ASCENT - A Program Designed to Support STEM Students through Undergraduate Research and Mentoring

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Abstract

This study introduces Lamar University's **A**ddre**S**sing the Gulf **C**oast R**E**gion's Graduatio**N** Ra**T**e Crisis in Mathematics and Computer Science (ASCENT). The main goal of ASCENT is the rapid graduation of outstanding mathematicians and computer scientists by providing scholarships and extensive academic support to community college students who transfer to Lamar University (LU) and to current upper level LU students to complete bachelor's degrees in mathematics or computer science in a timely manner. The academic support includes Summer Bridge and Enrichment program, undergraduate research, multi-level mentoring, and post-graduate placement. The ASCENT program targets talented "at risk" students who face social and economic hardship and provides them support to graduate on time. These "at risk" categories include women and minorities, community college students, first generation students and military veterans. Since the beginning of ASCENT in May 2012, the program has been successful in terms of recruitment, retention, and graduation. Moreover, ASCENT is responsible for institutionalizing undergraduate research at Lamar University. ASCENT's most significant contribution to LU is in the area of undergraduate research. Our ASCENT scholars conduct undergraduate research under the supervision of faculty mentors during the second summer of their program. The student scholars get control over their education in ways that are almost impossible to replicate in regular courses. They present their work at various conferences including the Texas STEM Conference in October. This undergraduate research initiative has increased the awareness of undergraduate research throughout the campus. As a result of this awareness Lamar University has established the Office of Undergraduate Research (OUR) in 2013 and the PI of ASCENT is serving as the OUR's Founding Director. OUR hosts undergraduate research expo, conference, talks, workshops etc. It also offers research and travel

grants to students. One of the other significant achievements of the ASCENT program is the introduction of a conference for S-STEM scholarship recipients in the state of Texas and Louisiana. We recently hosted the 3rd Texas STEM Conference on October 3, 2015 on the campus of LU. Over 120 students and faculty attended sessions created to emphasize improving STEM education. College and university faculty members, administrators, and peers involved in STEM education, or interested in getting involved, were invited to share and explore research, best practices, and ideas with their colleagues around the states of Texas and Louisiana. The conference was also attended by eight S-STEM PI or co-PIs. This paper describes the ASCENT approach, its structure and its expected results.

Keywords- *Bridge program, undergraduate research, STEM retention, timely graduation*

Introduction

ASCENT is a collaboration between the Department of Mathematics (MATH) and Department of Computer Science (CS) at LU, funded by National Science Foundation (NSF) and LU. The main goal of ASCENT is the rapid graduation of outstanding mathematicians and computer scientists by providing scholarships to Community College (CC) students who transfer to LU and to current upper level students to complete bachelor's degrees in MATH or CS. Based on the financial need, each student is awarded a scholarship of up to $10,000 annually for two years. Selected students are designated as ASCENT Scholars. The awarding of these scholarships is complemented by extensive academic support including Summer Bridge and enrichment programs, undergraduate research, and multi-level mentoring.

The primary motivation of the program is that LU's six-year graduation rate is very low (it was a troubling 33% in Fall 2009). A disproportionately large number of minority students and transfer students who come from low-income households exacerbate the problem of retention and graduation rates. Therefore, ASCENT is designed to:

1. address the problem of slow progress towards graduation among talented yet low-income students in MATH and CS,

2. enhance existing bonds and build new ones between LU and CC in the area, and

3. enhance upper-level experience in MATH and CS by building strong diverse student cohorts, easing the transition of transfer students to upper-level work.

The project targets upper class students and transfer students for the following reasons:

1. two-year graduation rates for LU upper level students and CC transfer students are well below those of its peer institutions,

2. the project extends models for highly successful NSF-funded LU projects (e.g., STAIRSTEP and INSPIRED) to upperclass and transfer students, and

3. over 70% of current LU scholarships are designated for freshman and sophomore students.

4. the majority of junior students take off-campus jobs to pay back the LU loans, hence putting downward pressure on the LU graduation rate.

Significance of Projects and Rationale

The objectives of the ASCENT program support the goals of the NSF S-STEM program:

1. Improved educational opportunities for students: More than 70% of the scholarships available for LU students are designed for freshman and sophomore students. Moreover, students who attend regional CCs often cannot afford to attend four-year colleges. Students who would not have otherwise had the opportunity to take advantage of what LU offers - namely, many undergraduate research opportunities, a low student-faculty ratio and a diverse campus- are now able to attend LU.

