

**STEM Opportunities for Academically Capable and Financially Needy Students entitled the "University of Southern Maine STEM Scholars Program," Award # 1153281**

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Research Interests: STEM Retention Programming. Computer Graphics, Technology, Communication Technologies, Human User Interface, Graphic Design, Cognitive Ergonomics, Interactivity, and Technology in Education

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### **Abstract**

The National Science Foundation awarded the University of Southern Maine with a grant for STEM Opportunities for Academically Capable and Financially Needy Students entitled the “University of Southern Maine STEM Scholars Program,” Award # 1153281. At the completion of our fifth year, this poster presentation provides an opportunity to present data on the success of our S-STEM program, as well as share some of the best practices learned and applied. The USM STEM Scholars Bridge Program has been a model for blending the elements of recruitment, retention, and placement into an integrated, comprehensive but non-intrusive program that promotes student success in transitioning from high schools and community colleges to University of Southern Maine. In the terms of broader impacts, the summer “Bridge Programs,” including the monthly seminars provided an increased awareness of STEM career opportunities for a larger, more diverse population of non-traditional, underrepresented, first-generation students with the goal of being placed upon graduation.

### **Rational and Significance**

Central goals of the S-STEM Scholars project provided non-traditional (NT) students with both a comprehensive summer “bridge” program as an introduction to college experience, and facilitated monthly developmental seminars as a framework to encourage scholastic success and support gainful employment in their selected academic STEM degrees. At the University of Southern Maine (USM), NT students comprise of a large proportion of the undergraduate population [3]. The National Center for Education Statistics (NCES) acknowledges there is no precise definition for non-traditional student, but suggests that part-time status and age are common elements [11]. Other common characteristics of the NT student include: full-time employment, single parent, and eligibility for financial aid. Any and all of these variables can accumulate into external obstacles toward the NT’s degree completion. Internally, the NT’s academic hurdles are similar to the traditional student; time management, course loads, technology access, and financial obligations [11].

Between the years 2012 and 2017, students from Computer Science, Environmental Science, Engineering, and Technology were selected to participate in the S-STEM program. In focusing on NT students, several external factors were identified to have a greater impact on their (NT) perception of the academic experience [9]. Numerous studies compared traditional to non-traditional student populations discovered that among NT students, managing competing priorities, such as work, children, extended family, voluntary service, and travelling time to-and-from campuses ranked the highest when compared to traditional students [14]. Many NT students reported that multiple external obligations in their lives contributed to difficulties with attendance, including family obligations concerning childcare [13]. Many of these conflicts were observed over the five years of scheduling S-STEM Scholar events where attendance to our S-STEM Scholars programs had to take into account that many of these students would have external obligations that would conflict with organizing group activities.

Additionally, many of our S-STEM Scholar participants came from both an older part-time student population, and/or commuter student population that reflected the increasingly larger portion of the overall student body. It was understood that these students have a higher rate of attrition from college than their more traditional (4-year) counterparts. However as documented research has determined, the reasons for the drop-out rate is not as well understood unless we review some of the potential causes [8]. According to the National Survey of Student Engagement from 2006, many of the external obstacles facing NT students contribute to the difficulty for them to develop peer relationships (study groups) at the university [14]. Those students that are employed and seeking degree completion identified many professional barriers exhibited in the workplace including a lack of tuition reimbursement, competing time management schedules, and/or lack of release time from work. Also institutional barriers inhibiting access to higher education included the high cost of tuition, and diminished affordability [4]. Furthermore, because adult learners (NTs) also face the barriers of simply coping with previously outlined external factors add additional stress and/or anxiety are compounded by the added academic stresses [4].

These NTs are also subject to age-related intimidations regarding their math performance influenced by the stereotype that adults are not as cognitively competent as younger students [4]. Though literature on math attitudes in adult learners is limited despite the acceptance of the importance of mathematical understanding, many adults dislike and avoid math, even those who are competent in math. The reason for this dislike and avoidance is likely a combination of math anxiety and low confidence [4]. Though NT students face specific barriers, they also exhibit particular strengths. They're inclined to ask more questions and contribute more in class. They're more prepared in drafting their coursework, and they are more likely to complete their coursework [14]. Recent research with adult learners has examined these concepts outside mathematics and consistently finds that adult learners with higher levels of self-efficacy and self-concept are more satisfied with their postsecondary experience, more persistent when faced with educational roadblocks, and more likely to enroll in future courses [4].

Understanding these issues around the NTs and math literacy, extensive tutoring services were provided to the students on either one-on-one or small group appointments by request of the STEM Scholar. Early in S-STEM program, several observations were made when more often, a request for tutoring was initiated once the student was on the verge of failure in their course versus identifying they might need assistance and preemptively requesting tutoring assistance or joining a student group. Once students were identified to have issues around Math literacy, they were encouraged to be more proactive. This concern around Math (and Science) literacy was reflected in several institutional retention policies in addressing the needs of NTs. Students should be encouraged to seek tutoring assistance from available learning-centers, and faculty should play an active role in continually identifying and recommending qualified students to work as tutors [7]. The successful implementation of these learning-centers consisted of providing adequate and appropriate facilities, preferably located in convenient locations for these NT students, especially those who commute or live off-campus. The creation of study groups is encouraged, as well as supervision of students to ensure completion homework [7]. Within these learning-centers, effective retention initiatives that supported student diversity in learning that may require different approaches to college teaching, even in math and sciences [10].

Preliminary evaluations of students found that while most students prefer the new approaches to learning, women and some minority students demonstrated differences in preferred learning styles as assessed by the Myers-Briggs Inventory [5]. Additionally, when considering the external obstacles and characteristics of NT students, it cannot be assumed that students are largely isolated from worldly concerns. Students may have learned to recognize “A” level mastery of the subject matter, and have a good idea of how long it will take to achieve it, but still have their plans interrupted by externally imposed changes in work schedules, by sick children (especially in single parent households) or other non-academic factors. These constraints are less severe with traditional student populations where traditionally many institutions of higher education are founded. Going forward, our institution will need to consider that divergent constraints are greater for the non-traditional student populations that now form the new majority in higher education [7].

According to the 2014 US Census Report, people with bachelor’s degrees in science, technology, engineering and math are more likely than other college graduates to have a job, but most of them don’t work in STEM occupations [2], [12]. As acknowledged, the report was not an indication of an oversupply of STEM graduates. Many STEM students are securing jobs in careers that were outside the traditional titles related to STEM in areas of supply-chain management, inventory control and quality control where technical knowledge is required [12]. It was identified there is a broad market for people with the right credentials, even though STEM jobs contribute to less than 6 percent of employment [12]. Additionally, STEM skills are in demand regardless if the occupations are not considered STEM occupations where STEM graduates use skills learned in their degrees [2]. According to the U.S. Department of Labor, the small percentage of U.S. workers employed in fields related to science and engineering are responsible for more than 50% of our sustained economic expansion [1]. To benefit our economy and society, our national priority should be on encouraging more students to study STEM. Unfortunately, the U.S. is trending in the opposite direction. In the early 1980’s, about 40 percent of the world’s scientists and engineers resided in the U.S. Today that number has shrunk to about 15 percent [1]. The STEM Scholars monthly seminars focused on promoting the pursuit of gainful employment, or graduate school and research in STEM. Developing essential and soft skills training over the five-year period, as well as promoting internships was a priority. As we look to the future of improving the size and the composition of the STEM education pipeline it is important to encourage auxiliary STEM-related educational practices and services for those NT students challenged by a conventional system that fails to understand or address their specific needs.

### **Project Specific Objectives:**

As outlined in the grant application, the following objectives were specified:

Objective 1 - To financially support 20 talented and financially needy incoming freshmen from entry to degree completion: This objective addresses the NSF S-STEM program goal to improve educational opportunities for students in identified populations of interest in Maine.

Objective 2 - To financially support 21 talented and financially needy community college transfer students from entry to degree completion: This objective addresses the NSF S-STEM

program's goal to improve educational opportunities for students in identified populations of interest in Maine. As part of the scholarship's realization, the goal was to identify transfer students from area associate degree programs transferring into a baccalaureate degree program into one of the participating S-STEM disciplines.

Objective 3 - To attain retention rate of 90% for USM/NSF STEM Scholars by the 2nd year of enrollment: This objective addresses the NSF S-STEM program goal to increase retention of students to degree achievement and improve student support programs. As part of the NSF scholarship achievement, to successfully complete a stage within an associate, baccalaureate, program in one of the S-STEM disciplines that is documented as a point of unusually high attrition.

