Extended Abstract with Poster

Lowering Barriers to Enhance 2 + 2 Transfer Student Success, Persistence and Retention: The Dallas STEM Gateways Collaborative

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Abstract

The University of Texas at Dallas, Collin College, and Richland College of the Dallas County Community College District have established a joint effort, the NSF-sponsored Dallas STEM Gateways Collaborative, to significantly increase the number of undergraduate students completing degrees in Science, Technology, Engineering, and Mathematics (STEM) in the North Texas region. Building upon previous cooperation among these three institutions and the remarkable concentration of high-tech businesses in the Dallas-Fort Worth Metroplex, the Collaborative has implemented best-practice methods to bring about a cultural change that will lead to a sustained increase in the production of STEM-trained graduates. First, the Collaborative has strengthened recruitment into introductory STEM courses and expanded the use of student mentoring within those courses to encourage student selection of STEM majors and classroom success. Second, it has increased opportunities for internships and undergraduate research experiences for students early in their college career to encourage students to remain committed to the pursuit of STEM majors. Finally, a concerted effort of curriculum alignment across all STEM fields at the three participating institutions combined with a formal professional development program aimed at spreading effective pedagogical techniques across all three institutions has been designed to enhance teaching effectiveness at the critical introductory level. The Dallas STEM Gateways Collaborative program is built to enhance the number, quality, and diversity of undergraduates successfully earning STEM degrees.

Introduction

There is now ample documentation that the United States is facing an economic crisis unless it

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increases its production of talented science, technology, engineering and mathematics (STEM) graduates.[1,2] As described in *Rising Above the Gathering Storm*,[1] the global demand for skilled STEM workers is increasing and the number of American students pursuing STEM careers is likely to continue to decline unless the Nation intervenes. In areas like the Dallas-Fort Worth metroplex, with its concentration of high tech businesses and industry and rapidly growing population, the need is made even more apparent.

The state of Texas, recognizing the need for a scientifically and mathematically literate citizenry recently introduced a new high school graduation requirement: each student must successfully complete four years of science and four years of mathematics to earn a high school diploma. Even with this additional high school preparation, many students who have an interest in STEM careers will find the traditional undergraduate courses in STEM fields intimidating. Furthermore, many who start their undergraduate careers in community colleges find barriers to transferring to four-year colleges and universities to finish their baccalaureate degrees.

In spite of the alarming national trends, many colleges and universities have recognized that by creating programs that excite and stimulate students early in their STEM careers, many more students will successfully earn their undergraduate STEM degrees.[3,4] For example, due to wide-spread efforts in the physics community, the number of undergraduates earning degrees in physics in the U.S. increased by more than 35% from 1999-2007 with almost all of these being domestic students. Detailed data are available from the Statistical Research Division of the American Institute of Physics. The lesson here is that focused efforts that address the entire student program, not just the curriculum, can lead to significant increases in the number of STEM majors.

To address the STEM workforce problem and to increase significantly the number of students earning undergraduate STEM degrees, the University of Texas at Dallas (UTD), Collin County Community College, and Richland College of the Dallas County Community College District have formed the Dallas STEM Gateways Collaborative (referred to as the "Collaborative" in this document), a cooperative project providing a comprehensive and coordinated set of activities focusing on the gateway experiences during the first two years of the students' undergraduate experience. The activities include recruitment and retention efforts aimed at STEM students combined with a series of curricular and faculty development activities that are designed to produce significant cultural changes in the institutions' focus on undergraduate STEM education. The activities build on and significantly extend existing collaborative activities and are in alignment with and enhanced by other recent initiatives at the three institutions. We report here on progress associated with establishing a pipeline of STEM students that begins in the high schools, proceeds through the two-year institutions and finishes with graduation at the four-year institution in STEM disciplines.

