact kind of advocate you want because he is an exemplar in his field. He's an award winning chemist. He has that legitimacy attached to him. And then he brings the record of achievement. I mean, look at his students! You can't argue with that!*
>
> *INTERVIEWER: What would you say is critical in this program that would be necessary to make it successful in another university with similar objectives? What would you have to replicate?*
>
> *ADMINSTRATOR: One is leadership that isn't just advocacy. Leadership that is very substantive. We are blessed to have Isiah Warner, who is not only a champion, but more importantly, he doesn't have to worry about getting on a bully pulpit to have credibility with his colleagues. He is an outstanding scholar by every dimension. And so when Isiah speaks, the faculty listen because he's one of them. He is one of the best of them, and he has credibility, and is someone who has excelled in the field that was a non-traditional field for an African-American of his generation. What an incredible icon. But he's also such a hard worker, and everybody knows that. So if one can be blessed with that kind of leadership. He also has good leadership in another sense of the word. He gets his staff really motivated. I mean, they are so committed to what they're doing and feel a real purposefulness in that they're making a difference. Those are powerful ingredients for people, whatever your color or gender.*

In sum, program staff and administrators agreed that the LA-STEM program was reproducible at other institutions with similar objectives. Program staff did warn that it was important to take into consideration local institutional and student needs to develop or adapt relevant elements (i.e., diversity training within LA-STEM). Program staff and

administrators cited one element as particularly critical to program success and difficult to replicate: the highly-dedicated, prestigious leadership of Dr. Warner.

## XVII. Conclusions

Qualitative analysis of our conversations with students, faculty, program staff and administrators indicates that the LA-STEM program is effective in meeting a range of program objectives and also that structured program elements contribute significantly to the support of students' academic success. Because the LA-STEM program is based upon theoretical and program models that seek to improve student retention and persistence in STEM fields, we reference other relevant research and evaluation studies framing findings from this evaluation.

Model programs, such as LA-STEM, incorporate structural elements founded upon grounded theoretical research on student retention and persistence to graduation. Such programs focus on students' academic and social integration into campus life by building community among members (Stoecker, Pascarella & Wolfe, 1988; Tinto, 1987, 1993; Astin, 1982, 1992; Astin & Astin, 1992; Pascarella & Terenzini, 1991, 2005; Seymour & Hewitt, 1997). The academic and social integration of underrepresented groups into scientific life is especially important because these students often lack prior access to experiences and opportunities that presage membership in a scientific community (Dryburgh, 1999; Mulkey & Ellis, 1990; Lewis, Ginsberg, Davies & Smith, 2004; Nettles & Millet, 1999). Further, high-achieving students from underrepresented groups may be isolated from their peers and the development of peer support networks for these students is essential (Fries-Britt, 1998; Wilson, 2000).

The LA-STEM program shares many common elements with other comprehensive support programs that seek to improve student retention and persistence in STEM majors, particularly for students from underrepresented groups. Structured elements in the LA-STEM program address key factors identified in the research literature as affecting underrepresented groups, such as inadequate academic and social integration, knowledge and skill development, support and motivation, and advising and monitoring. An examination of twenty exemplar programs designed to recruit and retain minority undergraduate STEM students demonstrated that most concentrated on five major areas of support: mentoring, financial support, academic support, psychosocial support (e.g. counseling, building a sense of community among participants, family involvement, etc.), and access to professional opportunities, such as research or internships (Gandara & Maxwell-Jolly, 1999; see also Tsui, 2007). These program elements were similarly identified by LA-STEM students and program staff as contributing to students' academic success.

LA-STEM has been successful in recruiting a diversity of talented and highly-motivated students, who are intrinsically interested in science and want to pursue STEM majors. Students' choice to attend LSU was highly influenced by LA-STEM's financial scholarships and early opportunities for undergraduate research. Similar programs and research have found that sufficient financial support of students was an important factor

affecting retention and persistence (Pascarella & Terenzini, 1991; Astin, 1993; Maton, Hrabowski & Schmitt, 2000; Maton & Hrabowski, 2004; Barlow & Villarejo, 2004; Building Engineering & Science Talent (BEST), 2004; National Research Council, 2005).

LA-STEM students were very positive about their Summer Bridge experience, particularly the peer interactions and sense of community fostered by the program. The large majority of students were glad to have participated in Summer Bridge and some said that Summer Bridge was "the best thing" about the LA-STEM program. In fact, the personal and social benefits of participation in the Summer Bridge program were the most valuable aspects of the experience, according to students. Though students did not always value individual components of the Summer Bridge experience as highly (such as some of the faculty research presentations and field trips to local laboratories), they clearly valued the experience as a whole. Students' comments demonstrated that the Summer Bridge program helped them to learn about life as a college student and gain awareness of resources, information and skills that helped them to succeed academically at LSU. High school-to-college bridging programs have been found to contribute to the success of other similarly-focused programs (Maton, Hrabowski & Schmitt, 2000; Clewel, de Cohen, Deterding & Tsui, 2006).

Most importantly, as a result of Summer Bridge, students formed a social network with their peers and began to create a community of scholars which they would carry with them into their undergraduate career. Students appreciated belonging to a high-achieving community of learners with similar academic interests. Students attributed their academic success to a culture of achievement within the LA-STEM program, reflected by the high expectations set by program staff and the GPA program requirement, and supportive peers. In line with other research and evaluation studies, building connections and friendships with other group members and feeling a sense of belonging to a community of like-minded learners were cited by LA-STEM students as contributing to their academic success (Astin, 1993; Tinto, 1993; Walters, 1997; Alexander, Foertsch & Daffinrud, 1998; Maton, Hrabowski & Schmitt, 2000; Maton & Hrabowski, 2004; Barlow & Villarejo, 2004; Building Engineering & Science Talent (BEST), 2004).

Academic enrichment offered by LA-STEM was also mentioned by students as supporting their success. As outcomes of the required weekly classes, students generally reported gains in time management and study skills, and in working collaboratively as a group and said that sessions offering professional development, particularly GRE preparation classes and information on and help with selecting and applying to graduate school, were very useful. Academic support and enrichment has also been documented as a critical program element by Maton, Hrabowski & Schmitt ( 2000), Barlow & Villarejo (2004), Maton & Hrabowski (2004), Building Engineering & Science Talent (BEST), (2004). While most reported that the weekly classes and peer mentoring sessions were helpful and contributed to building community among LA-STEM students, of all topics raised, Individual Development Plans and weekly classes received the highest number of student comments relating mixed or negative views on the value-added of these LA-STEM program elements. These observations came largely from juniors and

seniors who felt that the classes had become repetitious, redundant and of little or no benefit. Some students also said that the value of peer mentors declined as they progressed in their college career. Nevertheless, the program overall clearly had a positive impact on participants and their personal, professional and intellectual growth and development.

Peer mentoring—during Summer Bridge and beyond—reinforced group connections, provided positive opportunities for leadership within LA-STEM, and generated personal gains for both the mentees and the mentors. The contribution of peer mentoring to student retention and persistence are gains also documented by Astin & Astin (1992), Walters (1997), Nagda, Gregerman, Jonides, von Hippel & Lerner (1998), and Hathaway, Nagda & Gregerman (2002).

Strong support from program staff is another component of LA-STEM which students cited as important in contributing to their academic success. Students said that the academic and social support they received from program staff was a highly positive aspect of the LA-STEM program. Students often described program staff as mentors who were active and pro-active in helping them to succeed. Students from all cohorts described how program staff felt "like family" and how their interactions encouraged a strong sense of belonging among a supportive community. There is evidence demonstrating that LA-STEM and the LA-STEM program staff have helped students to persist in their STEM majors and influenced their decision to seek a graduate degree. A number of students told us that strong support from program staff had played an important role in helping them to persist in their major when they might not have otherwise due to academic or personal difficulties. Other research and evaluation studies have also highlighted the importance of program staff support in contributing to student retention and persistence (Tinto, 1993; Walters, 1997; Maton, Hrabowski & Schmitt, 2000; Barlow & Villarejo, 2004; Maton & Hrabowski, 2004; Building Engineering & Science Talent (BEST), 2004).

