AC 2007-1802: SUMMER RESEARCH EXPERIENCE FOR HIGH SCHOOL STUDENTS AND TEACHERS: A PILOT PROGRAM

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Summer Research Experience for High School Students and Teachers, A Pilot Program

Introduction

The *Summer Research Experience for High School Students and Teachers* (SEHS) a pilot program targeting high school students and teachers, was offered at Louisiana State University, a Carnegie Research I University. The program provided research and mentoring opportunities to students and teachers who were predominantly from rural schools. This academic and leadership program was developed as a result of informal surveys of students and teachers as well as requests by faculty researchers, teachers and entities outside of the university system. The SEHS program expanded and improved upon some existing programs on the university's campus and incorporated new activities and collaborations between various Science, Technology, Engineering and Mathematics (STEM) based entities within the university system and in the surrounding community. This pilot program was the result of an interdisciplinary collaboration among university STEM researchers, faculty departments and researchers and primary and secondary education school boards and superintendents. The collaborative effort provided a unique opportunity to strengthen K-12 connections to the university so that the community is more aware of research conducted by the university and the opportunities for learning for the students.

The Surrounding Community

Louisiana State University is located in Baton Rouge, the capital of the state. Baton Rouge is one of five metropolitan regions within the state and has a population of approximately 500,000. Of the state's total estimated population of 4.5 million for 2005, approximately 1.1 million live in rural locations. Within the city limits, the elementary and secondary school system is comprised of a combination of public and private institutions.

According to the US Census Bureau statistics for 2004, the median household income in the state is $32,700 with an estimated 20% of the population living below the poverty level. Only 19% of the population age 25+ has a bachelor degree or higher. The Census Bureau reports that approximately 64% of the state is white, 33% is African American, and approximately 3% is "other." [1] The state is also in the lowest percentile in the nation for beginning teacher salaries, ranging from $27,000 to $32,000. [2] The median salary range for teachers is approximately $39,000.

Literary Review and Historical Trends

A literary review of documents, papers and websites on STEM educational trends and on behavior and perception modification were used to assist in developing the SEHS program. The literary review of published documents was used to determine the historical trends and behaviors. The National Science Foundation (NSF) and the Department of Labor provided the majority of the STEM educational trend information for program development. [2, 9, 10]

Primarily, information on degrees conferred, and gender and ethnic trends in education were considered.

Historical and current data indicate that the need for science and engineering careers is increasing, yet the number of students choosing and completing traditional science degrees is decreasing. The decrease in students choosing and/or being qualified to enter science and engineering fields is continuing even with the programs geared towards increasing awareness and preparedness. The gap between students entering science and engineering (S&E) fields and graduating to meet the S&E employment needs was first noted in the early 1990's. Many researchers suggested that recruitment and retention into the qualitative science fields should include women and minorities to assist in filling in the employment gap. Since a large number of women and minorities were not opting to major in S&E fields, researchers conducted many surveys and longitudinal studies to determine the influencing factors on major choice. [3, 4, 5]

The typical influences are readily categorized by types of classes taken in high school, parents' education and socioeconomic status, and test scores. Other documented influences include mentors or high school professionals and their attitudes towards mathematics. Table 1 below is a comparison of the influences, whether positive or negative, and their corresponding reference documents. Influences and factors typically thought to be positive were in fact negative. For instance, a white female is negatively impacted by her family's increasing socioeconomic factor although the higher the socioeconomic background, the more probable the students, whether black, white, male or female, were prepared for the advanced courses.

Many of these researchers and authors note that the "the qualitative talent pool has emerged by grade nine and is essentially complete by grade twelve." [3] After the senior year of high school, migration is entirely out of the field and not into the qualitative fields. Other researchers noted that the losses of the pool occur at every education transition level; however the majority of the losses are between completion of high school and entering college. In addition to these factors, Ethington and Wolfe [5], in a longitudinal study, noted that the most significant factor for women was found to be the number of mathematics and science courses taken in high school. Berryman also concluded "that the early commitment to and preparation for careers is crucial." [3] Thus, many programs in the 1990s, focused on changing the attitudes of students, particularly women and minorities, in middle school.

Current Trends

According to the NSF Enrollment in Higher Education data of 2004, 31% of white students, 43% of Asian students and 35% of other minorities expressed an interest to major in S&E fields yet fewer than half the students complete an S&E degree within 6 years; the largest drop-out rate involves women and minorities. While enrollment in higher education institutions increased from 7 million in 1967 to over 15 million in 2000, the overall number of bachelor degrees conferred in the traditional engineering fields has decreased from approximately 80,000 in 1985 to 60,000 in 2000. This trend is also evident in mathematics and the earth sciences. In the same timeframe, psychology degrees awarded increased from approximately 40,000 to 75,000.

Data trends also indicate that despite the fact that more female students are earning bachelor level degrees, the majority of increase in S&E degrees for women are in psychology and the social sciences rather than the traditional engineering or basic science fields. The only exception appears to be chemistry, where women earned approximately 50% of the degrees awarded.

These science and engineering trends are similar for African American and Native American populations. The largest increase in enrollment within a minority group was the Asian sector, with an increase of 36% from 1992 to 1998. [9] Underrepresented groups were typically enrolled in 2 year institutions.

Table 1. Factors Influencing Career Choice by Gender and Ethnicity

Factor	Effect on Career/ Degree Choice (Generalized)				Reference
	Black Female	**Black Male**	**White Female**	**White Male**	
Socioeconomic Background		Positive	Negative	Positive	5, 7
Positive Attitude towards Mathematics	Positive	Positive	Positive	Positive (Significant)	5,6
Number of Mathematics & Science Courses Taken	Positive		Positive		5
High School Professionals	Negative		Negative		7
Mother's Education	Positive (Significant)	Positive (Significant)			8
Mother's Atypical Career Choice			Positive	Positive	6
Father's Education & Atypical Career Choice			Positive	Positive	8
Test Scores (High School)	Positive		Positive		6
Fathers Education Effect on Choice of Major				Negative	6
Choice of Major- Sophomore Year in High School	Positive	Positive	Positive (Significant)	Positive	6
High School Grades				Positive	6

A significant indicator used by NSF and other government agencies to determine the "scientific and mathematic" health of the nation is standardized testing of elementary and high school students. The science and math proficiency levels of students in the 4^{th}, 8^{th} and 12^{th} grades in each state were assessed using the National Assessment of Educational Progress (NEAP) test results. The NEAP " includes a content dimension divided into three major fields of science (earth, life, and physical) and a cognitive dimension covering conceptual understanding, scientific investigation, and practical reasoning. The science assessment also relies on both multiple-choice and constructed-response test questions." [2] The results are categorized into three levels: basic, proficient and advanced. The average score for the students in this state was 136. For reference, the average scores for all the states in 2000 ranged from 130 to 165, with the national average of 146. "Only a minority of students reached the proficient level, and at least one-third of students at each grade level did not reach the basic level. Among 12^{th} graders, that figure approached half, an increase from 1996. Across both subjects, very few students performed at the advanced level (only 2 to 5 percent)." [2]

In general, math scores imitate the science scores. "The proportion of fourth and eighth grade students reaching at least the proficient level in mathematics increased by a few percentage points from 1996 to 2000, when just over one-fourth of fourth and eighth grade students scored at or above that level. Among 12th graders, only 17 percent reached that level. Approximately one-third of students at each grade level scored below the basic level in 2000. The proportion of fourth and eighth grade students scoring below the basic level decreased from 1996 to 2000, but the proportion for 12^{th} graders increased." [2]

Although fewer students are qualified to enter research I universities, and of those qualified, fewer are choosing S&E fields, the demand for S&E-based employment is increasing. The Department of Labor, Bureau of Statistics, reports that "in 2004, engineers held 2.4 million jobs" with the majority of the personnel employed in the civil and mechanical engineering fields, approximately 16.4% and 15.6%, respectively." [10] The Department of Labor also estimates an expected average increase of 24% in science, engineering, and mathematics related jobs by 2014; the National Science Foundation reported an increase of 40% in S&E related jobs from 1980 to 2000. Both agencies predict the majority of the jobs will be in the biomedical, computer and environmental engineering fields. The Labor Department predicts that the number of jobs in civil, mechanical and chemical engineering will continue to increase with average employment needs ranging from 9 to 17%. [10] Currently, the gap between college graduates and the job market is being filled by international or foreign born students. Approximately 60% of graduate students and 70% of post docs in engineering fields are foreign born students. [9]

Funding Agency & the Associated Requirements

Funding for the *Summer Research Experience for High School Students and Teachers* program was primarily through the Center for BioModular Multi-Scale Systems, a National Science Foundation's EPSCOR grant and as such, the SEHS program had to meet the requirements stipulated in the mission and objectives of the research project. The grant's Education & Outreach (E&O) charge was to develop effective, sustainable programs that engage and familiarize a diverse population of students, educators and the public with the broad range of opportunities available through the STEM disciplines and the significance of STEM research to healthcare, biotechnology and related industries. All programs and activities, including the SEHS program, were structured to nurture and develop participants' understanding of STEM disciplines; to develop the participants' technical and nontechnical skills necessary to succeed in STEM fields; to provide scholarship opportunities; and to develop a hierarchical, interdisciplinary team oriented, model for integrating research and education.

Strategies employed by the E&O Team to achieve this mission include:

- Integrate initiatives into existing community and academic support systems;
- Fund and/or provide resources for hands-on learning of science and math within budget constraints;
- Develop and maintain activities that promote STEM disciplines to next generation;
- Develop and maintain partnerships with other institutions and organizations for present and future collaborations;
- Promote leading edge technology in the state;
- Locate additional supplemental and/or alternative funding for programs; and
- Disseminate programs on a regional and national level.

Influencing Factors

In order to assess the needs of the surrounding community and to meet the objectives of the E&O mission, research in the form of informal surveys and conversations with current high school students and teachers, coordinators and directors of science and math education programs and leaders in local industry were conducted. Results of these surveys and conversations indicated that the students have 1) unrealistic expectations of and/or little understanding of college academic requirements; 2) naive knowledge of available STEM careers; 3) little or no exposure to a college environment; and 4) inadequate exposure to research that is conducted at the university. It was reported that there is also a high number of students who have not been exposed to a broad range of experiences and locations outside of their immediate regions. These perceptions and attitudes, especially in rural schools, appear to contribute to the lower numbers of students selecting STEM majors and careers.

Especially distressing were the comments and attitudes towards science and math expressed by some students in a rural high school. The students who were interviewed had above average GPAs and had performed very well on their ACT with an average of 26 in their sophomore and/or first semester junior year in high school. Because of their academic abilities and other factors, the majority of these students had finished all of the course requirements for graduation from high school with the exception of 4th year English Composition and Physical Education. These students had the option to schedule advanced math and science courses, such as calculus, chemistry II or physics, in their senior years; yet several expressed a desire to work in a local grocery store or fast food restaurant their senior year instead of taking courses to advance their standing or even their placement in a college. Three of them stated that their goal was to work as a mechanic or other trade in the local petrochemical industry and they did not recognize the value in strengthening their academic preparation.

Historical Programs at the University

The College of Engineering and the College of Basic Sciences both provide a residential educational program for high school students. The minority engineering program within the College of Engineering has offered an induction program, *Recruit into Engineering of High Ability Minority Students* (REHAMS), for approximately 8 years. Each summer approximately 35 to 40 high school students reside on the university campus for 3 weeks for an intensive academic "boot camp" to prepare students for the challenges of university life. Students are required to take a math course, either calculus or college algebra, physics and chemistry. Students are also introduced to resume and portfolio writing, study skills, and the academic entrance policies. Participants tour several engineering labs and facilities on and off of campus, work on project management and presentation skills with industry partners and attend courses for money management and teamwork training.

The STEM content knowledge of the REHAMS participants is assessed prior to, during and subsequent to their attendance in the REHAMS program. In addition to receiving grades in their coursework, participants are given the National Engineering Assessment Survey (NEAS) prior to and at the end of the REHAMS program. Test scores from the NEAS typically improve by 20 to 25 points. As an example, the average test scores from the participants of the 2006 program increased from 36% at the beginning of the program to 57% after completion of the program.

For the past two years, the College of Basic Sciences has provided a one week academic intensive workshop for recent high school graduates entering the university majoring in biology. In the *Biology Intensive Orientation for Students* (BIOS) program, students are introduced to the first year biology content, the Biology faculty, staff and peers and the university degree process. This program was first implemented in the summer of 2005. Assessment results clearly show that the students participating in the summer workshop perform better in the freshmen biology classes and have a higher retention rate those students who did not participate in the summer program. [11]

In the summer of 2006, the College of Arts and Sciences initiated the GK-12 *Math Circle* program for high school math students. This program is similar to the REHAMS and BIOS in that high school students are exposed to university activities and research, attend academic workshops and reside on campus. Preliminary data on the impact of this program has not been released.

