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The Effects of Co-Enrollment on the Retention and Success of Mechanical Engineering Freshmen

Dr. Laura A. Ruhala, Kennesaw State University

Laura Ruhala, PhD, is an Associate Professor of Mechanical Engineering at Kennesaw State University, a newly formed university resulting from the consolidation of Southern Polytechnic State University and the former Kennesaw State University. Prior Laura was an Assistant Professor at the University of Southern Indiana. She enjoys research in biomechanics, impact, and engineering education. Laura earned her PhD from Penn State and her BSME from GMI Engineering & Management Institute, now known as Kettering University. She has years of industrial experience at General Motors and Pride Mobility. She has been involved with ASEE since 1996, most recently as a Director in the Mechanics Division. She lives in the Atlanta area with her wonderful husband, Richard, and their precious dog, Rosebud.

Dr. Hillary Steiner, Kennesaw State University

Hillary H. Steiner, Ph.D., is Assistant Professor of Educational Psychology and Associate Director of Learning Communities in the Department of First-Year and Transition Studies at Kennesaw State University. She received her Ph.D. in Educational Psychology with a concentration in Applied Cognition and Development from the University of Georgia in 2003, where a portion of her dissertation research was named "Paper of the Year" by Gifted Child Quarterly. A recipient of the American Psychological Association's national Teaching Excellence Award, she teaches first-year seminars and introductory psychology in a variety of learning communities. Her current research and professional interests include metacognition and self-regulation, faculty development, and the use of targeted learning communities to ensure STEM students thrive in their first year of college.

Ms. Catherine L. Bradford, Kennesaw State University

Catherine L. Bradford is Director of Kennesaw State University's Learning Communities Program and incoming Chair of the National Learning Communities Consortium, host of the annual National Learning Communities Conference. She teaches the first-year seminar within learning communities and provides academic and graduation coaching for a group of students attending the university on state-funded merit scholarships.

Dr. Ruth Ann Goldfine, Kennesaw State University

Ruth A. Goldfine, PhD, is a tenured Professor and Chair of the Department of First-Year and Transition Studies at Kennesaw State University, a position she has held since 2013. She holds a doctorate in English and has been teaching in higher education for nearly 20 years. Prior to joining Kennesaw State University, Ruth held a position as a Technical Editor at the University of Dayton Research Institute, where she worked closely with engineering faculty engaged in research projects. Throughout her career in academia, Ruth has worked primarily with first-year students, initially as an instructor of English composition and later as a first-year seminar professor. Her work in the classroom continues to inform her research, which is focused on first-year students, students in transition, and, most recently, first-year STEM students. Her research interests also include the use of technology in the composition classroom, first-generation students, and students in transitions beyond the first year of college.

Dr. Nirmal Trivedi, Kennesaw State University

Dr. Nirmal Trivedi is the Director of First-Year Seminars and Assistant Professor of English at Kennesaw State University. His research and teaching areas include first-year seminars, common intellectual experiences, peer mentoring, and digital pedagogy.

Mr. Scott Larisch, Kennesaw State University

Born in the east and reared in the Rockies, Scott Larisch holds certain degrees in higher education from appropriate schools with sufficient pedigree. After a brief sojourn as a slave of academe he pursued careers in research, aviation, and consulting. He returned to academe when he discovered that it was here that he could do what he most enjoyed and surround himself (for the most part) with people he enjoyed being around. Scott has traveled the country extensively, ultimately selecting a California girl as his life-partner and supreme leader. They have been residents of The South for two decades and consider it their adopted home. Together, they have four children, each special in their own way. In his spare time (hah!), Scott enjoys reading, cooking, hiking, and (almost) any sport that involves water. His current goals are to master the guitar, the longboard, and the FlowRider®.

THE EFFECTS OF CO-ENROLLMENT ON THE RETENTION AND SUCCESS OF MECHANICAL ENGINEERING FRESHMEN

Abstract:

This Work-In-Progress paper describes ongoing efforts at Kennesaw State University to combine a two-credit introduction-to-major course with a three-credit first-year seminar course. We are also implementing learning communities that will tie first-year introduction-to-major courses with other first-year courses such as English Composition 1 (ENGL 1101) and Introduction to Graphics. Since Mechanical Engineering is the largest engineering department at Kennesaw State, we are piloting this idea with a three-credit Introduction to Mechanical Engineering (ME 1001) course that includes learning outcomes typically found in a first-year seminar course. While trying to create a learning community for this project last fall, we experienced complications getting all instructors to agree to collaborate on content and assignments, which afforded us the opportunity to investigate the effects of co-enrollment alone on the academic success of first-year mechanical engineering students taking the same sections of a 2-credit-hour ME 1001 and a 3-credit-hour ENGL 1101. Academic success in ME 1001 among the students who were co-enrolled and those who were not co-enrolled is compared in this study. The success of the students was tracked using the following rubrics: attendance, course grades, peer evaluations during the design project, and retention for the following semester in the mechanical engineering program. The students that were co-enrolled had similar attendance and peer evaluation rates in the ME 1001 class, but earned lower grades in all areas. However the retention of the students that were co-enrolled was higher during the subsequent semester. Deeper analysis into the profiles of the students indicated that there were additional contributing factors to student success, and that student maturity and university experience may outweigh potential benefits of co-enrollment.

Background:

Research has shown that students who participate in first-year seminars are more successful academically and tend to persist in college to a greater degree than students who do not enroll in these seminars[1]. However, programs in the STEM fields, such as the Mechanical Engineering (ME) program at Kennesaw State University (KSU), typically have high-credit-hour requirements, as dictated by ABET, their accrediting body. Such high-credit-hour requirements leave little room for students to participate in classes that fall outside their majors, thus precluding or discouraging students in STEM majors from enrolling in a first-year seminar, which, at KSU, is a three-credit-hour course.

While, understandably, the addition of the three credit hours attached to the first-year seminar imposes an increased number of credit hours upon students, failure to take the course deprives them of the benefits of the seminar. These benefits have been shown to increase academic success and persistence, both at KSU and nationally[2].

The authors have received a grant to build a course that will offer students in high-credit-hour majors the benefits of a first-year seminar without substantially increasing the number of credit hours they are required to take. Specifically, students in STEM majors at KSU are typically

required to take a two-credit-hour course that is an introduction to their major field of study. This course shares in common some of the learning objectives of the first-year seminar. Consequently, we have envisioned a new seminar course that would integrate the introduction to the major course with the first-year seminar to create a new three-credit-hour course that incorporates the required information relative to the major and the essential elements of the first-year seminar. In this way, STEM majors will be given access to and benefit from the elements of a first-year seminar with an increase of only one-credit-hour, rather than three, in their programs of study. While this course will initially be implemented in Mechanical Engineering, the largest engineering program at KSU, it is hoped that the course can be a model for both the other engineering programs at KSU, and eventually have an even broader impact by becoming a model for STEM programs in the entire University System of Georgia.

The proposed course, which will be implemented in the upcoming Fall 2016 semester, will be modeled after an existing seminar that has been implemented successfully at Kennesaw State University within a targeted learning community for chemistry students. Extensive research has shown that learning community participation is linked to various beneficial educational outcomes[3], although in Mechanical Engineering sometimes those results are more quantitative than qualitative[4]. Learning communities, commonly defined as two or more courses linked by a theme, and in which students are co-enrolled, represent one of the ten High-Impact Practices (HIPs) designated by the Association for American Colleges and Universities[5]. However, learning communities traditionally function as a high-impact practice only when the faculty teaching in the community collaborate to design and administer integrative assignments and otherwise coordinate activities with one another. This research will explore whether the collaborative and integrative components of learning communities significantly impact the educational outcomes by first determining the impact of co-enrollment alone.

Implementing Only the Co-Enrollment aspect of a Learning Community:

At Kennesaw State University, first-year, full-time mechanical engineering students entering in Fall 2015 with fewer than 15 semester hours were required to either enroll in a set of linked courses open to only mechanical engineering students or enroll in a three-credit first-year seminar open to students from all majors. In this study, a total of 72 students who chose to co-enroll in linked courses are considered. The students were enrolled in one of three sets of linked English Composition I (ENGL 1101) and Introduction to Mechanical Engineering (ME 1001) courses. Each ENGL 1101 course enrolled 24 students, while its linked ME 1001 course contained these same 24 students plus an additional 16 non-co-enrolled students. ENGL 1101 was selected as the initial course to be tied to ME 1001 in a learning community since they are both intended to be first semester freshman courses.

The learning communities were not able to operate as imagined, as the instructors assigned to teach the ENGL 1101 courses decided not to participate in the collaborative and integrative components of the learning communities. So the authors, including the instructor that taught the ME 1001 courses, serendipitously landed in the unique position of being able to evaluate the effects of co-enrollment alone. As this is a work-in-progress paper, we are initially reporting here on only the effects of co-enrollment. In future semesters we will be comparing the results found here with results found from a truly collaborative learning community, and the results of the three-credit combination first-year seminar and introduction-to-the-major course.

The vast majority of the co-enrolled students graduated from high school just months prior to the start of these classes. Again, unlike in a formal learning community that includes collaboration on the part of the instructors to create integrative assignments, the English and engineering professors teaching these courses did not collaborate on content, syllabus, or classroom management.

Details of the ME 1001 Course:

ME 1001 was a two credit class, meeting weekly for one hour and 50 minutes. As was described above, three sections of the Fall 2015 ME 1001 course had a combination of students that were and were not co-enrolled with sections of ENGL 1101. These three sections of ME 1001 were taught by the same mechanical engineering professor with identical content presented each week. Since the students enrolled had widely varying mathematical knowledge, mechanical engineering topics were presented that did not depend heavily upon this knowledge. The overall goal of the course was to help students decide if they want to pursue mechanical engineering while still early on their academic paths.

A special topic of Engineering Failures was introduced to help students forensically identify the causes of engineering failures, and the subsequent engineering improvements that resulted directly from each disaster. The three disasters that were studied were the crash of Nigeria Air flight 2120; the World Trade Center collapse, debris removal and rebuilding; and the Challenger and Columbia space shuttle disasters. The Nigeria Air flight disaster taught students about the importance of engineering processes, and how this tragedy resulted in the current use of heat and fire detectors and retardants in airplane wheel wells. The World Trade Center analysis focused upon the technical causes of the collapse, the engineering techniques that were used to remove the debris, and the improved safety standards in the new 1 World Trade Center and upcoming 2 World Trade Center buildings. The space shuttle Challenger disaster focused on the need of engineers to understand components such as O-rings, and the pressure that can be placed on engineers to meet schedules. Lastly the Columbia space shuttle disaster taught students how even a lightweight piece of foam can do tremendous damage to a shuttle's wing when impacted with great energy.

For each disaster students received lectures, watched videos, participated in classroom discussions, and answered detailed questions. Student feedback indicated that the topics and assignments were popular with students regardless of their mathematical level.

Class lectures also discussed forces, free body diagrams, and dimensioning systems. Also lectures were presented on the mechanical engineering design process, one of which highlighted the use of Excel graphs in disseminating information efficiently. The students then spent one lecture in a computer lab learning how to handle hundreds of lines of data and create a graph that is easy for others to understand.

Nine different outside lecturers gave presentations. The topics that they discussed included engineering co-op opportunities, the difference between mechanical engineering and mechanical engineering technology, ASME, the aerospace and nuclear engineering minors, the ME curriculum, systems engineering and mechatronics engineering. The purpose of the outside

speakers was to help these students understand a variety of different types of engineering programs so that they can make an educated choice when selecting their major. Student interest in the speakers was high, as measured by the questions and classroom discussions that each invited speaker generated.

The textbook that was used for the course was *Studying Engineering: a Road Map to a Rewarding Career*, 4th edition, by Raymond Landis. Each week the students were required to read a chapter of the book and answered several questions. This was mainly an independent exercise as minimal class time was used discussing the textbook.

Finally, at the end of the semester the students broke into groups of three to design and build a car that connected to an existing launcher. The car that raced the longest distance won. This was the only time where the students that were co-enrolled with it ENGL 1101 were separated from the students that were not co-enrolled. The students were required to do individual sketches and descriptions of their cars, prepare a group design reports including free body diagrams, build their cars, and give a presentation to the class highlighting the strengths and weaknesses of their vehicles. They also rated their teammates and themselves on areas ranging from written and oral communication skills, to leadership and enthusiasm for the project.

Grading of ME 1001:

This 2-credit course was graded as follows: 65% assignments, 25% design project, and 10% attendance and instructor evaluation. The assignments section included weekly textbook questions, the engineering failure analyses, the outside speakers, and their Excel assignment. The design project grade included the individual design sketches and descriptions, the group report, the group presentation, and peer evaluations.

ME 1001 Grades and Co-Enrollment:

When looking at the grades that the students earned, it is clear that while the attendance rate of both groups of students were similar, the students that were co-enrolled with ENGL 1101 did not perform as well as their classmates on either the assignments or the design project. There were no differences with regard the design project peer evaluation scores. Since the assignments were specifically *not* dependent upon mathematical knowledge, it was initially unexpected and surprising that the co-enrolled students earned lower grades than those that were not co-enrolled.

SEMESTER GRADES				
TOTAL	ASSIGNMENTS *65%*	DESIGN PROJECT *25%*	ATTENDANCE *10%*	TOTAL *100%*
Co-Enrolled	81.7	87.9	95.2	**84.6**
NOT Co-Enrolled	88.6	93.4	97.2	**90.7**

Retention of ME 1001 students in the Mechanical Engineering Department and Co-Enrollment:

The retention rates in the mechanical engineering department the following semester also seemed to vary among the students that were co-enrolled with ENGL 1101 and the students that were not. The students that were co-enrolled with English 1101 were more likely to still be in the mechanical engineering department the following semester.

ME RETENTION % STUDENTS IN ME DEPT AS OF JANUARY 25, 2016	
Co-Enrolled	**85.3**
NOT Co-Enrolled	**79.1**

Discussion:

Academic success in ME 1001 among the students who were co-enrolled and those who were not co-enrolled was compared in this study. Student success was tracked using the following rubrics: attendance, course grades, grades and peer evaluations in group projects, and continuation the following semester in the mechanical engineering program. It initially seemed noteworthy that students co-enrolled with English 1101 had ME 1001 grade averages lower than students not co-enrolled, and that the co-enrolled students had a higher mechanical engineering department retention rate.

However it must be noted that there were more differences among the student populations then whether they were co-enrolled in ENGL 1101. The vast majority of the students that were co-enrolled were new to University life, having graduated high school just a few months prior. Meanwhile the vast majority of students who were not co-enrolled had already earned at least 15 University credits prior to the fall semester.

To try to find out more about the nature of the students, co-enrolled or not, an additional rubric was used: their math enrollment at the start of the semester. As shown below, this was very illuminating. While the majority of the students that were co-enrolled in ME 1001 and ENGL 1101 were in trigonometry or pre-calculus, the majority of the students that were not co-enrolled

were in calculus 3. Also, of the students that were not co-enrolled, more had completely met the evaluated math classes than were in the introductory college algebra class.

MATH ENROLLMENT AT START OF SEMESTER (%)							
	College Algebra	Trig or Pre-Calculus	Calculus 1	Calculus 2	Calculus 3	Differential Equations	All Math Completed
Co-Enrolled	15	53	26	3	3	0	0
NOT Co-Enrolled	2	14	20	14	32	11	7

Since the assignments in ME 1001 were specifically selected to not be dependent upon prior mathematical knowledge, it seems that student maturity and university experience were the root causes behind the students that were not co-enrolled earning higher grades than their co-enrolled counterparts.

With regard to student retention, however, it is still unknown why the students that were not co-enrolled, and were further along in their studies, had ME retention rates that were lower. As this paper is a work-in-progress, we will continue to follow and compare retention rates.

Conclusions:

It has been established that learning is positively impacted when students are able to engage with their peers[6,7]. This study attempted to evaluate whether co-enrollment alone, among two classes with professors that *did not* collaborate on content, syllabus or classroom management, would positively affect student grades, attendance and peer evaluations in ME 1001, and retention the following semester in the mechanical engineering program. The attendance and peer evaluations among the two groups of students were virtually identical. When evaluating the grades from ME 1001, it was tempting to think that the co-enrollment had, at most, no effect, and at worst, a negative impact on student grades. However when evaluating the student populations closer, it became clear that the student's collegiate and life experiences varied significantly, perhaps even overshadowing any effects of co-enrollment.

These results illustrate the difficulty inherent in evaluating two groups of students: traditional freshman and those who had delayed taking an introductory course. Future analysis of the effects of co-enrollment will need to address these student maturity differences, to ensure that co-enrollment is the only significant difference between the groups of students being analyzed.

Future Work:

We plan to continue to follow the progress of the students from the three sections of ME 1001, taught during fall 2015.

The authors also are busy currently implementing fully collaborative learning communities, tying the two-credit Introduction to Mechanical Engineering course with other courses commonly taken by incoming freshman: English Composition 1, and Introduction to Graphics. We are actively recruiting faculty members who wish to collaborate in these learning communities so that the students can fully benefit from the documented advantages of such communities. We do

not have a budget to compensate faculty members who agree to collaborate, so we are instead working on marketing efforts to educate the faculty members to the many possible student benefits of collaborative learning communities.

We are also continuing to develop a three-credit Introduction to Mechanical Engineering course that will combine the course learning outcomes of the intro-to-major course and the first-year seminar. This course will first be offered in Fall 2016. If successful, we hope that it will be a model for other engineering specialties within Kennesaw State University, and possibly even within the broader University of Georgia system.

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