Many students told us that LA-STEM was critical in introducing them to research, teaching them what research was exactly, and showing them the broader potential of contributing to science. In addition, several students told us that being a part of the LA-STEM program had strengthened their interest in going to graduate school, shown them a wider world of career possibilities, and increased their confidence in their ability to do science and to be accepted to and succeed in a PhD program. A number of students also told us that LA-STEM was their first exposure to what pursuing a PhD actually entailed and what working as a professional scientist might be like.

In this sample of talented, highly-motivated students, a majority said that their research experiences, particularly, had served to clarify, confirm and strengthen their incoming interest in going to graduate or medical school. These findings confirm studies that show research experiences among populations of largely white, affluent students serve to confirm or clarify students' pre-existing plans to attend graduate school (Lopatto, 2004, 2007; Seymour, Hunter, Laursen & DeAntoni, 2004; Hunter, Laursen & Seymour, 2007). However, other recent research and evaluation studies have focused on establishing the

effects of research experiences on retention, persistence, and promotion of science career pathways for underrepresented groups. Results from these studies have shown increased rates of student retention to graduation, high rates of students going to graduate school, and high rates of students earning advanced degrees in STEM fields or other professional degrees, largely M.D.s (Adhikari, Givant & Nolan, 1997; Foertsch, Alexander, & Penberthy, 1997; Walters, 1997; Alexander, Foertsch & Daffinrud, 1998; Nagda, Gregerman, Jonides, von Hippel & Lerner, 1998; Maton, Hrabowski & Schmitt, 2000; Hathaway, Nagda & Gregerman, 2002; Barlow & Villarejo, 2004; National Research Council, 2005; Clewell, de Cohen, Deterding & Tsui, 2006).

The qualitative evaluation shows that, individually and collectively, students participating in research experiences through the auspices of the LA-STEM program take away a comprehensive array of gains documented by recent research and evaluation studies as contributing to students' enhanced educational experience and their personal, professional, intellectual and technical growth (Fitzsimmons, Carlson, Kerpelman & Stoner, 1990; Kremer & Bringle, 1990; Kardash, 2000; Rauckhorst, Czaja & Baxter Magolda, 2001; Ward, Bennett & Bauer, 2002; Zydney, Bennett, Shahid & Bauer, 2002a, 2002b; Bauer & Bennett, 2003; Lopatto, 2004, 2007; Hunter, Laursen & Seymour, 2007; Seymour, Hunter, Laursen & DeAntoni, 2004; Russell, 2005, 2006; Russell, Hancock & McCullough, 2007) and that also support objectives and recommendations by the 2002 Boyer Commission Report and funding agencies and organizations promoting college science education (NSF, 2000b, 2003; National Research Council, 1999, 2000, 2003a, 2003b).

A majority of students described positive research experiences in which they developed quality working relationships with their research advisor. In the process of doing research, students gained familiarity and facility with technical laboratory skills and instrumentation needed to carry out the research. These opportunities helped students to feel more confident in their ability to do research. In addition, as a result of engaging in authentic research, a majority of students developed a clearer understanding of the nature of research work—that it is slow, repetitive, and that setbacks and failure are par for the course.

Between one quarter and one half of students reported a majority of gains across the six benefits categories, including: understanding how research is done; the transfer of learning between research and classes and the increased relevancy of coursework; improved critical thinking and problem-solving skills; gaining an understanding of how scientists work professionally; gaining a more mature understanding of how scientific knowledge is built; improved presentation skills, understanding how to design and carry out research; and changes in behavior indicating their growth as young professionals.

Benefits mentioned less frequently by fewer numbers of students reflected particular differences in research experiences, such as whether or not a student worked in a group setting, working in a specific disciplinary field, or whether students had enough sustained engagement to achieve longer-term outcomes, such as learning to defend one's research, presenting at a professional conference, and being listed as a co-author on a publication.

Some students did report instances of poor quality research experiences—some at LSU, but mostly at host institutions. Common elements of poor research experiences included little or no guidance and mentoring from the research advisor, being assigned only menial tasks, being academically underprepared to understand or meaningfully contribute to the research, and finding one self better suited to other interests and work.

Faculty research advisors were knowledgeable of LA-STEM"s program objectives to retain students in the sciences and recruit them to STEM PhDs. Across the range of topics covered in our interviews with research advisors, we found that their observations matched those recorded in our large qualitative research study. Descriptions of how they selected students and research projects, how they worked with students, the types of student gains they observed, the costs and benefits of directing students in research work, examples of poor student research experiences, as well as of the rewards systems, were all in line with what other research advisors at other institutions have had to say.

Research advisors' observations on the benefits to students of research experiences referenced gains they had seen among students they had worked with generally, rather than for specific LA-STEM students. In almost equal measures, advisors described how research experience: enhanced students' preparation to undertake graduate-level work; gave them various skills; informed a more realistic understanding of the nature of research work and brought about changes in attitudes and behaviors necessary to research; provided various personal/professional gains, such as establishing collegial working relationships with their advisors and with other research group members; and gave students hands-on experience of what it was like to "think and work like a scientist." Only a few advisors commented on ways in which research experience served to clarify students' thinking about their career intentions. Research advisors' comments support the view that students' gains a broad range of benefits contributing to their personal, intellectual and professional growth.

A majority of advisors recalled times when directing students in research work was problematic. Most commonly, research advisors reported that working with students who lacked interest in and motivation to do research were "no fun to work with." A majority of advisors also reported instances where students were underprepared to take on the science of the research and advisors struggled to re-structure projects. Given the objectives of LA-STEM to have students participate in research early and often, it may be worthwhile to directly address issues of project selection and scaffolding students' learning in future Faculty Mentoring Workshops.

In describing the benefits of directing students in research a majority of advisors said that they benefited from students' help and that students' work contributed positively to their professional scholarship and career advancement. In addition, a majority of advisors reported intrinsic gains from directing students in research, such as enjoying interacting with students.

In talking about the costs of directing students in research, a majority of research advisors described their difficulties in terms of the time and effort it required: student

research is time-intensive. Almost all advisors agreed that working with students slowed them down, and several felt they could get their work done faster *without* students' help. Directing students in research required advisors' extra time and effort and added to the pressures of balancing other professional commitments.

In our evaluation studies of undergraduate research programs at research universities, advisors report the same intrinsic rewards as do those at the liberal arts colleges, but their discussion of costs is often dominated by publish-or-perish pressures for faculty and by the need for timely progress on research by graduate students and post-docs who serve as advisors. Young faculty especially are often eager to take on undergraduates, both to hand down their own positive research experiences, and to staff their new labs with low-cost, readily recruited, help, but they find it difficult to juggle their educational and research goals, and do not perceive that research work with students is rewarded within existing institutional rewards structures. Given the growing variety of successful undergraduate research programs that do exist, it is very evident that these challenges are not insurmountable, but neither are they issues to be taken lightly.

We found program staff knowledgeable and professional in all respects. While early LA-STEM cohorts had clearly been upset by turnover in program staff, a new team was in place and they were working to make sure program requirements were plainly understood by students and consistently enforced. They described LA-STEM as a program providing multiple elements of support with the objective of meeting students' needs at every level. From program staff members' points of view, all of LA-STEM's program elements were considered critical to achieving program objectives. However, program staff acknowledged that strong leadership from Dr. Warner—his passion and dedication—was a driving force behind LA-STEM.

In talking with program staff and administrators it was clear that LA-STEM program was seen as a central support to LSU's mission to fulfill the objectives set out in the Flagship Agenda. Administrators, particularly, were clear in expressing the many ways in which the LA-STEM program supported LSU's institutional goals. Importantly, with its objective to promote the success of students from underrepresented groups, the LA-STEM program was also seen as supporting LSU's mission to redress historic racial inequalities in higher education in the South by increasing the representation of diversity on its campus and encouraging a racial climate and providing the resources necessary to support students' success. Insofar as LA-STEM program objectives were well aligned with LSU's Flagship Agenda, positive program and student outcomes from LA-STEM were seen as directly benefitting LSU.