SEHS Program Details

Based on current and historical trends, the need to be proactive to recruit and retain students into traditional science and engineering fields has substantially increased. The SEHS pilot program was designed to provide hands-on learning experiences in research and advanced technologies for high school students and teachers. Training the teachers in this unique way also provided a support system for students and a resource at the school. These interpersonal relationships between the university faculty and staff and the local and regional schools are necessary not only to change attitudes and perceptions but also to sustain the program.

The goals of the program are:

- to address the students' unrealistic expectations of college requirements through hands-on research experiences,
- to provide positive role models and activities to change their attitudes concerning STEM disciplines and careers,
- to develop relationships between the student and university staff, faculty and researchers, and
- to include high school teachers to improve the likelihood of broadening the impact of the program.

The *Summer Experience for High School Students and Teachers* pilot program consisted of 11 high school students, one mathematics teacher and two science teachers performing research in nine STEM related university laboratories. The high school students were required to work on a STEM focused research project for a minimum of five weeks; teachers worked in their assigned labs for six weeks. All participants in the program worked directly under the mentorship of faculty researchers and graduate students. A full listing of the SEHS participants, their assigned labs, the associated partner and the research project titles is presented in Appendix I and II.

A natural collaboration among the SEHS, the REHAMS and the *Math Circle* programs developed as a result of their similarities in program goals and expectations. In addition, this collaboration enlarged the recruitment abilities of each program and allowed for eliminating duplicate services, ease in hiring of staff and other essential personnel, and reduction in costs for tours and other activities in which larger groups have reduced rates.

In order to provide the university experience and develop a community for the SEHS, REHAMS, and *Math Circle* high school students, they were required to reside in the same dorm under the supervision of university mentors. In addition to the shared academic activities, students participated in movie and game nights, had outings to "LaserTag" and frequently had "Dinner Nite Outs"

Figure 1. REHAMS, SEHS and Math Circle Students at Johnson Space Center, Houston, TX

To instill a culture of service and to sustain the program by generating leaders and mentors for subsequent program years, the high school students learned teamwork, leadership, time management and mentoring skills. The SEHS and REHAMS students were collectively required to participate in the teamwork activities, work in groups to manage a "project" for ExxonMobil and to perform experiments at the Johnson Space Center in Houston, TX, Figure 1. Figure 2 shows one of the teamwork activities that the SEHS students and mentors participated in at the university's *Adventures Training* facility.

Students from *Math Circle*, REHAMS and SEHS programs attended the same classes for study skills and habits. These courses incorporated current books that included, *The 17 Indisputable Laws for Teamwork* and *The 21 Irrefutable Laws of Leadership* by John Maxwell [12, 13] and *The 7 Habits of Highly Effective Teens* by Sean Covey and Debra Harris [14] to assist students in learning practical time management skills, good study habits and characteristics of good team members and leaders. Additional required reading for the SEHS student included *Who Moved My Cheese? For Teens* [15] and one journal or conference paper related to their research project.

Integral components of the SEHS program are mentoring and service learning of not only the university student mentors but also the SEHS high school students. All of the SEHS and REHAMS participants were paired with mentors in the students' preferred STEM discipline. In addition to the academic and educational activities, the SEHS students were required to mentor elementary students in at least two science camps. Elementary campers and high school mentors were "self selected" through natural similarities in personality and interests, Figures 3 and 4. The high school students in the SEHS program also interacted with practicing engineers from industry and the state as well as several elementary and middle school gifted and talented teachers.

Figure 2. High school students and teachers in the SEHS program team up with university mentors to balance on an unstable disk at the *Ropes Challenge Course*

All of the participants in the SEHS program, four students in the *Math Circle* program, and 88 undergraduate students participating in the university's Summer Research Experience for Undergraduates presented their research findings or projects at the Annual Summer Undergraduate Research Forum and Expo. This forum also provides demonstrations of some of the hands-on activities of the summer elementary camps and outreach programs by various STEM entities to university faculty, staff and the general public.

Figure 3. High school senior, Josh Quinn (seated left) and juniors, Allen Bordelon (standing) and Jacob Clawson (seated far right), instruct elementary students in circuit design using SnapCircuits®

Figure 4. Mechanical Engineer, Ms. Anglyn Hughes, and high school junior, Shanee Turner(far right) instruct elementary campers in robot design

Participant Selection

All of the students in both the SEHS and REHAMS programs have either scored above a 21 on their ACT or have grades of B or higher in their high school science courses. Traditionally REHAMS participants self-select to participate or are either recruited by high school counselors or by university representatives at the regional high school *Engineering Week*. The SEHS program participants were recruited differently than the REHAMS program. All of the SEHS participants are recommended by their high school science or math teachers, visiting faculty and staff or by other Education and Outreach partners and have demonstrated either prior leadership abilities or service oriented activities.

Students were interviewed to determine their particular interests and preferred STEM courses. Based on that data, they were placed into a STEM lab with similar fields or research projects.

If selected to participate in any of the university's high school or elementary aged programs, the students and their parents submitted formal applications. In the application process, students and parents indicated if financial assistance was needed, completed work permits for students under the age of 16, signed waivers for advertising and marketing and were notified that the students were participating in an "experiment." Other requirements included proof of vaccinations, insurance waivers and transportation releases.

The demographics of the participants are presented in Table 2. Student participants in the program ranged in age from 15 to 17, with the majority of the students between their junior and senior years of high school. Additionally, eight of the students who participated in the SEHS program were female, 3 of the participants were African American and one student was Asian. All of the teachers were male and white and had degrees in basic science or math.

Table 2. Demographics of Participants

Total # of High School Students	# of Teachers	# of Schools	# of University Students	# of Faculty	Minority Students*	Female Students*
11	3	5	6	11	4	10

* Includes University Students

Mentor and Research Lab Selection

As with the students and teachers, university researchers and labs were generally self selected; however; placement and actual acceptance as leaders were then identified through personal relationships developed prior to the establishment of this program. All of the laboratories and university researchers except one have prior records of supporting educational and outreach initiatives within the university framework. These team members tended to be either already tenured faculty, PhD graduate level students or staff hired specifically for education and outreach programs, Figure 5. The minimum education of all of the research based mentors was a master's degree in a STEM related field. University undergraduate level mentors also had a prior history of mentoring or service learning activities and were in STEM related fields. Whenever possible, mentors and protégées were match by sex and race. The demographics of the mentors and university researchers are presented in Table 3.

Table 3. Demographics of Mentors and University Researchers

Total # of Researchers	# of Tenured Faculty	# of Professional Staff	# of Graduate Students	# of University Mentors	Minority	Female
11	4	3	3	6	5	14

Figure 5. Ms. Adrienne Lopez, Basic Sciences, instructs high school students on how to photographically document biological samples using the hand held stereoscope, *Scope on a Rope*

Assessment

In order for any program or endeavor to grow and succeed, formative assessment must be continually and consistently maintained throughout the program. Because the E&O program relies heavily on activities not typically presented in a classroom to meet its stated missions and objectives, it falls under the "nontraditional" category, as designated by the National Science Foundation. Nontraditional programs tend to be voluntary in nature; therefore, typical indicators of a successful nontraditional program can include the growth (or increase) in participant numbers and/or STEM based activities, the % return of previous participants to the following year's program, and a perceived change in attitude concerning STEM related activities. Successful nontraditional programs rely heavily on a "word of mouth" or a "reputation based" perception. [16] Because this was the first year of the program, growth or expansion of the program and % return of previous participants are not available.

This is contradictory to the assessment techniques used to determine success typically used by researchers and funding agencies, who gauge success by an "increase" of knowledge, an increase in the number of students choosing a STEM career or an increase in college graduation rates. For reliable data of this type of program, a longitudinal study of the students or teachers currently involved with the program and its affect on their choices and grades in school should be investigated. Recommendations on for this type of study and the associated assessment are in the *Recommendations for Improvement Section*.

Program assessment is essentially based on perceived attitude changes, whether or not the students made positive behavioral changes such as scheduling advanced courses and applying for the university in a STEM related field. High school participants completed surveys prior to and during the program. Additional information on content knowledge was assessed by supervising faculty and staff by reviewing the participants' journals about their experiences and assessing their final poster presentation. Assessment also included follow up interviews with participants two months after the summer program ended.

All of the high school students participating in REHAMS and SEHS were given a survey at the end of each week and asked to rate their various courses, tours or activities. Table 4 shows the results of the survey rating these activities. The majority of the respondents in this survey were associated with the REHAMS program. The survey was also given to the Math Circle students who attended a particular activity such as the 7 Habits course, the Exxon program and several tours. Activities were rated on a Likert scale from 1(least-liked) to 5 (best-liked). The ratings indicated that the environmental tour was the least-liked activity. The 7 Habits Course and the Adventures Training activities were the favorite activities of the participants with scores of 3.19 and 3.14, respectively. A representative comment of each of the activities is included in the table.

These activity survey results are consistent with the expressed impressions of the overall REHAMS program as reported by the students at the end of the program. The overall impressions were fairly positive. The majority of the REHAMS students reported a dissatisfaction with the workload in the time provided which resulted in very little free time. To some extent contradictory to the REHAMS students, the majority of the SEHS students were extremely positive in their feedback of the program and have recommended younger students to the mentors and vice versa.

In reviewing the SEHS students' weekly journals, as expected, the students kept information concerning their projects, such as research notes and experiment details. However, several students also included questions that they would ask their mentors, prepared individual budgets, and developed basic plans and portfolios for college. These students also took notes at the various academic preparedness courses. Additional comments concerning the schedules and roommate issues were also documented. These comments and concerns were given to the university counselors who in turned used the feedback to have open discussions about relationship issues and dorm life in general. If the university mentor felt that they could not resolve the issues, the coordinator was contacted. In two cases, the students were given the opportunity to discuss personal issues with professional counselors in the College of Engineering.

TABLE 4. Survey Results of Activities in the REHAMS & SEHS Programs

How Do You Rate The:	On a Scale of 1 to 5	Representative Comment or Brief Summary of Comments
Mentor Dinner?	2.74	Food was good, some mentors had not shown up
Counselor Activities?	2.44	Want to have more input into activities
Adventures Training Activity?	3.14	"Best activity of the whole program"
Environmental Engineering Tour?	2.26	"More activities besides water quality"
Civil Engineering Tour?	2.29	More Hands On
Electrical Engineering Tour?	2.47	"The man was fun, just the demonstrations need to be for our age group."
Mechanical Engineering Tour?	2.96	" The car was cool…"
Petroleum Engineering Tour?	2.53	"messing with the parts in a plant was the best part"
Industrial Engineering Tour?	2.35	Instructor was boring
7 Habits Course?	3.19	"Too much work"
NASA Trip?	2.63	Different hotel, more to do on Saturday
College Panel?	3.33	"It was just really informative and inspired me to get my stuff together."

Approximately two months after the conclusion of the program, students and teachers at St James Science and Math Academy had informal discussions and answered some basic questions relating to their perceptions of their current environment. Students reported the courses they were taking in the fall and spring semesters of their senior year and if they had applied to a university. In these follow up surveys and informal questioning sessions, the SEHS students reported a positive change in their perception of engineering and science research. All of the students reportedly signed up for additional science and math courses in their junior and senior years of high school. Several students commented they understood the relevance to doing their homework, continuing to take science classes and that they are more prepared for university level work than their classmates. One student stated, "I can tell the difference between me and the other students who weren't in the program- other students only see life here [at school]." One of the teachers also reported plans to attend graduate school in the Fall of 2007 under the direction of the summer faculty mentor.

The majority of the SEHS students indicated they had an interest in further participation and would be willing to respond to additional assessment instruments in subsequent years after graduation. Several of the students recommended younger students to the program and were actively involved in mentoring junior high students in the "BEST Competition" at their feeder middle school. Eight of the students reported that they were admitted to Louisiana State University, and of those, three reported that they pre-selected engineering as their major, three selected chemistry, and one biology. One student plans to attend the university after his military training in the Fall of 2007. Two of the students are attending universities elsewhere but plan to major in STEM disciplines.

The positive impacts of the SEHS program were noted not only by the students but also by their mentors and faculty researchers. All of the mentors, except one, reported a positive experience with the high school students and teachers; two commented they would like for their high school students to come back and work in their labs in college. One faculty member stated, “I treated her just like one of my undergraduate students. I would love for her to come work in my lab.”

