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Revisions and Analysis of Transfer Pathway in First-Year Engineering

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Introduction

The First Year Engineering (FYE) program at the University of Kentucky commenced the Fall semester of 2016. At that time, a transfer student in the College of Engineering would enroll in EGR 112, a version of EGR 101-Engineering Exploration I specifically for transfer students, and then in EGR 103-Engineering Exploration II the next semester. EGR 112 did not adequately meet the needs of transfer students as most of them already had some fundamentals of engineering background and knew their intended major. EGR 112 was redesigned to include a professional development component and more in-depth work in Microsoft Excel, which would help them in other courses such as physics. Making these changes reduced complaints from the transfer students with regards to the requirement to take First-Year Engineering courses, but they still expressed a desire to complete the required courses within one semester of their arrival in the College. Thus, EGR 215 was created, combining material from EGR 112 and 103. It was given the designation of a 200-level course since the students taking the class would be sophomores at a minimum and this number change could enhance the appeal of a first-year course. FYE faculty began teaching a combined EGR 112 and 103 in the Fall 2017 semester. EGR 215 was officially approved by the University Senate as a course for the Fall 2018 semester.

Background - Requirements for Enrollment in EGR 215

The University of Kentucky defines a transfer student as a student that has completed one full-time semester at another college. If the transfer student has less than 30 credit hours they are required to enroll in the course sequence that traditional first year students take: EGR 101, 102, and 103. Students with 30 credits or more that have taken Calculus 1 or will be taking Calculus 1, and have also taken a programming course, or will be taking EGR 102 – Fundamentals of Engineering Computing, can enroll in EGR 215.

Background – Enrollment and Diversity Goals

In the last decade we have seen STEM occupation growth outpace non-STEM by a factor of nearly 2:1 [1]. At a rate of nearly 100%, these occupations require some type of postsecondary education for employment as opposed to 36% for non-STEM occupations [1]. This need for individuals with STEM degrees has led to large growth in STEM undergraduate student numbers. Post-recession STEM degrees awarded have increased by 43% from 2010 to 2019 [2]. This need for STEM degrees is reflected in the strategic plan for the College of Engineering at the University of Kentucky with a goal of adding nearly 43% more students to the College between 2019 and 2025. The success of transfer students through thoughtful and intentional transfer pathways is one way to diversify reach and obtain enrollment targets of the University and meet STEM occupational demand.

The growth and need for STEM majors are well documented. This growth has not necessarily been experienced by underrepresented groups in STEM majors. Despite an increase in female students being awarded STEM degrees of 50% between 2010 and 2019, male students were awarded more STEM degrees by a factor of approximately 2:1 in 2019. During this same timeframe, degrees conferred to Black students has decreased from 9.6% in 2010 to 8.5% in 2019 [2]. The strategic plan of the College of Engineering at the University of Kentucky also includes enhancing the diversity among the student body. To meet this goal and reverse the trend among conferred degrees among underrepresented groups, a supportive transfer pathway may be used. As indicated based on data collected from the National Center for Education Statistics (NCES) Figure 1, Black or African American, Hispanic or Latino, Native Hawaiian/other Pacific Islander and American Indian or Alaska Native identified students were all more likely to have attended community college prior to obtaining a Bachelor's degree. This indicates that enhancement of transfer pathways for community college students can aid in meeting enhanced diversity goals. From this same dataset, female students reported attending community college prior to obtaining a Bachelor's degree at a rate of 3% higher than male students. This further indicates that creating and enhancing a suitable transfer pathway can increase diversity among students pursuing Bachelor's degrees at a 4-year institution [3].

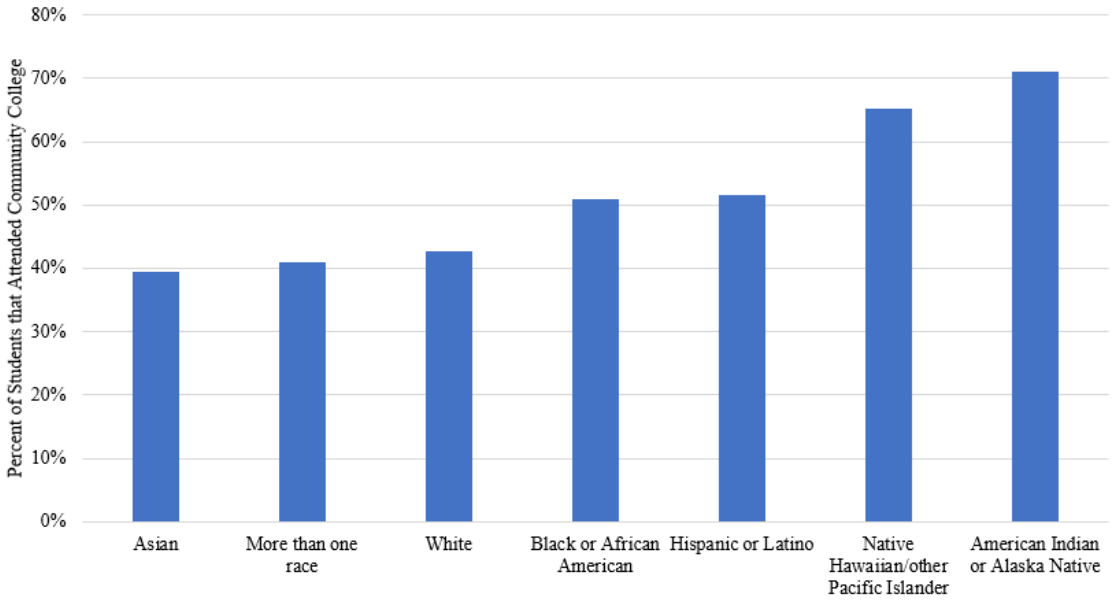


Figure 1 – Percent of students that obtained a Bachelor's degree and attended a community college *[3]*