Results and Discussion

The Collaborative is a partnership between three institutions (UT Dallas, Collin College and Richland College) to facilitate the recruitment and success of STEM students. Specific programs include the following with selected activities highlighted in subsequent sections. The successful 2+2 articulation program in engineering (including important curricular alignment agreements) between Collin College, Richland College and UT Dallas was expanded to all STEM disciplines at both Collin College and Richland College. Enhanced Advising has played a key role in this effort at the community college level. Direct presentations to students, parents, and counselors coupled with the offering of Technical Dual Credit coursework at local high schools has produced a collaborative recruitment effort aimed at making the 2+2 programs known to high school juniors and seniors in the diverse Dallas-Fort Worth Metroplex. Expansion of the award winning Peer-Led Team Learning (PLTL)[5-9] program in gateway STEM classes at UT Dallas has occurred and is in the process of being leveraged to Richland College and Collin College. There have been many collaborative activities among the three institutions to build a STEM student learning community. These activities have included opportunities for: undergraduate research and internships, joint student organization activities, an undergraduate research fair and STEM mentoring career workshops. A Faculty Innovation Grant Award program was created to facilitate research and education innovations across all three institutions. There has been an expanded effort at Richland College to address the Math and Science Tutoring needs of STEM students in specific higher level Math, Physics and Chemistry courses. An outreach effort at Collin College to build a pipeline of STEM students targeted to attend UT Dallas through Robotics Camps and College Robotics Competitions is bearing success. Finally, and of particular significance, a robust method for the tracking of Collin and Richland transfer students within classes and degree programs at the University of Texas at Dallas has been developed to aid the Collaborative in channeling resources to appropriately lower transfer barriers for students.

Articulation Agreements

A major early activity of the Collaborative was the development of articulation agreements between UT Dallas and, respectively, Collin College and Richland College in the STEM disciplines. Separate agreements for engineering and computer science, biology, chemistry, physics, mathematics and geosciences was the result of a series of department specific alignment-articulation meetings of professors, deans and department chairs from each of the Collaborative's member institutions. In addition to the formal agreements, survey data show that participant views of each other's institutions have grown positively through collaborative interaction. Participants reached accord on course prerequisites, course content and instructional materials with each formal agreement including a provision for an annual review. Further, a matrix of the course equivalencies for each discipline, constructed by the STEM academic advisors from the three member institutions, became an attachment to each agreement. All who participated in the development of the STEM articulation agreements have agreed that these agreements provide

clear and safe paths for the Collin and Richland students who plan to earn a STEM baccalaureate degree at The University of Texas at Dallas. As these articulation agreements have been institutionalized, they now represent a platform for recurring future communication/collaboration among the STEM departments across all three campuses.

Summer Undergraduate Research Experiences for Transfer Students

Undergraduate research experiences have been shown to be an excellent opportunity for engagement and persistence within STEM degree plans.[10] Thus, the Collaborative placed twenty STEM students from Collin and Richland College in the research laboratories of UT Dallas faculty in the summers of 2011 and 2012 with an additional twelve planned for the summer of 2013. The research areas covered a wide STEM base including biology, chemistry, geosciences, applied mathematics, electrical engineering, mechanical engineering and computer science. The response from faculty and students has been overwhelmingly positive with, for example, a molecular biology student commenting that this is the best experience of her life and a faculty member sending an unsolicited e-mail report that his engineering student is outstanding and completing tasks so quickly that the faculty member is challenged to keep him occupied – a good problem to have! Most importantly, all twenty students who have participated in the program are currently or will be pursuing STEM degrees at UT Dallas.

Peer Led Team Learning (PLTL)