The majority of research advisors planned to continue their participation in the LA-STEM program. Though department and faculty buy-in of directing undergraduates in research was reported to vary considerably, the general view was that there were enough STEM faculty at LSU to support LA-STEM and other undergraduate research programs. Given that a number of faculty originally contacted for an interview had no recollection of mentoring a LA-STEM student, a publicity campaign at LSU to raise the profile of the

program and advertise the awards and accomplishments of LA-STEM students should be considered.

Overall, sustainability of the LA-STEM program was largely predicated upon the success of acquiring adequate and ongoing funding. Senior program staff were continuing to write grant proposals for further funding support, but acknowledged that ongoing funding from the NSF was unlikely in the longer-term. We raised the issues of institutional support and sustainability of the LA-STEM program with LSU administrators with whom we spoke. They expressed strong support for the LA-STEM program. They reiterated the ways in which LA-STEM's program objectives aligned with those of the institution and said that funding invested in the Flagship Agenda and other STEM initiatives on campus demonstrated institutional support of and an ongoing commitment to the success of the LA-STEM program. Administrators were encouraging that funding from the state and Board of Regents would be continuing. However, absent any source of secure future funding, the sustainability of the LA-STEM program remains an open question.

Program staff and administrators agreed that LA-STEM's program elements were readily reproducible elsewhere, given sensitivity to varying student needs and institutional contexts. However, they emphasized one factor as particularly critical to program success that was difficult to replicate: highly dedicated and distinguished leadership, such as that provided by Dr. Warner.

The collective commentary of students, faculty, program staff and administrators, indicates that the LA-STEM program has been effective in meeting its program objectives of recruiting diverse and talented students to LSU, retaining them in STEM majors, and in encouraging their entry to advanced degree programs. By students' and staff members' accounts, structured program elements worked effectively to integrate them academically and socially to campus life at LSU and played significant roles in promoting their academic success. LA-STEM's success in achieving program objectives validates theoretical research informing the ways programs are structured to promote student retention and persistence in STEM majors, particularly for underrepresented groups, and contributes to what we know about "what works."

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# XIX. Appendix A.

## Quantitative and qualitative data gathered for the external evaluation of the LA-STEM Research Scholars program.

| PARTICIPANTS | Assessment method | Type of Survey | # of Surveys | When administered | # of Ints. | When interviewed |
|---|---|---|---|---|---|---|
| Freshmen (graduating Spring 2011)<br>*Summer Bridge* students entering LA-STEM program 2007, including REU, Peer mentoring | Survey population and interview sample | SALG with open-ended comments | 23 | End of Summer/Fall 2007 | 18 | End of Summer/Fall 2007<br>Spring semester 2008 |
| Sophomores (graduating Spring 2010)<br>LA-STEM program, including Summer Bridge, REU, Peer mentoring | Survey population and interview sample | SALG-like plus URSSA | 9 | End of Summer/Fall 2007 | 13 | End of Summer/Fall 2007<br>Spring semester 2008 |
| Juniors (graduating Spring 2009)<br>LA-STEM program, including Summer Bridge, REU, Peer mentoring | Survey population and interview sample | SALG-like plus URSSA | 13 | End of Summer/Fall 2007 | 8 | End of Summer/Fall 2007<br>Spring semester 2008 |
| Seniors (graduating Spring 2008)<br>LA-STEM program, including Summer Bridge, REU, Peer mentoring | Survey population and interview sample | SALG-like plus URSSA | 16 | End of Summer/Fall 2007 | 15 | End of Summer/Fall 2007<br>Spring semester 2008 |
| Faculty mentors | Survey population and interview sample | SALG-like plus URSSA | 32 | End of Summer/Fall 2007 | 15 | End of Summer 2007<br>Fall semester 2008 |
| LA STEM program staff | Interview population | | | | 7 | Spring semester 2008 |
| LSU administrators (Department chairs, Dean of Sciences, others) | Interview sample | | | | 5 | Spring semester 2008 |
| Non-participating STEM students/comparative group | Interview sample | | | | 3 | Spring semester 2008 |
| | Observation | | | End of Summer/Fall 2007 | | |

| INTERVIEWS | Students | Faculty | Staff | Admin | Non | TOTALS |
|---|---|---|---|---|---|---|
| End of Summer/Fall 2007 | 27 | 6 | | | | **33** |
| Fall semester 2008 | 27 | 9 | 7 | 5 | 3 | **51** |
| **TOTALS** | **54** | **15** | **7** | **5** | **3** | **84** |

| SURVEYS | Students | Faculty | Staff | Admin | Non | TOTALS |
|---|---|---|---|---|---|---|
| Summer Bridge | 23 | | | | | **23** |
| SALG-like plus URSSA | 38 | | | | | **38** |
| Faculty survey: SALG-like plus URSSA | | 32 | | | | **32** |
| **TOTALS** | **61** | **32** | | | | **93** |

## XX. Appendix B

Protocols Used in Interviews for the LA-STEM External Evaluation

- LA-STEM Summer Bridge Program Student Interview Protocol

- Interview protocol for:
— LA-STEM OSI REU Participants
— LA-STEM Peer Mentors
— LA-STEM Research Scholars (Sophomores, Juniors and Seniors)
— Non-participants

- LA-STEM Faculty Research Mentor Interview Protocol

- LA-STEM Program Staff Interview Protocol

- LA-STEM Administrator Interview Protocol

LA-STEM Summer Bridge Program Student Interview Protocol

*Goals:*
*Probe students' experience of the LA-STEM Summer Bridge program and its effectiveness in meeting program objectives of:*

- *building a sense of community,*
- *preparing incoming students for research and leadership roles at LSU and beyond,*
- *helping students to develop existing skills into skills they can use for college success,*
- *providing an orientation to LSU and the demands of college coursework,*
- *clearly defining for students LA-STEM program objectives and expectations for student performance.*

Program elements to probe:

- Morning classes
- Afternoon participation in workshops or faculty research presentations and demonstrations
- Lectures on the value of research and the importance of the PhD degree in STEM fields
- Field trips to research sites (i.e., Pennington Biomedical Research Facility, Albemarle Process Development Center, Center for Advanced Microstructures and Devices, etc.)
- Social activities
- Mentoring – sources, extent, and nature of mentoring from the advisor; mentors' view of their job and how they do it
- Advising sessions
- Tutoring and study sessions
- Development of peer and mentor support networks and feeling part of a learning community
- Summer Bridge resources (program handbook)
- Other elements that may emerge as important in program experiences

We are most interested in how the LA-STEM Summer Bridge Program helps to support incoming freshmen and their transition to college. Try to establish connections between program elements or components and students' response to them and their effects on their views about college and longer-term career and educational outcomes. That is—what interpretations do students make of their experiences that lead them to the satisfaction and career indicators?

Most students are entering freshmen; some may be upper-classmen.

Interview:
Thank you for participating. The goal of the evaluation is to understand students' experiences with the LA-STEM Summer Bridge program and how we can help LA-STEM to improve its Summer Bridge Program.

*Remind about anonymity and confidentiality. Check on consent form.*
*Microphone ON.*

Why did you choose to come to college at LSU?

How did you find out about the LA-STEM Research Scholars program? Was this program an important influence on your decision to attend LSU? Was the stipend particularly important to you? Why? What other factors contributed to your decision-making?

When did you first become interested in science? Did you take a lot of science and math in high school? Do you feel that your high school did a good job of preparing you for college-level work?

Have you identified a major yet? If so, when did you become interested in this field? Do you know what you want to do for a career? (check for intentions to go to graduate school) What's influenced your thinking about what you want to do professionally for a career? (Interest, parents, teachers, friends?) Did you think about getting a Ph.D. before you came to college?

Give me an overview of the LA-STEM Summer Bridge Program. Is there a typical schedule you follow for the day? Does the day go pretty quickly?

How are the classes? Is it useful to get this kind of early introduction to coursework? Are your classes about what you expected? (Better, worse, harder, easier?) Was the experience helpful? Any suggestions for other students or the program?

Tell me what skills they're helping you work on in Summer Bridge?

*Listen for/check skills:*

- *Time management, study strategies*
- *Long-term planning*
- *Working with others*
- *Giving presentations*
- *Communicating with faculty in a professional manner*

Tell me about the afternoon sessions?
What did you find useful about the afternoon sessions?