Background – Enhanced Transfer Pathway Benefits

Since the introduction of 'transfer shock' by Hill in 1965, institutions have attempted to lessen the negative effects of transferring from a 2-year to 4-year institution. Based on a summary of existing studies, Hill asserted that transfer students in general have a negative correlation between the first semester of transfer academic performance and academic performance at a 2-year institution [4]. In most instances, this decrease in academic performance was limited to the first semester of transfer. As summarized by [5], much emphasis in studying transfer student

success has been placed on student characteristics/performance outcomes. However, current research focus includes the transfer students' entry and exit to their respective program. This paper describes attempts to enhance student's success at the entry to a STEM degree with an introductory course. As such, previous research on course content is of most importance for review here.

Davis et al. describe four areas of success for transfer students, personal network, institutional resources, individual/self, and the campus environment [5]. The most important of these themes is a supportive personal network. In general, transfer students feel greater anxiety and discomfort in sharing their ideas and thoughts openly in a classroom setting [6]. From this same study, transfer students reported at a significantly higher rate that discrimination and harassment classroom policies were less likely to be enforced. Transfer students also valued less team-based projects compared to non-transfer students. This may be attributable to transfer students having a significantly more difficult time asking fellow students for help compared to non-transfer students [6]. This would indicate that creating an inclusive, team-based environment exclusively for transfer students, as described in this paper, may increase the ability of students to ask peers for help, which as described by Davis et al. [5] is significant in transfer student success.

Course Revisions - EGR 112 to EGR 215 History

EGR 112 was first delivered in the Fall 2016 semester and was designed to build a transfer student cohort at the start of their studies in the College of Engineering (COE). However, the course was very similar in nature to EGR 101, the entry level class for freshmen coming into the College. The content of both courses was related to the engineering disciplines offered in the COE, study skills, basic communication skills, and content around three of the Engineering Grand Challenges. The transfer students provided feedback indicating they were not gaining much from the course because they'd already learned those skills at their previous institutions or from high school, and they already knew what major they wanted to study[7]. The course was reworked for the Spring 2017 semester to include career readiness topics to help them find co-ops and internships, as well as more hands-on experience in Microsoft Excel. This iteration of EGR 112 was much better received, however, the transfer students were still moving into EGR 103 with freshmen students, and they were anxious to move into their departments. It was determined that taking the transfer student cohort and mixing them in with the freshmen students was not a benefit to them. The high withdrawal rate from EGR 112 was unacceptable (8%) and did not align with the COE Strategic Plan with respect to enrollment and retention. COE realized a course should be created wherein the content from EGR 112 and 103 would be combined so that transfer students would complete FYE studies in one semester and then move into their intended major departments. This content would focus on professional development, engineering design, and the practice of engineering.

Course Revisions - EGR 215 Evolution

Over time, the scope and rigor of the design project has changed in EGR 215 primarily due to the varying backgrounds in coding experience that the transfer students have. It was decided initially

to focus primarily on mechanical aspects of engineering design (and not involve circuits or programming) in EGR 215, with the development of a Rube Goldberg project. The first project chosen was “Pour a Bowl of Cereal”. Students in the class were broken into teams of five or six students based primarily on their schedules outside of class by using the team building tool, CATME. Once provided the prompt of the design challenge, individuals were assigned to write an algorithm for pouring a bowl of cereal. Then, in class, the individuals on each team developed an agreed upon algorithm, and then as a class a final algorithm was developed to include eight or nine steps, depending on the number of teams in the class. Each team would then be responsible for the design and build of one of the steps of pouring a bowl of cereal. Teams were required to mathematically model a step of their process in either Excel or MATLAB and to have a mechanical drawing of their final design. Some materials were provided for the students but they were encouraged to use as many found materials as they could. Then, towards the end of the semester, teams were given the opportunity to integrate their builds for a final demonstration.

In the Spring of 2019, a new Rube Goldberg prompt was introduced: assembling a hamburger. At this point, it became more evident to the FYE team that students leaving EGR 215 did not have the same hands-on skills that their freshmen counterparts in EGR 103 had. In order to better prepare the transfer students in EGR 215 for their future courses, it was determined that an electronics and coding component should be brought into the design project, and because of the varying backgrounds of the transfer students, some of that material would have to be either presented in class, or provided in the form of online resources. Students were provided Arduino kits to work with in class and were shown how to wire a servo motor to the Arduino board and how to program it to rotate in MATLAB. At this time, students were also pushed to develop components in the Innovation Center, the College of Engineering’s maker space. OnShape was presented for 3D modeling of the components and the development of an assembly model. All students completed a 3D print and a laser cut.

Between Fall 2017 and the end of Spring 2019, the team project consisted of each team developing a step, or series of steps, needed for a process to work, so teams had to collaborate amongst themselves to successfully accomplish the full process. Over the summer of 2019, with the collaboration of a graduate teaching assistant, a new project was developed that would be completed fully by four to five students on a team. The project was a small-scale tower crane that consisted of subsystems so each member of the team would take primary responsibility for one subsystem. This process mirrored the EGR 103 design project, which was also broken into subsystems by team members. Each team member would be responsible for a proof of concept document completion for his/her subsystem, as well as a 3D model, and prototype, and then final integration with the rest of the team. To encourage creativity in design, teams were tasked with coming up with a purpose for their tower cranes, and for developing an appropriate backdrop or stage for their final product. This allowed for teams to have different looks to their designs. This project was used by teams for two semesters, between Fall 2019 and Spring 2020.

Course Revisions - