A Comparative Analysis of Underrepresented Minority Groups Taking a New First Year Engineering Course (Extended Abstract)[1]

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Abstract

The University of Texas at Arlington (UTA) enjoys a culturally diverse and rich student body that includes many underrepresented minorities and the university has been designated as a Hispanic Serving Institute (HSI). As part of its mission, UTA has been seeking strategies to increase retention of their engineering student population. A new first year engineering course was created at UTA in order to address this issue, especially as it applies to retaining students within underrepresented minority groups. Specifically, the course utilizes active teaching and learning methods that have shown to be especially effective not only for engineering students as a whole, but in encouraging underrepresented minorities to gain the knowledge and confidence they will need to further their academic and professional careers. This presentation will compare the student performance metrics for all participating student populations to assess the effectiveness of this new class as it relates to underrepresented minorities.

Keywords

Demographic study, SCALE-UP, active learning

Background

UTA has created a new first year engineering course, named ENGR 1300 – Engineering Problem Solving, designed specifically to address student success and retention. It is intended that students take this course during their first semester at UTA with a co-requisite of Pre-Calculus. Specifically, considering UTA's diverse student population, ENGR 1300 is designed using the SCALE-UP[1] method, which has been implemented in many universities[2] and has been shown to increase student success, regardless of student background. The SCALE-UP method includes using a classroom that focuses on active learning, implementing problem-based activities, and encouraging peer instruction and collaborative learning among diverse student groups. Additionally, other "high touch" teaching strategies are emphasized as these have been shown to positively affect student success.

Methodology

The complete discussion of the methodology may be found in this abstract[3]; however, for ease of discussion, it is also included here. The SCALE-UP method required several modifications of the existing curriculum in order to facilitate implementation of active, problem-based learning strategies. First, a new classroom was constructed as shown in Figure 1. Students are arranged around around circular tables in teams of three, and marker boards are mounted around the room.

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This arrangement allows students to solve problems together, fostering peer instruction, which has been shown to be more effective in student success than traditional lecture-based styles. The arrangement also allows the professor to easily move among the students as they work on solving problems. This physical arrangement allows more one-on-one instructor interaction, providing for more personalization of the learning process.

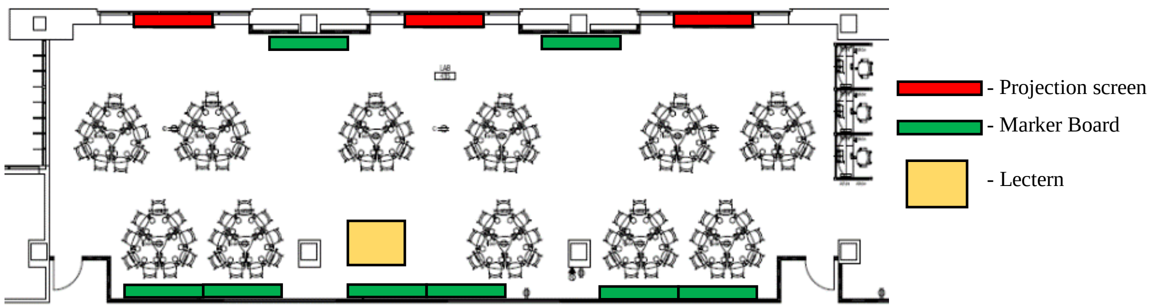

Figure 1. *Classroom layout*

The second key strategy was the hiring of upperclassmen to act as in-class assistants. These assistants offer support during the class by essentially reducing the student-to-teacher ratio, again, providing more one-on-one instruction within the class. Also, students are often more comfortable asking the assistants rather than their teacher. Finally, in order to increase more one-on-one instruction and to relieve the increasing demand of office hours due to the number of students, the assistants conduct free tutoring sessions in the evenings where they help the students by guiding them through the problem-solving process. The in-class assistants are key contributors in fostering an environment where students are open to learning the material by asking questions of their peers.

Finally, the in-class teaching methodology had to be constructed focusing on active learning rather than traditional lecture style learning. Traditional lectures and passive learning techniques have shown to be decreasingly effective in student success and knowledge retention. Therefore, active, problem-based learning has been implemented in ENGR 1300. This method involves mini-lectures that leave time to focus more on students applying knowledge by solving problems within the classroom. Students work in their teams around the marker boards solving engineering mathematical and coding problems, allowing them to learn the principles of the class by solving real-world engineering problems, rather than simply relying on notes and examples from the professor. Also, the students have many tools to help them learn robust studying skills, such as a reading guide, interactive online tools, and additional challenging problems that they use to practice further with each other. Class time focuses on actively learning the process of problem solving with “high touch” interactions between the professor and in-class assistants, rather than passively learning through limited example problems solved by the professor alone.

Results and Discussion

This study will present student success findings first between genders and then among the major ethnic groups represented in ENGR 1300. First, we will consider the differences in student performance between genders. In this study, success rate is defined as earning a C or better in this course. As can clearly be seen in Figure 2, females taking ENGR 1300 far outperformed their male counterparts when considering letter grade distribution. Also, females enjoy a higher success rate over their male counterparts. Female success rates were 59.8% in the Fall and 65.7% in the Spring, while male success rates were 57% and 59.9% respectively.

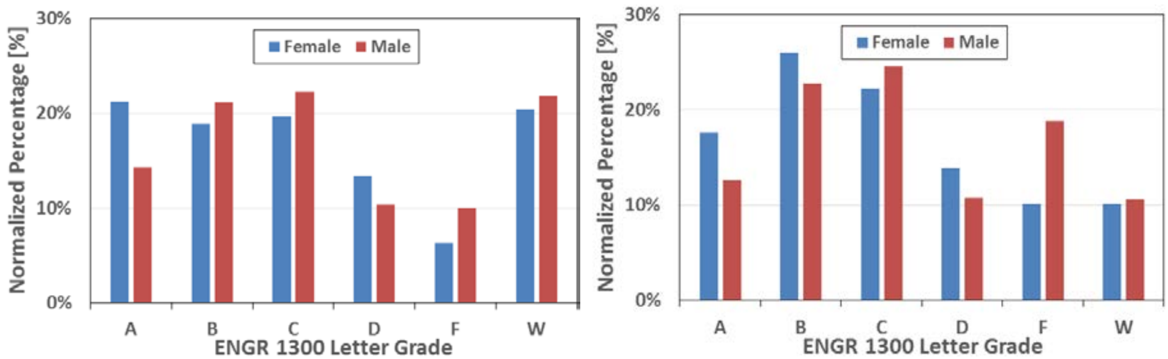

Figure 2. *Normalized grade distribution comparing genders for Fall 2015 (right) and Spring 2016 (left)*

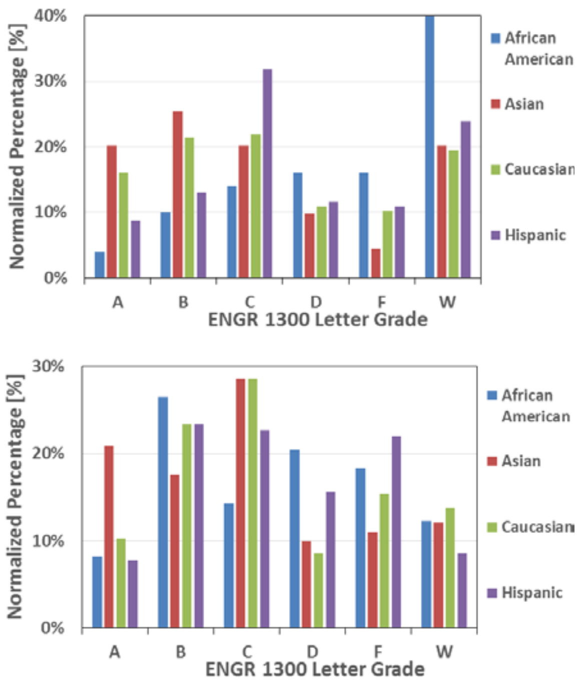

Figure 3. *Normalized grade distribution comparing the major ethnicities represented for Fall 2015 (top) and Spring 2016 (bottom)*

It should be noted that the withdrawal rate in the Fall was much higher than in the Spring. Anecdotal evidence from the students indicated that they assumed that ENGR 1300 was similar to the one credit course it replaced and its lack of rigor. Therefore, they insufficiently prepared for the first exam, resulting in very low test scores. To combat this perception for the Spring semester, a low-stakes quiz was added before the first exam. The addition of this self-diagnostic tool, along with the natural change on student perception of ENGR 1300, let to a much lower withdrawal rate in the second semester.

To further explore the effectiveness of ENGR 1300, we will focus on the four main ethnic groups represented. Figure 3 shows the comparison of grade distributions for these ethnic groups for the Fall and Spring semesters, and Figure 4 shows the comparison of success rates. The first notable difference is seen when comparing the success rates between these two semesters. All ethnic groups saw a success rate increase in the Spring semester, which can be attributed to minor adjustments made in the delivery of the class and student perception of

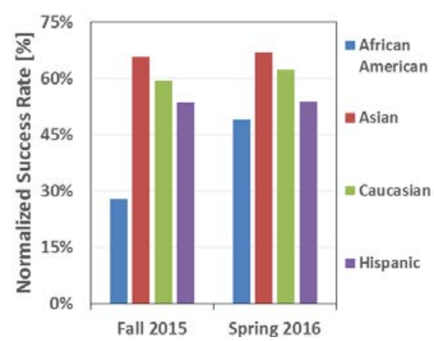

Figure 4. *Normalized success rates comparing the major ethnicities represented*

difficulty. The second notable difference is the drastic improvement of the African American students. Furthermore, the Spring success rate shows that all student groups are performing more uniformly.

Finally, in order to further understand the cause of the improvement of the different minority groups, Figure 5 analyzes the success rates of the groups versus their initial admission status. In the Fall semester, the success rates for these four groups were greatly affected by their admission status, heavily favoring first-time, first year students to the point that most of the ethnic groups performed to the same level. This fact initially suggested that admission status had more effect than other factors, but in the Spring this factor did not present remarkable differences among the student populations with the exception of Asian students. Though new, first-time, first-year students had higher grade averages than the transfer student population in both semesters, more analysis is need to determine the impact of this variable when considered along with data on repeat students, class-roll restrictions, and math qualifications.

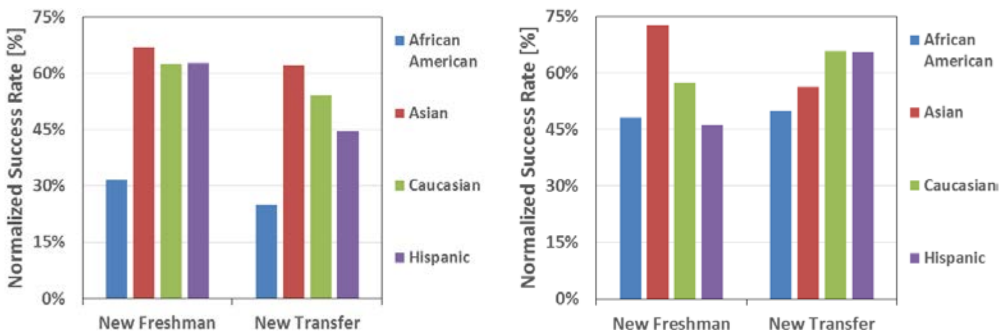

Figure 5. *Normalized success rate for the major ethnicities further separated by admission type. The grades for Fall 2015 are on the right and for Spring 2016 are on the left*

Conclusion and Future Work

This paper demonstrates the initial passing success rate among students in the new first year engineering course. The passing rates, and the improvement of student success from one semester to the next, seem to indicate the positive learning outcomes of problem-based, active learning, with high-touch teaching strategies. More analysis is needed to explore effects of prior education experience along with other variables that could possibly influence success. However, the semester-to-semester improvement of success rates were observed across gender and ethnic groups, and this initial analysis provides data that may be used to encourage participation from students of underrepresented groups in engineering.

References

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2 Ingram, B., M. Jesse, S. Fleagle, J. Florman, and S. Van Horne, Cases on Higher Education Spaces: Innovation, Collaboration, and Technology, IGI Global, Hershey, PA, 2013, pg. 165-185.

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David J. Ewing –Earned a Bachelor of Science degree in Mechanical Engineering from Pensacola Christian College and a PhD in Mechanical Engineering from Clemson University. He spent several years teaching in a first year engineering program at Clemson University. He is now a senior lecturer at the University of Texas at Arlington, where he continues to teach first year engineering courses. Combined, he has been teaching first year engineering courses for over five years. His previous research involved thermal management systems for military vehicles.