2.   Increased Retention of Students to degree achievement: The Summer Bridge and the enrichment program, undergraduate research and multi-level mentoring program not only make the transition easier for transfer students but also improve confidence and expectations of success. At the same time, these programs help both transfer students and existing LU students to graduate within two years of participation in the ASCENT program.

3.   Improved student support programs at institutions of higher education: According to a recent study, LU is among the nation's top 100 universities with the highest number of graduate degrees awarded to minority students [3]. With the help of ASCENT, LU continues to work to meet the challenge of taking able but under-represented students and helping them succeed.

4.   Increased numbers of well-educated and skilled employees in technical areas of national need: the project not only increases the number of mathematics and computer science graduates from LU by a total of 24, but it also significantly decreases their time to graduate. In addition to these 24 students, the project encourages other students to pursue degrees in STEM fields by arranging workshops, seminars etc.

Program Structure

ASCENT recruits students primarily in spring of each year. A complete ASCENT application consists of all of the following material:

1. A Lamar University Transfer Application for Admission, including a recommendation letter.

2. The completed Free Application for Federal Student Aid (FAFSA).

3. This ASCENT Program application requires personal information, academic

history, one academic reference, and a completed essay.

To be eligible for the scholarship, students must satisfy all of the following requirements:

- Pursue a bachelor's degree in Mathematics or Computer Science or Computer Information System.
- Meet federal eligibility guidelines and requirements to receive financial aid
- Be a US citizen or permanent resident or refugee
- Be an upper-level MATH or CS or CIS major (60 or more credit hours in Fall of the starting year)
- Attend a one day interview
- Hold and maintain a 3.0 overall GPA
- Complete the ASCENT Application Packet
- Participation in ASCENT summer activities (both in Year 1 and Year 2 of the program).

Summer Bridge and Enrichment Program

The 5-week ASCENT summer program has been developed to provide students with unique opportunities: a Bridge program that includes a specialized mathematics course offered just to ASCENT Scholars, an on-campus orientation program, and an enrichment program that includes a research experience with a faculty member. In the first summer, students attend the orientation and are enrolled in a discrete mathematics course taught by one of the Co-PIs of the program. As it is the only course that students take, the light course load allows them to start building a relationship with their mentors and helps transfer students to become familiar with the LU campus and the resources available to them. Summer Bridge Programs for transfer students have been successful in increasing academic and social engagement for transfer students [4]. In the second summer, Scholars have an opportunity to conduct research with a faculty member. They also attend career workshops, professional seminars, conferences. Students are supported financially throughout the Summer Bridge program. Among the

resources provided are summer housing and lodging at no cost, and a tuition waiver for the course from LU. They also receive a $500 stipend from the grant in both summers.

LU offers ASCENT Scholars, in addition to financial support, a wealth of academic support, career development, and community building activities that will promote the program's ability to meet the objectives of the program.

Following the selection of recipients, Scholars participate in one orientation session that introduces Scholars to the program, faculty, alumnae, and each other. The orientation also sets themes for the current year, introduces requirements and opportunities, and assigns faculty and peer mentors. In addition, Scholars participate in the following discussions:

· The McNair Scholars Program by the Director of the program,

· Information on career placement services from the Director of LU Career Placement Services, and introduction to graduate studies by the Dean of LU Graduate Studies.

Creating research questions and/or identification of knowledge gaps is one of the critical steps in research activity and it requires critical thinking [1]. During the Summer Bridge course in Year-1 the students are encouraged to discuss knowledge gaps and are presented a list of available and possible research projects. They are also allowed to choose one significant project on their own. Last year, one ASCENT scholar chose a research project outside the provided list. The student extended his ideas from a research project of graphics to a 3D-printing related project presented at the 3rd Texas STEM Conference at LU.

It is our observation and findings that the structure of the Bridge course is achieving its objectives. The course accommodates students from different backgrounds very effectively. As shown in Figure 1, the majority of MATH and theoretical CS concepts have an overwhelmingly common part, such as propositional logic, predicate logic, basic structures, number theory, cryptography, induction, recursion, counting and relations. The only uncommon parts are proofs (familiar for

MATH students, but unfamiliar for CS students) and algorithms (familiar for CS students, but unfamiliar for MATH students).