Objective 4 - To attain an 85% or higher rate of graduation for USM/NSF STEM Scholars: This objective addresses the NSF S-STEM program goal to increase retention of students to degree achievement and improve student support programs, as part of the NSF scholarship achievement for students to receive an associate, baccalaureate in one of the S-STEM disciplines.

Objective 5 - To attain an 80% placement rate for the USM/NSF STEM Scholars in STEM jobs: This objective addresses the NSF S-STEM program goal to increase numbers of well-educated and skilled employees in technical areas of national need.

Objective 6 - To establish articulation agreements with the participating community colleges: This objective addresses the NSF S-STEM program goal to improve educational opportunities for students, as part of the NSF scholarship achievement for transfer students from an associate degree program to a baccalaureate degree program in one of the S-STEM disciplines.

### **Addressing Project Objectives and Results**

Over the course of the five-year program, Objectives 1 and 2 were met with a total of 72 participants that were provided educational opportunities and resources toward degree completion. Between Fall 2012 to Spring 2017, 72 students (4-year and transfer students) went through the STEM Scholars programs. A breakdown of those participants' results is as follows:

#### Overall Group

- 69.44% (50) have either graduated or on target to graduate May 2017
  - 33.75% (27) graduated
  - 31.94% (23) graduating Spring 2017
  - 12.5% (9) over the goal of 41 students
- 30.56% (22) did not complete the program
  - 15.28% (11) left the program by dropping below full time status requirement, yet stayed in school on part time status
  - 9.72% (7) left the program for poor academic performance requirements, status unknown
  - 4.17% (3) left the program to pursue a non-STEM identified degree

- 1.39% (1) left the program to transfer to a different out-of-state program in Computer Science

In regards to Objective 3 - To attain retention rate of 90% for USM/NSF STEM Scholars by the 2nd year of enrollment; and Objective 4 - To attain an 85% or higher rate of graduation for USM/NSF STEM Scholars. The breakdown of the 2012-2017 STEM Scholars Retention numbers and Graduation Rates as compared to the overall USM population is as follows:

- Cohort One: Freshmen Retention [Year-One to Year-Two] 30% Retained.
- Cohort Two: Freshmen Retention [Year-One to Year-Two] 90% Retained.
  - USM - First to second year retention rates of first-time bachelor's degree-seeking undergraduates (all) 65% Fall 2014\*
- Cohort One: Freshman degree earned in four years – 20%
- Cohort Two: Freshman degree earned in four years – 80%
- Cohort One: Transfer (Juniors) Retention: Year One – Year- Two: 82% Retained.
- Cohort Two: Transfer (Juniors) Retention: Year One – Year- Two: 70% Retained.
  - USM 69.2%\*\*
- Cohort One: Transfer (Juniors) degree earned in two to three years – 36%
- Cohort Two: Transfer (Juniors) degree earned in two to three years – 79%
- Cohort Three
- Seniors: all eight (100%) are expected to complete their degree by May 2017.

\*<https://nces.ed.gov/ipeds/datacenter/InstitutionProfile.aspx?unitId=acb1acb0b0af>

Table 1\*\*Source [http://usm.maine.edu/sites/default/files/oir/overall\\_retention\\_grad.pdf](http://usm.maine.edu/sites/default/files/oir/overall_retention_grad.pdf)

Sophomore, Junior & Senior Transfer Students							
Cohort	Year	Count	Retained To:				Degree Earned [1]
			Term 2	Year 2	Year 3	Year 4	
Fall	2012	862	85.2% *	69.2% *	48.5% *	17.6% *	36.9% by Year 4
Fall	2013	714	88.7%	69.6%	45.0% *	21.0% *	38.8% by Year 4
Fall	2014	692	82.8%	64.3%	39.9%		17.9% by Year 3
Fall	2015	717	85.8%	70.4%			0.7% by Year 2
Fall	2016	686	0.0%				

\* Cohort has been adjusted as allowed by IPEDS definitions

Notes:

[1] Not included in retention values. For example, those earning a degree by year 4 are not retained to year 4. Transfer students include both Transfer (TRF) and Readmitted (REA) students

Objective 5 - To date, the USM/NSF STEM Scholars program students are on track in regards to placement into STEM careers. Since the last reporting period, eighteen students graduated in May 2015 and eight of scholars are on track to graduate in May 2016. The May 2015 graduates

are reporting 89% success in career placement within their area of study, and/or enrolled in graduate studies in their field of study. The upcoming graduating cohorts of freshmen and transfer students are on track to be gainfully employed.