*Listen for/check program elements:*
Lectures on the value of research and importance of the PhD degree in STEM fields

- Field trips to research sites (i.e., Pennington Biomedical Research Facility, Albemarle Process Development Center, Center for Advanced Microstructures and Devices, etc.)
- Mentoring – sources, extent, and nature of mentoring from the advisor; mentors' view of their job and how they do it
- Advising sessions
- Tutoring and study sessions
- Development of peer and mentor support networks and feeling part of a learning community
- Summer Bridge resources (program handbook)

Tell me how peer mentoring works in the Summer Bridge Program? Is peer mentoring an important aspect of LA-STEM, do you think? Why? Why not?

What other sources of support and help have you found in the Summer Bridge Program?

Did LA-STEM organize group activities for socializing for you? What kinds of social activities did you engage in as part of the Summer Bridge Program? Were these fun? Helpful? In what way?

Now that you've gone through the Summer Bridge Program, do you feel like there's a sense of community among LA-STEM students? Have you made friends? What makes it feel like a community?

Do you think that, because of the Summer Bridge Program, you now have a better understanding of what going to college means in terms of the demands of college coursework? Has it helped orient you to the university, LSU?

Do you feel the Summer Bridge program has prepared you for your first semester of college? How so?

Do you feel that you have a clear understanding of the LA-STEM program and what it expects of students?

What have you gotten out of doing this, personally, in terms of your own education, interests, and plans?

What advice would you give LA-STEM about the Summer Bridge Program? What would you change? Have we missed anything about the Summer Bridge Program you think is important?

Finally/just to get your big picture view, would each of you summarize, in just a few words, what you think is important about the Summer Bridge Program?

*Thanks for your participation!*

Interview protocol for:

LA-STEM OSI REU Participants

LA-STEM Peer Mentors

LA-STEM Research Scholars (Sophomores, Juniors and Seniors)

Non-participants

*Goals:* *This study is an independent external evaluation of the Louisiana Science, Technology, Engineering and Mathematics (LA-STEM) Research Scholars Program, an initiative designed to improve the retention and pursuit of university degrees for undergraduates majoring in STEM disciplines. Participants in the LA-STEM program are in a unique position to describe their perceptions, experiences and to provide feedback on the program in order to help determine the extent to which LA-STEM is meeting its program objectives.*

Establish:

Year in school
Discipline

To begin:

Why did you choose to come to LSU? What influenced your decision to attend LSU?
Have you/when did you declare a major? What has influenced your decision to pursue a science major?
When did you become interested in science (elementary, junior, high school?) Are you interested in going on to graduate school? Did you think about going to graduate school before coming to college?
Did you take a lot of science and math in high school? Do you think your high school science and math classes prepared you for college coursework?

Motivation:

How did you find out about the LA-STEM program?
What has motivated you to participate in the LA-STEM Program?

Did the opportunity to do research as an undergraduate offered by the LA-STEM program influence your decision to attend LSU? (Career-linked? Educational reasons? Work skills?)

How important is a stipend? How much do get? Adequate for needs?

Were you worried about whether you would get into the LA-STEM program? Was it competitive to get into?

LA-STEM Program

Summer Bridge:
When you started, did the LA-STEM Summer Bridge Program ease your transition to college? Academically? Socially? Help you feel part of a community? Has a sense of community carried over into the school year? How is it different?

From your experience, has the LA-STEM program provided the right kinds of support to help you do well? (Advising, program staff monitoring, tutoring, other resources). Have support services been helpful if needed? Any difficulties? Anything missing?

Listen/check for: quality of peer mentors, quality of project counselors, quality of faculty advisors, quality of LA-STEM program staff

Check on other Summer Bridge elements: quality of/interest in faculty research presentations, field trips, social activities.

Would you say you have had good mentoring? How many mentors do you have (peers, faculty, research advisor, others?) Which mentors are the most valuable to you?

Do you think you're receiving the training and support that you need to do well in your coursework? What in particular has been a help?

Peer Mentoring
Tell me about peer mentoring in LA-STEM. First, were peer mentors valuable to you in the Summer Bridge program? Later on?
When did you start serving as a peer mentor? Were you glad to be a peer mentor, or was this something you would rather not do?
Did you gain anything from being a peer mentor (helping others, gains in confidence, etc)? Were there costs to being a peer mentor (time demands, interruptions, etc)?
Any advice you'd give to other peer mentors? To LA-STEM program staff about peer mentors/mentoring?

Research Experiences
Is doing research as an undergraduate an important part of LA-STEM? How many opportunities have you had (summer, academic year)? How have your experiences been? How have they contributed to your education?

Participation:
How are you made aware of the research opportunities open to you?

How does the selection process work? How strong is the competition for places?

Matching:
How are you paired with a summer research faculty advisor? How were you matched to particular research projects, groups?

- By own initiation? Asked by faculty? Mutual selection process (chose project, then interviewed with several faculty to find good fit)?
- Chose/design own project? Assigned project? List of suggested projects?

How important is getting a good match to the quality of the experience, your satisfaction, success of the research project?

Student gains from UR: What have you gained from your research experience? What have you learned that you would not have learned without research experience? (Check gains checklist, back of protocol).

*Listen/check for:*

- "thinking and working like a scientist—*application:* how science research is done, critical thinking, problem solving, transfer of coursework to research and vice versa; *knowledge gains:* gains in greater depth of knowledge, greater connections between/within the sciences;
- personal-professional gains—gains in confidence to do science, contribute to science, developing a collegial working relationship with faculty members (post docs, graduate students, lab technicians), peers, other scientists;
- "becoming a scientist"—changes in attitudes, behaviors—increased patience, perseverance, initiative to work independently, try things out on one's own, greater understanding of professional norms and practices;
- clarification/confirmation of intended career/graduate school plans
- enhanced preparation for workforce/graduate school entry
- skills: *communication:* presenting research, defending oral argument, technical writing; techniques, computer use, increased reading comprehension of journal articles, better time management, ability to find information.

The UR experience:

We're interested in how the daily work in your research group or laboratory took place. First, tell me about who you worked with. Who would you say was the person you interacted with most on an everyday basis?

(If not the faculty member) – what was that person's position in the lab? (Grad student? Postdoc? Technician or senior scientist of some kind?)

What kinds of interactions did you have with your everyday advisor (person named above)?

Probe for: setting rules and expectations, learning techniques, discussing data, planning next steps, etc. (authenticity of experience)

What kind of help or advice did you feel you needed in conducting your research?

Did you feel comfortable asking your advisor for help or advice whenever you needed it?

Who else did you ask for help or advice?

*(If prior discussion is about someone besides faculty member)*: We also want to know how the faculty fit into this picture. How often did you interact with the faculty member in charge of the lab?

For how long?
Did you schedule meetings or meet up informally?
What kinds of interactions or discussion did you have with the faculty member? (what did you do when you met with him or her?) (Probe for: setting rules and expectations, learning techniques, discussing data or next steps, write-up/poster at end)

Did you get any help or advice on your research from anyone outside the lab? (other students, other faculty, LA-STEM faculty advisor, family, etc. )
Were there other undergraduates in the lab? Did you interact with them?
Overall, do you think you got the right amount of help or advice that you needed?
If not, what else would have been helpful to you?
(For experienced students: probe for differences in what I need now vs. what I needed when I started)

*Nature of scientific task:*
Another thing we want to know about is what kind of work you were actually doing. Tell me a bit about your work—how much time did you spend in the lab each week? How often and for how long?

Did you have a particular place to work – a desk or a lab bench? Was it your own or did you share?

What kinds of things did you do when you were at the lab? *(This could get long and boring so try to probe for: doing experiments or making measurements, reading, graphing or analyzing data, making sense of data, talking to others, etc.- mix of tasks and level of them).*

*Probe for specific tasks that would be typical of authentic science: Did you (do X)? Did someone show you how to (do X)? Probe for help and support on doing these, also for did they have some independence on doing them.)*

- Keep a lab notebook with the information needed for this particular type of research?
- Conduct particular procedures or run experiments?
- Organize and analyze your own data? (e.g. make graphs or other displays)
- Read research articles from journals? (did you get any advice on how to make sense of them?)
- Search the literature for research articles related to your work?
- Design your own experiment or measurement?
- Present a talk or a poster, write a final report?