The integration of Peer-led Team Learning (PLTL)[9] into the UT Dallas STEM learning framework has been supported, in part, by the Collaborative. The PLTL program began in the Fall of 2008 with a pilot group of 161 students in General Chemistry I (CHEM 1311) PLTL and for whom the DFW (grade of D, F or Withdrawal) rate was less than 19% - an 18 percentage point drop from the preceding five-year historical average of over 37%. In the Fall of 2009, student enrollment in CHEM 1311 PLTL increased by 41% to 227 students and the DFW rate for that cohort was a remarkably low 9%, which provided additional encouragement for other STEM disciplines to consider PLTL support. Presently, up to twelve courses each long semester are PLTL supported including general and organic chemistry, physics and calculus with over 1000 students participating annually. Typical results show that students perform more than half of a letter grade higher simply by participating in PLTL. The PLTL program has now been institutionalized with partial support from student fees and online registration as for regular classes. The student demand is high with, for example, PLTL slots in chemistry often completely filling within an hour of being made available online. Finally, both Collin College and Richland College are now considering PLTL programs modeled after that of UT Dallas. In the former case, a faculty innovation grant (*vide infra*) from the Collaborative was awarded to Collin College biology faculty for a pilot study.

Faculty Innovation Grants

The Collaborative has introduced a faculty innovation grant program designed to facilitate faculty and student interaction across the 2 year and 4 year institutions. Thus, at least one faculty member from UT Dallas and either Collin College or Richland College are required as co-PIs on any submission. The series of recurring meetings across institutions that led to the formal articulation agreements described above have served as a critical vehicle in stimulating discussion among faculty concerning common research interests, resulting in the development of proposal ideas. This further solidified the value of regular faculty meetings involving members from all three institutions to the goals of the Collaborative. For example, Prof. Juan Gonzalez (UT Dallas) and Prof. Jonathan Lawson (Collin College) were awarded a proposal in 2012 on "Student-Directed Whole-Genome Sequencing of Enviromental Bacteria". This proposal involves both faculty members and their students interacting across institutions with Gonzalez providing a UT Dallas presence at Collin College and Lawson and Collin College students working in the UT Dallas research laboratories. Of particular note, this project connects directly to Lawson's formal biology course taught at Collin College.

Transfer Student Data Tracking

In order to benchmark and track the Collin College and Richland College transfer student population at UT Dallas, a robust, secure method is needed for accessing student data that addresses the appropriate questions relating to absolute numbers of STEM transfer students, identification of transfer student gateway courses, performance in classes and time to graduation in STEM fields. In addition, the impact of specific programs, including the summer research experience and PLTL for example, on transfer student numbers and performance hinges on such a method. One of the most significant achievements of the Collaborative has been the development of a method to track transfer students at UT Dallas. These data are providing rich information to not only assess progress, but to target interventions that will allow for greater transfer student success. Selected data are shown in Figures 1 and 2. The Collaborative objective of filling the pipeline with STEM students is shown to be working well as represented by the enrollment data in chemistry (Figure 1) over a five-year period. There is a dramatic increase in transfer students from Collin College and Richland College (as monitored by enrollment from the Dallas County Community College District, of which Richland College is a member) in the gateway chemistry courses at UT Dallas, but not in transfer students from other institutions. However, as shown in Figure 2, representative data from the same gateway chemistry courses clearly show that transfer students need intervention to be more successful as transfer student performance lags significantly behind that of native UT Dallas students. The data in both Figures 1 and 2 are consistent with data for gateway mathematics and physics

courses. As we implement Collaborative interventions, the success, persistence and retention of transfer students will be tracked by our innovative data collection methodology. Conversely, specific *data driven* interventions at the three institutions can now be targeted to aid transfer students in final STEM baccalaureate success.