### Cohort Groups

Cohort One: Ten freshmen - Eleven transfers (Bridge Program - All)

- Graduated 8 38.10%
- Lost 13 61.90%
- Total 21

Cohort Two: Five freshmen - Twenty-two transfers (Bridge Program, freshmen only)

- Graduated 20 79.42%
- Lost 7 20.59%
- Total 27

Cohort Three: Twenty-four junior and senior transfer students. (No Bridge program)

- Graduated 22 91.67%
- Lost 2 8.33%
- Total 24

### Student research projects and internships:

To date, students from Year One and Year Two have participated in several research projects and sponsored academic research. This information is in more detail within the student profile section. Here are some of the highlights:

- STEM-Scholar (Env Sci) has been an active member and officer of their Environmental Science Club, participated in research on the feeding habits of juvenile river herring in the Penobscot River Estuary with Dr. Karen Wilson. This student has also presented her research at the Northeast Fish and Wildlife Conference, and University of Southern Maine's Thinking Matters Student Exhibition.
- STEM-Scholar (Env Sci) presented his research on Smelt Diets in the Penobscot River Estuary with Dr. Karen Wilson at the Northeast Fish and Wildlife Conference, and University of Southern Maine's Thinking Matters Student Exhibition. He also volunteered time with local high schools and clubs on environmental projects.
- STEM-Scholar (Env Sci) has been member and officer of DES student group and University of Southern Maine's Thinking Matters Student Exhibition, and coordinated events in the Portland area for environmental activities.
- STEM-Scholar (Eng) participate in the University of Southern Maine's Thinking Matters Student Exhibition and has been tutoring Statistics and Thermodynamics courses, volunteering for the Engineering Expo student competition, and an officer in the Engineering Students club.
- STEM-scholar (Tec) participated in an internship in the summer of 2013, as well as has been employed in his field of study part-time since his internship. He has been a volunteer for the Maine Appalachian Trail Club maintaining hiking trails.

- STEM-Scholar (Tec) has been teaching Basic Electricity at a local community college in her field of study, and a member and officer of her Student Manufacturing Society.
- STEM-Scholar (Comp Sci) has been coaching middle school Ultimate team, and designed a digital logic course for seventh graders.
- STEM-Scholar (Tec) has been involved in another scholar's team as a representative of Creative Writing Collective Magazine Team.
- STEM-Scholar (Env Sci) was accepted for the Kappa alpha omicron international honors society for environmental science. He was in the founding class at USM. He has also been involved with a research project, Titled - "Why is the River Brown?" Sponsor - DES and EPA, and Dr. Karen Wilson Funded – DES. He has also been a member and officer of a social fraternity leading community service activities for his chapter.
- STEM-Scholar (Tec) has been doing an internship (12-15 hours a week) with the USM IT and developing training modules and developing interactive maps.
- STEM-Scholar Tec) has been doing work-study within the Information & Innovation/Maine Cyber Security Cluster for the University of Southern Maine in Portland.
- STEM-Scholar (Tec) has been doing work-study within the Information & Innovation/Maine Cyber Security Cluster for the University of Southern Maine in Portland.
- STEM-Scholar Eng) participated in University of Southern Maine's Thinking Matters Student Exhibition.
- STEM-Scholar (Eng) participated in University of Southern Maine's Thinking Matters Student Exhibition.
- STEM- Scholar (Com Sci) participating in an internship within his field of study and is working part-time 10-15 hours a week.

