Extended Abstract with Poster

AURAS: Increasing Retention in High-loss Mathematics and Chemistry Courses

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Abstract

The University of Texas at Arlington (UTA) is implementing AURAS, the "Arlington Undergraduate Research-based Achievement for STEM collaboration", as a combined effort of the Colleges of Science and Engineering to increase retention of incoming first-semester freshmen in these colleges. The goal of AURAS is to use research-based approaches and best practices to increase the retention of science, technology, engineering and math (STEM) majors, particularly women and other students underrepresented in STEM. Specific objectives dovetail to meet this goal, with program components linked to one or more of these objectives. Program components include (1) implementation of the recognized best-practice "Emerging Scholars" program in high-loss courses in mathematics (specifically, Pre-calculus and Calculus I & II) and chemistry (Chemistry for Engineers and General Chemistry) courses, and (2) undergraduate research opportunities ("authentic experiences") pairing first- and second-year undergraduates with faculty mentors for the purpose of providing research experiences. The authentic experiences component began in Spring 2010 and the first Emerging Scholars programs in mathematics and chemistry began in Fall 2010.

Once data from three semesters of implementation of the Emerging Scholars courses was collected and analyzed, it was apparent that this model of instruction was effective in improving

success rates in high-loss courses. Current efforts are devoted to exploration of ways to make the project more sustainable. The paper will document the success of the program and discuss current efforts toward sustainability. The project is supported by National Science Foundation grant #0856796.

Introduction

The Science, Technology, Engineering, and Mathematics Talent Expansion Program (STEP) is a congressionally-mandated program administered by the National Science Foundation (NSF). The STEP program has as its goal increasing the number of students (U.S. citizens or permanent residents) receiving associate or baccalaureate degrees in established or emerging fields in science, technology, engineering and mathematics (STEM) in the United States.

UT Arlington's STEP grant #0856796 began in Fall 2009. It is called AURAS, the Arlington Undergraduate Research-based Achievement for STEM collaboration. The way in which AURAS is intended to increase the number of graduates in the STEM fields is to increase the pass rates in a set of courses which were identified as high-loss courses for students intending to major in Biochemistry, Chemistry, Mathematics, Physics or one of the 8 undergraduate engineering majors. Note: a 9th engineering undergraduate major in Bioengineering was added in Fall 2012. The identified courses were Pre-Calculus II, Calculus I, Calculus II, General Chemistry I, and Chemistry for Engineers.

The designed interventions intended to produce a change in pass rates for these courses were modeled after the Emerging Scholars Program (ESP) implementations [1]. The ESP model requires increased student time in a seminar/workshop setting to promote key features and to "learn how to learn" mathematics or chemistry. The ESP model has been adapted at over one hundred campuses across the nation and has been broadened to include a variety of introductory science and engineering courses as well as those in the introductory mathematics sequence. Research studies show that the ESP model positively impacts retention in a STEM-based major.

The AURAS program

The AURAS program at UT Arlington is a combined effort of the Colleges of Science and Engineering. It has as its specific goal to increase retention of incoming first-semester freshmen in these colleges. At the time this effort was proposed, the first-year retention rates in the colleges were approximately 69%, meaning that for students beginning as first-time first semester freshmen in the Fall of 2008, only 69% of this group of students returned to UT Arlington in the Fall of 2009. Specific objectives of the AURAS program designed to increase the retention rates are:

Objective #1: Pedagogical reform in high-loss courses to provide intensive intervention to target students.
Objective #2: Authentic learning experiences to increase STEM interest and offer financial support.
Objective #3: Discipline-based research and evaluation to verify results and foster long-term change**.**

Implementation of AURAS

In Fall 2010 the first courses under the ESP model were begun, with approximately 25 students in AURAS sections of Pre-calculus II, Calculus I, General Chemistry I and Chemistry for Engineers. In each case, the lecture sections for the AURAS students were the same sections open to non-AURAS students, lab sections (where required) were the same as those for non-AURAS students, but an additional "AURAS seminar" was added for the AURAS students. The AURAS seminar was a 4-hour unit designed not only to help students master course material by providing help and additional challenging content but also to provide a sense of community and engagement to those involved. The program was modeled after successful Emerging Scholars Programs at other schools (e.g., UT Austin), but also included elements of the Learning Assistant Model (e.g., University of Colorado at Boulder) to provide additional study and college career skills to the students.

Additionally, undergraduate research experiences were available to those who successfully completed the AURAS coursework. In these cases, interested students were matched with faculty in the College of Engineering and College of Science. Students received a stipend for up to 10 hours of work per week, over the period of one semester, renewable when both the mentor and mentee requested it.