Recommendations for Improvement

Despite the overall success of the SEHS Pilot Program, issues did arise between two mentors and student groups. One disagreement resulted in one student not completing the program. In one of the labs in which there were issues between the faculty research mentor and the high school students, a teacher from the same school was also assigned to this lab. These particular students were reportedly more “irresponsible” than the students who were placed directly with researchers alone. The students would arrive late in the morning or they would try to have the teacher influence the researcher’s goals and objectives. Once a clearer channel of authority and expectations was delineated, the students’ performance improved. The recommendation is to either have students in a lab without a teacher or partnered with a teacher from a different school.

In the case of the student that did not complete the program, the main issue was the conflicting personality types of the student and the faculty member. This particular female faculty member is in the middle of the tenure process and had less experience with education and outreach at the high school level. The student has a relatively shy, reserved personality and did not express needs or questions rather well. This interpersonal dynamic as well as the environment of the lab, unfortunately, resulted in the student opting not to continue the program and he is now hesitant to pursue a degree in a traditional STEM field. Although this appears to be a failure, it may actually be a success for the student in that he is better equipped to make a career choice that may be more suited for his abilities and personality. This situation also provided a learning experience for the younger faculty member that would not have been possible in her current department.

Because this was a first year of the program, the main emphasis was on development of the program to meet the E&O goals and coordination of the program with the various partners. Initial program details and assessments were based on other programs, such as REHAMS and the Science Adventures Summer Day Camps. In order to thoroughly assess the program, more detailed assessment tools and program criteria were developed specifically for the SEHS program. However, the true success can only be determined through a longitudinal study of the students and teachers over the next several years.

Program recommendations include:

- Developing clearer programmatic guidelines and additional assessment to gauge the success of the research projects for students.
  Given the wide range of ages of the participants and the various projects available, the research projects tended to vary in difficulty and complexity among the labs. Researchers and staff developed basic guidelines for the research projects. The guidelines provided initially were based on the science or math courses the students had already completed in school and were similar to a science fair model. The students, along with the researchers, were to express a theory, create a plan of experimentation, and ultimately develop a conclusion. Some of the researchers gave students fully unknown research topics and some researchers gave some basic experiments. In one case, the student participants reported being a bit overwhelmed with the research topic. As a result the research was scaled back accordingly. Increase in knowledge content of the participants' research area needs to be formalized with the mentor. This may be achieved through testing or presentation to the group of mentors at the end of the program.

- Improving communication between organizing staff and researchers.
  Communication between the researchers and staff was primarily email based and was fairly consistent. However, some minor miscommunications did occur. An example of the miscommunication was a change in a lab schedule that was not relayed to the staff in charge prior to the students arriving on campus. These students were assigned to mentor at the first week of the elementary science camps so that their research portion of the summer was not disturbed.

- Standardizing the rewards across the REHAMS, SEHS and *Math Circle* Programs.
  The SEHS students were financially compensated for their work in the labs and at the science camps whereas the students in the Math Circle and the REHAMS programs were not. Naturally, this caused some minor friction among the students in the various programs.

- Limiting outside activities of the high school students during the summer and/or reducing the length of the program.
  Several of the students had to leave in the middle of their research projects to participate in other activities. At the onset of the program, the coordinator was well aware that students in leadership tend to have outside activities other than scholarship and thus, made exceptions throughout the program.

- Sustaining the sense of community developed during the summer program.
  The students suggested a "My Space Forum" for the program to discuss thoughts and to "keep in touch with other kids" not in their high school. The majority of the students have maintained contact with the university mentors through this forum, although it has not been formally sanctioned by the university.

- Requiring all of the students to reside on campus.
  Two of the senior students who participated in the program did not want to reside on campus since they would be residing at home during their foreseeable college years. These two

particular students performed very well in the labs and participated in the tours with the other students, but did not appear to form as strong a bond to their peers or have some of the leadership opportunities as the other students living in residential housing.

- Continuing the development and expansion of the program.
  Currently, due to lack of funding, there are no plans to continue the leadership STEM based research program on LSU's campus or in the surrounding region. This program provides a unique opportunity for qualified students who may not otherwise chose to attend the university or enter STEM fields.

Budget

Participants in the SEHS program were compensated for their work and were provided living expenses, including housing and three meals a day. The two SEHS students who preferred to remain at home were only compensated for their time in the lab and their lunchtime meal. Expenses for transportation to and from the elementary camp sites and to and from their labs, if off campus, were not reimbursed. Transportation, hotel costs and tour fees were all provided to the participants. The participating teachers all opted for a weekly stipend that covered their lab employment and living expenses. One teacher opted to stay in his current housing outside of the Baton Rouge community and commute; his travel expenses were not reimbursed.