#### Employment and Graduate School for early graduates

- Southern Maine CC instructor
- Graduate School Environmental Science
- A&L Laboratory
- IBM
- GAR Manufacturing
- Graduate School Computer Science
- Network Security
- Sage Data Security
- Pratt & Whitney
- Peregrine Turbine Technologies
- Bath Iron Works
- Graduate School - Biology
- Maine Medical Center Research Institute

In regards to Objective 6, USM is committed to developing college level articulation agreements with the community colleges. Presently there are 27 STEM related articulation agreements with area community colleges as well as two 2 others in the works that are STEM-related. Several new degrees have been developed at USM in Information Technology (BSIT) and Cyber



Security (BSCS) since the STEM Scholars program began in 2012. The BSIT program will include the option of spending two of the four years at local community colleges – Southern Maine Community College, York County Community College and Central Maine Community College – and a four-year option based entirely at USM. The new program initially will involve existing courses and faculty as it ramps up. The degree program will provide a smooth path of transfer from Maine’s community college system to a bachelor’s degree from USM based on a nationally standard curriculum, university officials said. A degree in information technology will prepare students to fill a gap in the workforce of Maine’s IT cluster, they said. Local industry and state government officials have asked for the program, which will improve the statewide prospects for excellence in the computer-based delivery of services and information. The U.S. Department of Labor has a bright outlook for the occupations that graduates of the program can seek, with more than 100,000 job openings nationally.

An additional new development in collaborations with USM, selected Maine Community Colleges, and the University of Maine system is the development of a system-wide Cyber Security lab and beginning Fall 2016, USM will be offering a cross-system degree in Cyber Security with nearly twenty new admitted students.

### Reflection

Each cohort of S-STEM participants was selected from a qualified list of students that had also been accepted to the University of Southern Maine. To date a majority of students have completed their degrees and/or are on-track to complete their degree within a predetermined timeline. The major goal of the grant is retention and graduation toward placement into STEM careers. In reflecting on some of the planned programs student remarked as influential, the programming developed for both the Summer Bridge program and the monthly S-STEM seminars that was devoted toward career development and transition to employment or graduate school was deemed positive.

Some of the activities developed for the Summer Bridge programs included field trips to area businesses and government institutions that seek USM interns and graduates. Programming for the monthly S-STEM seminars included USM graduates in relevant STEM program areas to provide direction and insight on their own successes and experiences to relate best practices, as well as provide question and answer sessions for the STEM Scholars. Additional programming that was considered helpful included resume and cover letter development, career and internship searches, and practicums of enhancing their interviewing skills with mock interviews with faculty and guest panelists. These soft skills (essential skills) development programming, along with addressing strengths and weakness were identified as some of the most influential from student feedback.

In addition to the auxiliary programming for S-STEM participants, developing a pipeline transfer students from area community colleges was essential as part of the S-STEM scholars program. At present USM is committed to developing college level articulation agreements with the community colleges. A number of articulation initiatives have been implemented at the department levels within the STEM academic areas with 27 STEM related articulation

agreements with area community colleges as well as two 2 others in the works that are STEM-related.

In consideration of what worked and reviewing areas for improvement going forward, providing financial resources toward tuition and tutoring offered the most significant return on investment toward student success. The integration of faculty mentoring as representing each of the participating STEM areas provided greater oversight to student advising needs and managing academic scheduling within the timeframe of the grant. And finally, professional development of the STEM scholars as extracurricular activities is an important objective to build success in an academic program. In the case of the non-traditional student, the final result of our success in graduating with more students than originally projected was an important accomplishment.

In regards to areas for future improvement, each year of the S-STEM program built upon the successes of the previous semester without repeating those activities that became redundant. It is important to continuously seek feedback from your student population, even when they're reluctant to provide this commentary in traditional forms. Seeking alternative and various means of communication is effective. Additionally, incorporating some of the successes in programming and targeted tutoring services could prove as influential within the greater student population. S-STEM has served as an example of an incubator for successful STEM student retention strategies and experiences for the non-traditional student population.

## **Closing**

In reviewing the accomplishments of the STEM Scholars program and meeting goals and objectives, the program exceeded the expectations of providing academic opportunities to 41 students by assisting and graduating an anticipated 50 students to enter the workforce with degrees in Computer Science, Engineering, Environmental Science, and Technology. In comparing the current retention rates of the SSTEM Scholars to the greater population of students at the University of Southern Maine, on average the STEM Scholars did better. However though we did not meet the ambitious goals of the grant, our numbers were trending upward to those goals. Going forward the project provided opportunities and experiences to share and improve retention rates in the future. Many of these students were able to complete their degrees more rapidly and advance on to careers in the workforce, or pursue graduate studies. Providing a channel through the STEM Scholars for degree completion changed the outcomes for fifty new graduates.

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