Overall, how would you rate your own understanding of what you were doing and why it was important? Why do you think so?

Overall, how would you rate your progress on your research project? Why do you think that?

Other components

Tell me a bit more about the other aspects of the LA-STEM Program. What do you think has been the best thing about the LA-STEM Program? What aspects of the LA-STEM Program did you find useful?

> Probe some specifics: mentoring, academic support, engagement in research, etc. Are there other ways in which the LA-STEM Program could provide support that would be useful to you? What's missing?

Was it helpful to you to meet other LA-STEM students who were doing research? What kinds of interactions did you have with them?

Tell me about your interactions with LA-STEM Program staff. Are they helpful?

> Probe for interactions: during application; during seminar; anything outside these formal processes.

Any other aspects of the program organization that you found helpful or that could be improved (application process, money issues, poster session, etc.)?

Sources of student satisfaction:

What has contributed to your level of satisfaction (or dis-satisfaction) with LA-STEM?

What has contributed to your level of satisfaction (or dis-satisfaction) with your research experience?

> Listen for: amount/quality of contact with faculty advisor
>
> Match of UR project with student interest

Non-participation:

Do know any students who applied and were not accepted?

Do students who do not participate in UR lose out in some ways?

> (short/long-term, career choices/chances/skills)

What have you learned that you would not have learned without LA-STEM? Would you expand on that? What learning has been most important to you? Why?

Targeted groups:

Are there particular advantages for a woman (or student of color) in getting research experience as an undergraduate?

Would you recommend other women/students of color to summer research? Why?

Has the experience been different in any way than it would have been if you were a white male student? (Check for any positive or negative experiences.)

Summary

Overall, how would you sum up your experience of LA-STEM so far?
What have you found hardest or most challenging about research?
What have you found most rewarding?

What's been best about participating in LA-STEM? Why?

What hasn't worked so well for you? Why?

What do you think has contributed to your level of satisfaction (or dissatisfaction) with your research experience?

Are there any ways in which this research experience has NOT met the expectations you had when you began?

Do you think you'll do research again? (probe: Did your research experience have any effect on your feelings about continuing in research?)

Do you think you'll continue in science? (probe: Did your research experience have any effect on your feelings about continuing in science?)

Probe for differences in future plan, e.g. Yes more science but not this field; yes more science and this field: yes more research in or out of this field.

Sum some of this up and check it, e.g. 'So I understand you to say you are interested in going to med school and still planning to do that, but you are more interested in medical research than you were before.' This will help us check the complicated info we get from surveys and multiple sets of plans.

Confirm or check level of certainty, e.g. "So it sounds to me like you have several ideas right now and aren't sure which one you'll pursue, but you're hoping that more research experience will help you sort that out."

One of LA-STEM's objectives is to help you to be successful in pursuing a science (engineering, math) major and to encourage and prepare you for graduate school. Do you think LA-STEM helped you persist in your major? Has participation in LA-STEM strengthened your intention to go to graduate school? How so? Has LA-STEM helped to prepare you for graduate school? How so?

What will take away with you from your experience in LA-STEM?

Advice:

If you could give advice to the LA-STEM program, what would you tell them?
If you could give advice to faculty research mentors in the LA-STEM program, what would you tell them?

If you could give advice to other students who are considering the LA-STEM program, what would that be?
Do you have any advice for LA-STEM Program staff?
Any other advice?

Other issues? Other comments? What have I missed? Anything that you think is important and want to add?

*Thanks for your participation!*

Gains checklist (to be used as a reference in interviews):

Tell me about some of the changes can you see in your (or in the students') understanding, skills, confidence, or attitudes, etc.
(students) since your first undergraduate research experience?
(Ask first without probing; then ask for gains by category.)

Development of collegial relationships with faculty/peers/others:
Sense of "community" of researchers?
Possible effects:

- Sustained or increased interest in the discipline/career
- Bonding with faculty (and, thereby, the discipline/career path)
- Increased persistence in major/career direction

Increased understanding of research/science:

- What research is
- The research process,
- How scientists think: "habits of mind"
- How scientists work on real problems
- What science is: authentic experience/real science
- How scientific knowledge is built

Intellectual gains:

- Knowledge (subject/cross disciplinary)
- More complete/concrete understanding of field
- Critical thinking/problem-solving
- Approaches to research problems
- Hands-on/experiential learning (Makes coursework more meaningful/relevant)
- Opportunity to apply theory in practice

Increased skills:

- Research and lab techniques
- Conducting literature reviews
- Working collaboratively
- Communication (writing, presentation, argument)

Changes in approach to learning:

- Shift from passive to active learners
- Greater personal responsibility
- Learning to work independently
- Other

Personal/Professional Gains:

- Increased self-confidence in ability to do research
- Self-esteem

Benefits of establishing a mentoring relationship
Working collaboratively (peers/faculty)
Prestige of having done research as an undergraduate

Career Direction:

Clarification, confirmation, choice of a career path (inc. graduate school)
New knowledge about possible career options
Engagement of students of color (in the sciences)

Enhanced career preparation:

Greater readiness for more demanding research/careers in the sciences
Professional socialization: understanding how the profession works/professional conduct/how you enter it.
Opportunities for networking
Strengthen qualifications/chances of entry to graduate/professional school of choice, job options.
Real work experience
Networking opportunities
Eases transition to graduate/professional school or work

# LA-STEM Faculty Research Advisor Interview Protocol

*Goals:* *This study is an independent external evaluation of the Louisiana Science, Technology, Engineering and Mathematics (LA-STEM) Research Scholars Program, an initiative designed to improve the retention and pursuit of university degrees for undergraduates majoring in science, technology, engineering and mathematics disciplines. The goals of this evaluation are to determine the extent to which the program is meeting its objectives.*

Establish:

- discipline,
- years in department/as a faculty member,
- tenure (and/promoted) status.

How long have you been engaged in the LA-STEM program?
How many other faculty members in your department work with LA-STEM students?

How many LA-STEM students did you have this summer? Working alone, and/or in small groups? How many LA-STEM students over time?

How many LA-STEM students do you work with during the academic year? Working alone, and/or in small groups?

LA-STEM Program objectives:

Tell me what you understand to be the objectives of the LA-STEM Research Scholars program.

Do you feel that LSU and LA-STEM are meeting their objective of recruiting the right students?

Do you feel that the LA-STEM Summer Bridge Program is successful in helping to integrate freshmen into the academic and social life of LSU and preparing them for a successful college experience?

Do you believe that LA-STEM Research Scholars are receiving the mentoring that they need to succeed academically? Would you please explain why you think that?

- Quality of peer mentors?
- Quality of project counselors?
- Quality of LA-STEM program staff?

Do you believe that LA-STEM students are receiving the training and support for coursework, access to support services, and preparation for graduate school? Would you please explain why you think that?

Do you believe that LA-STEM student scholars have access and opportunity to engage in authentic undergraduate research experiences? Would you please explain why you think that? Are enough faculty (across all STEM disciplines) involved?

Matching:

How do particular students become matched with you?

How do students come to be working on particular projects? (You select? They propose/select from options/negotiate)

Student gains from LA-STEM:

What do you most want students to gain from the LA-STEM program?

What do you see students gaining as a result of the LA-STEM program?

What are the longer-term consequences you predict for LA-STEM students (career or personal)?

What is "lost" (if anything) by students who do not participate in LA-STEM, and with what consequences—including their career choices and performance?

Targeted groups:

Do you feel a personal commitment or is it a personal objective, to serve as a mentor particularly for women or for students of color?

Are there particular advantages for a woman (or students of color, or other less-represented groups in the sciences) in getting research experience as an undergraduate?

The UR project:

The project: What are you looking for in a "good project" for LA-STEM student research scholars? Are there some essential elements that make an undergraduate research experience "good" or "authentic"?

Listen for: Experiences that can change in students' views of what science is/student discoveries about the nature of science, dealing with the nature of research (frustration, slow progress, changes of direction in research questions and design in light of data).