In the Summer of 2015, the three-credit hour Bridge course was dual listed in the university scheduled as MATH 2305 (Discrete Mathematics) and COSC 2375 (Discrete Structures). Both the instructor (an ASCENT co-PI) and students believe that the Bridge course was a very interesting and exciting journey. To make this experience enjoyable for both MATH and CS students, the Instructor of the Bridge course implemented the following:
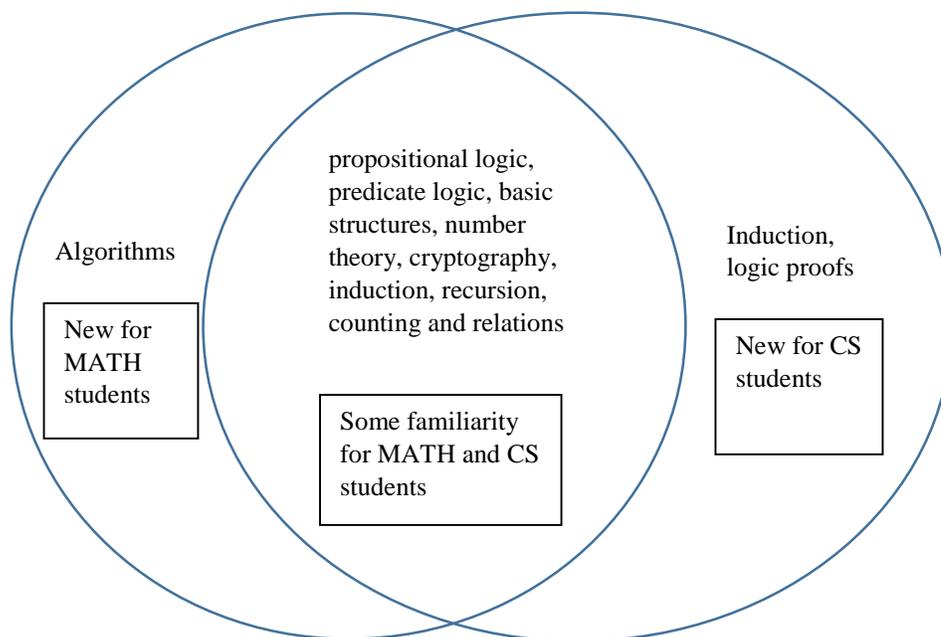
Figure 1. The main topics of the Summer Bridge course

1. since the Algorithms course needs prerequisite courses Programming Fundamentals I, II, and III, the instructor introduced the concepts needed from these courses in order to teach the chapter related to Algorithms from the adopted textbook.

2. to stimulate the communication skills and team cooperation, the instructor paired each MATH student with one CS student. In this way, the CS student was able to explain programming-related details to any potential question, and, similarly, the MATH partner

was able to explain the precise steps in a formal proof required to in a Discrete Mathematics exercise.

3. the instructor rewarded active participation in class with "stars" – also known as incentives, which were later added into the calculation of the final grade.

Undergraduate Research

One of the core ingredients of this project is giving undergraduates the opportunity to participate in research projects. We feel research is one of the best tools for getting students interested in pursuing a career in mathematics or computer science. Undergraduate research enhances ASCENT Scholars' enjoyment of their studies and help them to excel. It has been documented time and again that undergraduate research leads to improve: academic success, learning comprehension, rates of retention and rates of graduation. Program leadership promote the importance of undergraduate research both as a learning experience and when applying for a future career position or graduate education. We want to have undergraduate research more integrated with what is done in the classrooms in ordinary courses. Research should be part of what all students must learn to some extent to do. OUR has the potential to strengthen ties between regular coursework and research by following the methods originating in ASCENT. The ASCENT program is involved in cutting-edge topics for the benefit of our society, such as cyber-security, 3D-printing, big data analysis, graph theory, stochastic analysis and more.

The Office of Undergraduate Research

ASCENT's most significant contribution to LU is in the area of undergraduate research. As described earlier, ASCENT scholars conduct undergraduate research under the supervision of faculty mentors during the second year of the program. Scholars are getting control over their education in ways that are almost impossible to replicate in the classroom. Students present their work at Annual Texas STEM Conference annually in October. This undergraduate

research initiative has increased the awareness of undergraduate research throughout the campus. It has become a model for increasing research activities at LU. Having a course (Summer Bridge course offered by ASCENT) with few lectures dedicated to research followed by student presentations has been successful in introducing students to research. As a result of this awareness LU established the Office of Undergraduate Research (OUR) in 2013 and the PI of ASCENT is serving as the founding director of the office. OUR creates, facilitates, and enhances opportunities for students interested in conducting undergraduate research and creative activities. OUR hosts expos, conferences, talks, workshops, short presentations for all students. It provides funding opportunities for student research and scholarship through a range of programs.