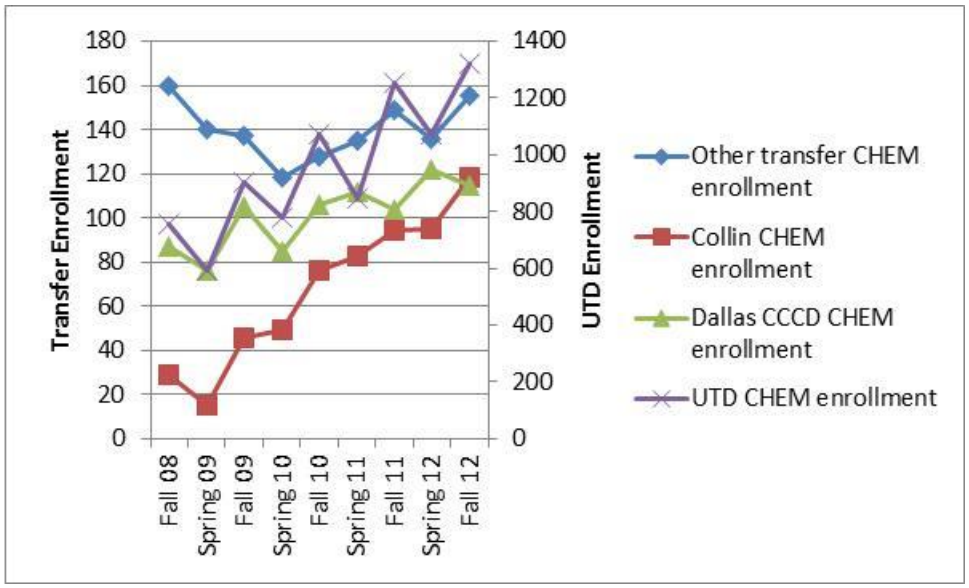

Figure 1. Enrollment data for transfer and native students in chemistry courses at UT Dallas.

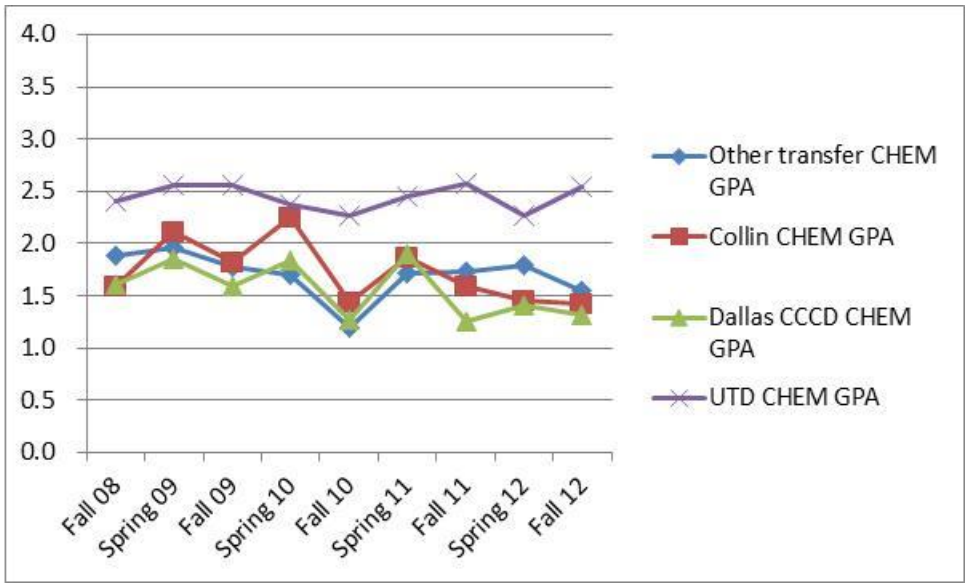

Figure 2. Average GPA of transfer and native students in chemistry courses at UT Dallas.

Summary and Conclusions

The Dallas STEM Gateways Collaborative has been established to provide a comprehensive and coordinated set of activities across three campuses (UT Dallas, Collin and Richland Colleges), focusing on the gateway experiences during the first two years of the students' undergraduate career with the ultimate goal of establishing and growing a pipeline for STEM majors from the two year institutions, Collin College and Richland College, to UT Dallas that will lead to more STEM majors in an absolute sense and greater opportunities for success and engagement as these students proceed to STEM degrees. The pipeline has been established with focus now being drawn to interventions that will facilitate transfer student success at the four-year institution.

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DAVE GALLEY
Dave Galley serves as the Director of Engineering and is a member of the faculty at Collin College. He has twenty years of industrial experience working as an engineer and in management and executive capacities. His current interests focus on the recruitment and success of STEM students from high school through the university and into the workplace.

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