How do you get your students to work at an appropriate theoretical level and level of complexity in lab work? Is this a problem area? How resolved?

Essential features of research (across disciplines):

Are there patterns in a typical project? What type of project works best for students? Freshmen vs. seniors, etc.

Are some of these elements common across different fields? Are there things that you want students to learn that are particular to your discipline?

Structuring the experience (teaching research science):
How do you structure/set up the research experience so that students can learn the things that you think are important?
What helps students to understand how science is done/how knowledge in the discipline is constructed?
What are the most difficult aspects of learning the research process for students? Causes?
Are some/all of these things that you can teach?

Opportunities for students to present their own work? How done? Value?
Learning to argue a case/field questions?

Collaborative work:
Do the students work collaboratively with you (with other students, anyone else)?
What's the importance of these experiences?

"Success":
What do you like to see in a student and their work that tells you that their LA-STEM experience has been successful? What changes in students do you see as a result of UR experience?

How do you evaluate their work/progress? How do you convey this to your student(s)?

How "successful" (in these terms) are most of your students?

Student gains from UR experience:

What do students gain from research experience? What do they learn that they would not have learned without research experience? (Check gains checklist, back of protocol).

*Listen/check for:*

- "thinking and working like a scientist—*application:* how science research is done, critical thinking, problem solving, transfer of coursework to research and vice versa; *knowledge gains:* gains in greater depth of knowledge, greater connections between/within the sciences;
- personal-professional gains—gains in confidence to do science, contribute to science, developing a collegial working relationship with faculty members (post docs, graduate students, lab technicians), peers, other scientists;
- "becoming a scientist"—changes in attitudes, behaviors—increased patience, perseverance, initiative to work independently, try things out on one's own, greater understanding of professional norms and practices;
- clarification/confirmation of intended career/graduate school plans
- enhanced preparation for workforce/graduate school entry

- skills: *communication:* presenting research, defending oral argument, technical writing; techniques, computer use, increased reading comprehension of journal articles, better time management, ability to find information.

Which, if any, of these gains, carry over into coursework? Carry over into life, generally?

Mentoring:
Tell me something about your role as a research advisor/mentor?
What does it mean (in practical terms) to be a good research mentor?
How much time does it take? How often do you and your student(s) meet?

Do you have ongoing research (academic or personal) relationships with your research apprentices after the summer program is over?

What proportion of them work with you on research projects more than once?
(When do these relationships typically start?)

Do you help your research students in their academic program or career development in particular ways? (encourage/assist with graduate or professional school entry/contacts)
Do they ask your advice about career options?

Faculty gains:
How important to your professional career is your research engagement with undergraduates?

Tell me something about the professional or personal gains that that you have discovered in working with undergraduate researcher and that encourage you continue doing this.

*Don't prompt, but listen for:*

Helps to stay current in the field
Intellectual growth/stimulation
Increases energy/enthusiasm
Sustains my research agenda
Undergraduates make good research assistants
Students offer new perspectives, innovative approaches, create new knowledge
Great projects/great students—success stories, level of scholarship,
Publications/presentations? (Summer students or those who continue to work on a project with their advisor/mentor during the academic year?)
Their achievements reflect back upon me—prestige/reputation (colleagues and students)
Departmental rewards
Increased pride/confidence
Creates networking opportunities (discipline, graduate schools, industry)
Improved interaction with students
Development as a teacher/researcher
Improves my teaching

Faculty costs/losses:
Are there any losses to you in offering UR experiences to students?

*Listen for:*

Time issues: takes away from own research work/mentoring takes a lot of time/time for preparation, grading work/heavy teaching load also (No grad students to take up the slack)
Risk: UR teaching not valued by department
Costs: funded work requires valid/timely results reporting/cost of maintaining equipment, support staff/
Students: lack HS prep/motivation or maturity/lack enough time or difficulties in prioritizing or assessing time commitment needed/fear of failure, confidence lacking.

Departmental/Institutional gains:
What are the benefits to departments or to the institution overall from engagement in the LA-STEM program? What drives/sustains it?
(Listen for changes in climate, building of "learning communities?")

Departmental/Institutional support:
Is your work with LA-STEM student researchers recognized/rewarded by your department/institution? How?
Are there any pressures to participate? (Check for untenured faculty)
Are there any (other) obstacles to getting faculty to participate?

The future:
Will you be participating as a research mentor next summer (and/or during the academic year)?
What recommendations do you have for improving the LA-STEM program?

Advice:
If you could give advice to the LA-STEM program, what would you tell them?
If you could give advice to faculty members participating in the LA-STEM program, what would you tell them?
If you could give advice to students who are considering the LA-STEM program, what would that be?
Do you have any advice for LA-STEM program staff about this program?

What structural elements of the program do you think are central to its success, and to what degree are these sustainable?

Which, and to what extent, are the structural program elements that you see as central to program success transferable or adaptable by programs with similar objectives?

Other comments/suggestions?

*Thank you for your willingness to be interviewed!*

Gains checklist (to be used as a reference in interviews):

Tell me about some of the changes can you see in your (or in the students') understanding, skills, confidence, or attitudes, etc.
(students) since your first undergraduate research experience?
(Ask first without probing; then ask for gains by category.)

Development of collegial relationships with faculty/peers/others:
Sense of "community" of researchers?
Possible effects:

- Sustained or increased interest in the discipline/career
- Bonding with faculty (and, thereby, the discipline/career path)
- Increased persistence in major/career direction

Increased understanding of research/science:

- What research is
- The research process,
- How scientists think: "habits of mind"
- How scientists work on real problems
- What science is: authentic experience/real science
- How scientific knowledge is built

Intellectual gains:

- Knowledge (subject/cross disciplinary)
- More complete/concrete understanding of field
- Critical thinking/problem-solving
- Approaches to research problems
- Hands-on/experiential learning (Makes coursework more meaningful/relevant)
- Opportunity to apply theory in practice

Increased skills:

- Research and lab techniques
- Conducting literature reviews
- Working collaboratively
- Communication (writing, presentation, argument)

Changes in approach to learning:

- Shift from passive to active learners
- Greater personal responsibility
- Learning to work independently
- Other

Personal/Professional Gains:

Increased self-confidence in ability to do research
Self-esteem
Benefits of establishing a mentoring relationship

Working collaboratively (peers/faculty)

Prestige of having done research as an undergraduate

Career Direction:

Clarification, confirmation, choice of a career path (inc. graduate school)
New knowledge about possible career options
Engagement of students of color (in the sciences)

Enhanced career preparation:

Greater readiness for more demanding research/careers in the sciences
Professional socialization: understanding how the profession works/professional conduct/how you enter it.
Opportunities for networking
Strengthen qualifications/chances of entry to graduate/professional school of choice, job options.
Real work experience
Networking opportunities
Eases transition to graduate/professional school or work

LA-STEM Program Staff Interview Protocol

*Goals:* *This study is an independent external evaluation of the Louisiana Science, Technology, Engineering and Mathematics (LA-STEM) Research Scholars Program, an initiative designed to improve the retention and pursuit of university degrees for undergraduates majoring in science, technology, engineering and mathematics disciplines. The goals of this evaluation are to determine the extent to which the program is meeting its objectives and also include identification of:*

- *how funding may be best directed to leverage program effectiveness*
- *what structural elements of the program are central to its success, and to what degree are these sustainable?*
- *which, and to what extent, are the structural program elements that are central to program success transferable or adaptable by programs with similar objectives?*

Establish:

- staff role in LA-STEM
- time with LA-STEM

Describe your role here with the LA-STEM program. What do you do? What are your responsibilities? How long have you been engaged in the LA-STEM program?

LA-STEM Program objectives:

Do you feel that LSU and LA-STEM are meeting their objective of recruiting "the best and the brightest," especially in terms of recruiting underrepresented populations?

Do you feel that LSU and LA-STEM are meeting their objective of identifying applicants that have the academic, social, and motivational dispositions needed to achieve program goals?

Do you feel that the LA-STEM Summer Bridge Program is achieving the goal of successfully integrating freshmen into the academic and social life of LSU and preparing them for a successful college experience?

Do you believe that LA-STEM student research scholars are receiving the mentoring that they need to succeed academically? Would you please explain why you think that?