Texas STEM Conference

All ASCENT students presented their research in at least one research conference (Texas STEM Conference). Texas STEM Conference was first held in 2013 with a primary goal of providing a platform to undergraduate STEM researcher in Texas. ASCENT PI is the founder of the conference. One of the biggest achievements of the ASCENT program is the introduction of a conference for S-STEM scholarship recipients of the state of Texas and Louisiana. This annual conference hosts student presenters from other universities in Texas and Louisiana such as University of Houston, Sam Houston State University, UT Arlington, St. Edwards University, El Paso Community College, Lee College, University of New Orleans and Louisiana State University. Besides students, S-STEM PIs attend this conference too. College and university faculty members, administrators, and peers involved in STEM education, or interested in getting involved, are invited to share and explore research, best practices, and ideas with their colleagues around the great state of Texas and Louisiana. The 3rd Texas STEM Conference was hosted at the campus of LU on October 3, 2015. The conference included oral presentations and

poster presentation with 43 presenters. More than 100 students and faculty including 10 S-STEM PI/co-PIs attended the conference.

Faculty, Peer, and External Mentors

One of the most important objectives of the ASCENT project is student mentoring. The project provides four distinct categories of mentoring:

1. The PI and Co-PI's serve as *lead faculty mentors* for their respective disciplines. The ASCENT Scholars typically meet their faculty mentors three times per semester (at the beginning, in the middle, and at the end of the semester).

2. *ASCENT Faculty Advisors*, who are faculty members volunteering to assist and to monitor each student's academic progress and discuss educational and career aspirations.

3. *Peer mentors*, who are senior students primarily chosen from the previous cohort. Scholars meet once in every semester with their peer mentors. The student mentors assist Scholars in becoming involved in social and professional networks that exist for STEM majors at LU. Research has shown that such cohort mentoring programs also improve retention of the mentors [2].

4. *External mentors*, who are LU Alumnae and individuals working in related fields. An external mentor is paired with an ASCENT Scholar according to his/her field of interest. The ASCENT project includes a Professional Seminar Series to bring alumnae volunteering as external mentors onto campus to meet their respective student mentees. With the help of the most active LU Alumnae, the Advisory Board of the CS Department helps to recruit external mentors.

Recognition

LU ensures local recognition of student achievement. We promote our ASCENT Scholars via acknowledgement by the President at our Convocations and other occasions. Public recognition, particularly from senior administrators, affirms women and minority students in their choices of nontraditional careers [5].

Evaluation

The recent data shows that the six-year graduation rate at LU has increased for the last few years in MATH and CS. The current rate is 50% and 42.9% respectively. ASCENT is one of the reasons of such improvement in the past 6 years.

As expected, ASCENT has helped both MATH and CS in recruiting students. It is also our observation that we have more students pursuing a double major now because of the ASCENT program. Many students are double majoring in MATH and CS. Moreover, a significant increase in double majoring can be observed in Physics, Electrical Engineering, Mechanical Engineering, and Management and Business Administration. The table below (Table 1) shows a significant increase in enrollment especially in the past 3 years.

Major	SP '10	Fall '10	SP '11	Fall '11	SP '12	Fall '12	SP '13	Fall '13	SP '14	Fall '14
MATH	51	56	52	51	51	50	49	67	63	67
CS	81	96	98	118	100	143	113	167	141	147

Table 1: Mathematics and Computer Science Enrollment at Lamar University

It is our observation and findings that ASCENT students enjoy doing research. Research of the first three cohorts of ASCENT Scholars (22 students) have resulted in 52 presentations in regional and national conferences, and 3 publications. The experience they have with the Bridge program helped them to focus their attention on research more than they had previously. Many

of them are likely to be engaged on research in some capacity after they graduate. Even though most of them plan to go to graduate school at some point, many of them enter industry before that. Out of 11 students graduated from this program, five of them are working in STEM field and two of them are pursuing Ph.D. in MATH and CS.

Conclusion

As demonstrated in this article, the ASCENT grant is one of the most successful and exciting academic events for Mathematics and Computer Science students and mentors involved. We conclude that the objectives of the ASCENT program have been overwhelmingly accomplished in its first three years. As part of future work, the ASCENT investigators are encouraging and helping the ASCENT students to pursue a Master in Mathematics and/or Computer Science.

Acknowledgment

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