Discipline-based research focused on conducting educational research in the areas of Physics (spatial intelligence), Mathematics (understanding of continuity and derivatives) and Chemistry (methods for effective instruction of stoichiometry and learning outcomes-based assessment strategies).

Results

In Spring 2012, at time of the project's 3rd year review, results of the AURAS ESP classes were seen to be very promising.

As shown in Table 1, four classes with high drop and failure rates were targeted during each of the semesters Fall '10, Spring '11 and Fall '11. For each of the two fall semesters, there is data from Math 1323, Precalculus II. The table shows the pass rate for those two fall classes combined: for the students in the AURAS seminar for Precalculus, the pass rate was 56%, compared with the pass rates of 35% for students in the same lecture section but not in the AURAS seminar, and the pass rate of 42% for students in all Precalculus lecture sections but not in the AURAS seminar. At the same time, the drop rates for students in the AURAS seminar in either semester was 21% as compared to the drop rate of 35% for students in the same lecture section but not in the AURAS seminar, and a drop rate of 27% for students in all lecture sections but not in the AURAS seminars. The results for the Chemistry for Engineers (Chem 1465) class have been more dramatic. There was a Chem 1465 class during each of the three semesters shown in this table. Students in the AURAS seminar for Chem 1465 have an 80% pass rate compared to a 51% pass rate for students not in the AURAS seminar, and have a drop rate of 0% compared to a drop rate of 18% for students not in the AURAS seminar.

Fall 2010, Spring 2011 & Fall 2011 composite												
Course		A	B	C	**Pass**	D	F	I	Q	W	**Drop**	Total
Math 1323*	ESP	5	16	6	**56%**	3	8	0	0	10	**21%**	48
Math 1323*	non-ESP (1)	13	14	24	**35%**	10	34	0	3	48	**35%**	146
Math 1323*	non-ESP (2)	57	84	96	**42%**	62	108	1	8	146	**27%**	562
Math 1426	ESP	15	14	12	**80%**	8	0	0	0	2	**4%**	51
Math 1426	non-ESP (1)	17	34	37	**56%**	19	17	0	2	31	**21%**	157
Math 1426	non-ESP (2)	85	218	206	**48%**	156	147	2	6	239	**23%**	1059
Math 2425#	ESP	5	4	9	**72%**	2	2	0	0	3	**12%**	25
Math 2425#	non-ESP (1)	12	11	12	**65%**	1	7	0	1	10	**20%**	54
Math 2425#	non-ESP (2)	32	52	47	**52%**	14	39	1	4	64	**27%**	253
Chem 1441	ESP	15	15	15	**71%**	8	6	0	1	3	**6%**	63
Chem 1441	non-ESP (2)	166	176	226	**48%**	134	225	4	8	238	**21%**	1177
Chem 1465	ESP	13	15	19	**80%**	5	7	0	0	0	**0%**	59
Chem 1465	non-ESP (2)	19	54	89	**51%**	45	49	2	4	53	**18%**	315
(1) non-ESP same section					*** Math 1323 Fall 2010 & Fall 2011 only**							
(2) non-ESP all sections					**# Math 2425 Spring 2011 only**							

Table 1. ESP vs. non-ESP composite class performance results over the first 3 semesters

Additional semesters' results are being analyzed at this time and will be available at the time of the presentation.

The Future

A tenet of the STEP program is to create institutional change which will remain after the life of the grant funding. After the first year's result were available, it became clear to the Department of Chemistry & Biochemistry that the AURAS seminar was making a meaningful difference in the success rates of its majors. The department took the step of requiring that its chemistry majors and biochemistry majors enroll in the AURAS section on General Chemistry I. At the urging of the Internal Advisory Committee for AURAS, the sustainability of the AURAS efforts have been under consideration even during the 2nd year of implementation of the ESP courses. Efforts toward sustainability are focused on making less labor-intensive the instructional interventions. With this in mind, the AURAS seminar for Chemistry for Engineering was reduced to a 2-hour seminar in Fall '12. The results of this modification are not yet available, but student satisfaction appears to be increased. The sustainability of these efforts continue to be front and center in the planning for the remaining years of this grant and for the continuation of components of this successful project beyond the grant period.

References

1. Treisman, Uri. Studying Students Studying Calculus: A Look at the Lives of Minority Mathematics Students in College. The College Mathematics Journal, Vol 23, No 5 (Nov 1992), pp. 362-372.

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