- Quality of peer mentors?
- Quality of project counselors?
- Quality of faculty advisors?
- Quality of LA-STEM program staff?

Do you believe that LA-STEM student scholars are receiving the mentoring they need to become effective leaders? Would you please explain why you think that?

Do you believe that LA-STEM student scholars are receiving the training and support for coursework, access to support services, and preparation for graduate school? Would you please explain why you think that?

Do you believe that LA-STEM student scholars have access and opportunity to engage in authentic undergraduate research experiences? Would you please explain why you think that?

Matching:

How do match particular students with faculty research advisors? How do students come to be working on particular projects?

Student gains from LA-STEM:

What do you most want students to gain from the LA-STEM program?

What do you see students gaining as a result of the LA-STEM program?

What are the longer-term consequences you predict for LA-STEM students (career or personal)?

What is "lost" (if anything) by students who do not participate in LA-STEM, and with what consequences—including their career choices and performance?

Targeted groups:

Are there particular advantages for a woman (or students of color, or other less-represented groups in the sciences) in getting research experience as an undergraduate?

"Success":

What do you like to see in a student that tells you that their LA-STEM experience has been successful?

How do you evaluate their work/progress? How do you convey this to your student(s)?

How "successful" (in these terms) are most of your students?

The LA-STEM Structure:

How do you structure LA-STEM to encourage student success? Why? What elements are important?

Probe: financial support, Summer Bridge, academic enrichment, staff support, research experience, program values ("culture of achievement/success", high expectations, peer group support, etc.

What helps students the most, in your opinion?
What are the most difficult aspects for students of being in LA-STEM?

Mentoring:
Tell me something about your role as mentor?
How much time does it take? How often do you and your student(s) meet?

Do you help your students in their academic program or career development in particular ways? (encourage/assist with graduate or professional school entry/contacts)
Do they ask your advice about career options?

Gains:
Tell me something about the professional or personal gains that that you have discovered in working with students in LA-STEM.

Costs/losses:
Are there any costs to you in terms of time? Other personal costs?

Departmental/Institutional Gains:

What are the benefits to departments or to the institution overall from engagement in the LA-STEM program? What drives/sustains it?
(Listen for changes in climate, building of "learning communities?")

The future:
Will you be participating as a research mentor next summer (and/or during the academic year)?
What recommendations do you have for improving the LA-STEM program?

Advice:
If you could give advice to the LA-STEM Program, what would you tell them?

Do you have any advice about how to improve the LA-STEM program?

How do you think funding should be best directed to leverage program effectiveness?

What structural elements of the program do you think are central to its success, and to what degree are these sustainable?

Which, and to what extent, are the structural program elements that you see as central to program success transferable or adaptable by programs with similar objectives?
Other comments/suggestions?

Thanks for your willingness to be interviewed!

# LSU Administrator Interview Protocol

*Goals:* *This study is an independent external evaluation of the Louisiana Science, Technology, Engineering and Mathematics (LA-STEM) Research Scholars Program, an initiative designed to improve the retention and pursuit of university degrees for undergraduates majoring in science, technology, engineering and mathematics disciplines. The goals of this evaluation are to determine the extent to which the program is meeting its objectives. We are hoping to interview a small number of LSU administrators who are in a good position to comment upon the LA-STEM Research Scholars program and its importance to the Office of Strategic Initiatives, to LSU's Flagship Agenda, and to LSU, overall.*

Establish:

- administrative position
- general description/overview of job responsibilities
- years working in academe (various positions over time?)

What is your familiarity with/knowledge of the LA-STEM program?

Does it/how does this initiative fit in with LSU's flagship agenda?

Can you provide any insight on contributions the LA-STEM program is making to LSU and LSU's stated mission?

Can you provide any insight into LA-STEM's value to the Office of Strategic Initiatives, to LSU's Flagship Agenda, and to LSU, overall?

LA-STEM Program objectives:

Tell me what you understand to be the objectives of the LA-STEM Research Scholars program.

Do you feel that LSU and LA-STEM are meeting their objective of recruiting the right students?

Do you feel that the LA-STEM Summer Bridge Program is successful in helping to integrate freshmen into the academic and social life of LSU and preparing them for a successful college experience?

Do you believe that LA-STEM Research Scholars are receiving the mentoring that they need to succeed academically? Would you please explain why you think that? What knowledge/evidence do you have of:

- Quality of peer mentors?
- Quality of project counselors?

- Quality of LA-STEM program staff?

Do you believe that LA-STEM students are receiving the training and support for coursework, access to support services, and preparation for graduate school? Why you think that?
Do you believe that LA-STEM student scholars have access and opportunity to engage in authentic undergraduate research experiences? Why? Are enough faculty (across all STEM disciplines) involved, do you know?
In your view, what role does LA-STEM play in achieving LSU's longer-term objectives? How important, do you think, is it to support students' involvement in research? Is this important also to LSU's mission?

Student gains from LA-STEM:
What do you most want students to gain from the LA-STEM program?

What have you seen regarding students' gains from participating in the LA-STEM program?
What are the longer-term consequences you predict for LA-STEM students (career or personal)?
What is "lost" (if anything) by students who do not participate in LA-STEM, and with what consequences—including their career choices and performance?

Targeted groups:
Are there particular advantages for a woman (or students of color, or other less-represented groups in the sciences) in getting research experience as an undergraduate?

Do you feel a personal commitment or is it a personal objective, to support women or students of color?

Departmental/Institutional gains:
What are the benefits to departments or to the institution overall from engagement in the LA-STEM program? What drives/sustains it?
(Listen for changes in climate, building of "learning communities?")
Departmental/Institutional support:

Is work with LA-STEM student researchers recognized/rewarded by departments/institutions? How?

The future:
What do you see as the future of LA-STEM? What support is there here at the university, and with the state legislature for the continued funding contributions toward LA-STEM?
What structural elements of the program do you think are central to its success, and to what degree are these sustainable?
Which, and to what extent, are the structural program elements that you see as central to program success transferable or adaptable by programs with similar objectives?
Other comments/suggestions?

Thank you for your willingness to be interviewed!

# XXI. Appendix C

Participant Observation of a Peer Mentoring and Peer Group Study Session
9 Lockett Hall
3:00pm-4:30pm, September 27, 2007

*External Evaluator Anne-Barrie Hunter conducted a participant observation of a peer mentoring and peer group study session, a class that is required of all LA-STEM students scheduled twice weekly on Tuesday and Thursday afternoons.*

The class was held in the basement of Lockett Hall in a small-sized, slightly-sloped auditorium with white-washed cement-block walls, overhead fluorescent lighting and three banks (right, center and left) of green-padded, auditorium seating arranged in locked rows, rising towards the back of the room. At the front of the room, two lecterns were set on stage, raised about a step, with two large green chalkboards spanning the wall behind.

I arrived at 3:10 and students were already clustered in small groups of four or five and were actively engaged in talking among themselves. There were approximately 75 students. "Mr. Anthony" (as they call Mr. Picado) and Ms. Sibley were standing at the stage, each talking with one or two students. I edged into a seat in the left back corner of the auditorium.

The conversations among students were quite lively, and the noise level in the room was a low, rumbling din. The row seating appeared awkward for students, making it difficult to interact as a group: many students were twisted around in their seat to address a group member the row behind them, sitting in a seat and straining forward to hear a student three or four chairs over, or standing in the row and leaning against the back of a seat in order to talk to other members in their group in front of them.

I listened to the conversations going on in groups around me, though often it was difficult to catch people's words, given all of the conversations going on in the room. In one group, I heard a woman ask about graduating early. Another woman told her "You'll have to plan your coursework very carefully if you don't want to end up here for five years." The first woman said that she was spending a large number of hours in the lab. She described accidentally spilling something on the floor and how, as a result, the whole room had to be cleaned: "That was a drag!" The second student reassured her that it was typical to make mistakes like that when first starting research, and then moved the conversation on saying, it was a good strategy to plan on working in the lab "three or four hours at time," to take a "good chunk of time," and that it was "typical to have to work a lot of hours, but graduate students always work late." She recommended, "Really plan ahead, plan your time! Then you'll be able to get a year ahead." She informed the woman she was talking to that she was glad to talk anytime, and that she'd be over in the Student Union if she wanted to talk later.