Additional operating expenses include lab costs, researcher salaries and project coordination fees, supplies, and program T-shirts. Lab expenses, such as equipment rental and experiment supplies, and faculty time were not reimbursed. The university researchers essentially donated their time to this project. Project coordination and operating expenses were estimated at a ¼ time of the E&O coordinator's compensation since other projects were being managed simultaneously. All of the students' textbooks and workbooks for time management, teamwork & leadership development and study skills courses were provided. These educational supplies were also provided to the REHAMS and *Math Circle* students who participated in the courses so these expenses are included in the budget. Additionally, because these students are minors, for their safety the students and undergraduate student mentors were required to wear program T-shirts on tours, outings and other special events on campus. Again, if REHAMS and *Math Circle* students participated in an SEHS sponsored program, they too, were required to have the T-Shirt. Other program essentials such as pencils, book bags, nametags, snacks and notebooks were donated by other corporate/non-profit partners.

The overall estimated budget of the SEHS program was approximately $150,000 for 20 participants; 15 students and 5 teachers with an average individual expense of $8,800.00. Actual program expenses averaged $4600 per person and totaled approximately $64000. The difference between the estimated and the actual is due mostly to the reduced number of participants, donations made by outside entities or consolidating activities with the other high school programs. The full comparison budget of actual vs. estimated expenses is presented in Appendix III.

Conclusions and Acknowledgements

In conclusion, the preliminary assessment data suggest that the SEHS Research Program was successful in changing attitudes and perceptions of the students, promoting STEM disciplines and careers and developing interpersonal and leadership skills of the participants. The program met all of the goals and objectives set by the program and the applicable goals and objectives of the E&O team. In addition to meeting the goals and objectives, the program expenses were below the estimated budget.

Overall the selection process and matching of the participants, mentors and projects was successful. All of the student participants have utilized their research projects in their schools and regional science fair projects.

The success of the SEHS program can be attributed to several factors: an accurate assessment to the community needs, creative and talented participants, and adequate funds. Most of these factors have been addressed in previous sections. However, one factor that has not been highlighted and has had a huge impact on success of the program is having an outstanding team with a vision and the perseverance to meet the goals. The team is comprised of individuals who are highly motivated to change the surrounding environment to improve the STEM education level of the students and teachers, to provide opportunities for the character and leadership development of the university students and faculty, and to provide opportunities to increase STEM knowledge to the community as a whole. This team is comprised of not only the salaried staff employed by the program but also numerous partners and professionals gave their time and expertise to these programs. In addition, these partners have been willing to provide valuable insight for improvements in the program that may not be readily tangible or quantifiable. The SEHS program attributes its success to these partners and mentors. Without their support, the program would not have been able to achieve the success it did in such a short period of time.

An alphabetical listing of the partners and their affiliated organization is provided below:

- Dr. Steven Beck, Laboratory for Creative Arts & Technology
- Mr. Matthew Bennett, Graduate Student, Mathematics
- Dr. Ed Cancienne, Superintendent, St. James Parish Schools
- Mr. Elvis Cavalier, Director of School & Community Programs, St James Math & Science Academy
- Ms Erica D'Spain, Research Assistant, School of Veterinary Medicine
- Dr. Jost Goettert, Faculty Mentor, Center for Advanced Microstructures & Devices
- Ms. Anna Haldane, Co-Coordinator of Elementary Science Adventures Camps, Audubon Council Girl Scouts
- Ms. Cindy Henk, Scanning Microscopy Lab Manager, College of Basic Sciences
- Ms. Mindi Huguett , Graduate Student, Biological Engineering Department
- Ms. Adrienne Lopez, HHMI Scope on a Rope Coordinator, College of Basic Sciences
- Dr. Todd Monroe, Faculty Mentor, Biological Engineering Department
- Ms. Tracy Morris, Cleanroom Manager, Center for Advanced Microstructures & Devices
- Dr. Frank Neubrander, Faculty Mentor, Mathematics
- Mr. Jerry Peck, Graduate Student, Mechanical Engineering

- Dr. Lisa Podlaha- Murphy, Faculty Mentor, Chemical Engineering
- Ms. Sheri Wischusen, REU Program Director, College of Basic Sciences
- Dr. Matgorzata Witek, Research Associate, Chemistry

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