In other groups, I could see students giving each other "high fives," one group of students was laughing, and students in other groups were huddled around a laptop computer looking at and talking about something on the screen.
I turned my attention to another group of students sitting near to me and heard this conversation: "Reps don't energize me at all!" one student said. The other responded, "If you work late, go out and exercise and you'll get extra energy to finish studying." "Yeah, you're right, I know what you mean."

Mr. Anthony waved some papers in his hand and asked the students whether everyone had signed the attendance sheet. A few hands went up, and he gave the sheets to one of the students to sign and hand on to the others. He and Ms. Sibley spoke with each other for a few minutes and at about 3:30pm Ms. Sibley left.

Students continued talking in their groups. I noticed one student, a man, sitting alone working on his laptop.

Mr. Anthony asked for the students' attention and reminded the peer mentors to hand in their reports. He then asked the class some questions. "How do you find out about research?" Students jumped in: "Faculty here really encourage students to do research. Don't be afraid. Go talk with them. Find out what they're doing." "Spend time in a lab, find out if you like it."

"And if you find you're washing dishes, what do you do?" Mr. Anthony prompted. "Ask to do more. Take the initiative. Tell 'em you're not doing enough." "And if you don't like the research you're doing?" Mr. Anthony followed up. "Go tell the prof. Tell him you're not enjoying it. Faculty are receptive. They'll help you find a good place." "And what if your work schedules are getting too demanding?" Mr. Anthony inquired. "Grades come first!!!!" a chorus of students responded. "What about etiquette in the lab?" Mr. Anthony continued. Again, students jumped in: "Obey safety concerns! Pay attention when they say, 'Don't eat in the labs.'" "Always ask first if you have questions about the equipment." "Ask if you don't know where something is. Don't forage for it." "Ask if you don't understand." "Read the manuals!" "Graduate students are real approachable. They were a lot like you at one point. Don't be intimidated." "Graduate students are pretty much the same as us, they just get to do research more and have more experience." Then Mr. Anthony asked, "How about getting time in at the lab?" "Six to eight hours a week. But check in with faculty." "Your grades have to come first. Just make sure your work is at a good stopping place. Plan ahead. Talk to faculty. They're real approachable."

The question session ended at 3:45pm and Mr. Anthony dismissed the upper-classmen. There was a general bustle of movement and rush of conversation in the auditorium as students gathered their notebooks, backpacks, umbrellas, etc., put on jackets, said good-byes to their friends, navigated their way out of the row of seats and left. Approximately 25 students remained.
Mr. Anthony directed the students to work on their group assignment, an exercise in which the group is to prepare an action plan to address the problems of a fictitious student. Each group is given a different profile of a pretend student with various learning

problems or difficulties and the group works collaboratively to develop a learning plan and suggest strategies the student may use to ameliorate their situation.

The remaining students formed into five groups: one group of women (mixed race/ethnicity); one group of men (mixed race/ethnicity); one group of men and women (all African American); and two groups of men and women (mixed race/ethnicity). The man (White) noted earlier as working alone, did not move into a group, but continued to work on his own. About 20 minutes later, he started talking to two other White male students who were sitting in the row in front of him.

Students talked and there was a good deal of laughter. Some ate snacks. Some were sitting, some standing. The atmosphere was very informal and relaxed. The hubbub in the room of students' conversations sounded relaxed and pleasant. Mr. Anthony moved from group to group checking in with students on their progress, answering questions and interacting with them. In general, however, it was difficult to tell exactly how much work was really getting done.

After 25 minutes or so, Mr. Anthony had finished circulating among the groups. I saw a woman approach him and motion him over to her seat. He went over and she pointed to something on her laptop computer screen. She looked happy and excited, and Mr. Anthony returned her enthusiasm. I couldn't hear what he said, but he shook her hand and smiled. (He later related to me that students were always excited to share with him news of a good grade.) He chatted with her group for a few more minutes and then excused himself and walked across to the front of the auditorium. He surveyed the room to see if anyone needed his help, and then came over to talk with me.

We conversed about the class, the LA-STEM program, and a bit about factors affecting students' decisions to drop out of STEM majors and what strategies are known to help underrepresented groups persist in STEM majors. Mr. Anthony expressed to me how much he enjoyed working with the LA-STEM students. A student waved to him across the room and Mr. Anthony excused himself to go assist the young man.

I left the peer mentoring and peer group study session at 4:20pm, mindful that I needed to be back at the OSI offices before the doors of the building were locked at 4:30pm. The buzz of students' conversations continued.

# XXII. Appendix D

Demographic data for LA-STEM Interview participants.

Note: To preserve the anonymity of respondents, we do not break out the samples by multiple variables simultaneously.

| Demographic Category | Demographic | Students | | Faculty, program staff and administrators | |
|---|---|---|---|---|---|
| | | (N=57) | (%) | (N=27) | (%) |
| **Gender** | | | | | |
| | Male | 28 | 49% | 14 | 52% |
| | Female | 29 | 51% | 13 | 48% |
| **Race/Ethnicity** | | | | | |
| | White Not Hispanic | 26 | 46% | 16 | 59% |
| | Black Not Hispanic | 24 | 42% | 5 | 19% |
| | Hispanic | 4 | 7% | 4 | 15% |
| | American Indian | 2 | 4% | | |
| | Asian/Pacific Islander | 1 | 2% | 2 | 7% |
| **Student Class Status** | | | | | |
| | Freshman | 18 | 32% | | |
| | Sophomore | 13 | 23% | | |
| | Junior | 8 | 14% | | |
| | Senior | 18 | 32% | | |
| **Faculty Research Advisor Status** | | | | (N=15) | (%) |
| | Tenured: Associate or Full professor | | | 9 | 60% |
| | Non-Tenured: Assistant professor | | | 4 | 27% |
| | Non-tenure track: Research faculty | | | 2 | 13% |
| **Discipline** | | (N=57) | (%) | (N=15) | (%) |
| | Biological sciences | 12 | 21% | 5 | 33% |
| | Chemistry | 10 | 18% | 1 | 7% |
| | Physics | 8 | 14% | 1 | 7% |
| | Chemical engineering | 4 | 7% | 1 | 7% |
| | Biological engineering | 4 | 7% | 1 | 7% |
| | Biochemistry | 3 | 5% | | |
| | Computer science | 3 | 5% | 1 | 7% |
| | Electrical and computer engineering | 3 | 5% | 2 | 13% |
| | Civil engineering | 2 | 4% | | |
| | Mechanical engineering | 2 | 4% | 1 | 7% |
| | Industrial engineering | 2 | 4% | | |
| | Mathematics | 1 | 2% | | |
| | Geology | 1 | 2% | | |
| | Nutritional/Food Sciences | 1 | 2% | | |
| | Engineering | 1 | 2% | | |
| | Environmental science | | | 2 | 13% |
| | Kinesiology | | | 1 | 7% |

| Demographic Category | Demographic | Students | | Faculty, program staff and administrators | |
|---|---|---|---|---|---|
| **Type of Interview** | | **(N=57)** | **(%)** | **(N=15)** | **(%)** |
| | Undergraduate research experience | 35 | 61% | | |
| | Summer Bridge | 16 | 28% | | |
| | Peer mentor | 3 | 5% | | |
| | Non participant | 3 | 5% | | |
| | Faculty research advisor | | | 15 | 56% |
| | Program staff | | | 7 | 26% |
| | Administrator | | | 5 | 19% |
| **Number of Interviews** | | **(N=69)** | **%** | **(N=69)** | **%** |
| | Individual interviews | 37 (2 by phone) | 54% | 27 (3 by phone) | 39% |
| | Focus group interviews | 5 (20 students) | 7% | | |
| **Time of Interview** | | **(N=57)** | | **(N=27)** | |
| **Site visit 1** | End of Summer/ Fall 2007 | 27 | 7 individual interviews; 20 students in 5 focus groups | 7 | individual interviews |
| **Site visit 2** | Spring 2008 | 30 | individual interviews | 20 | individual interviews |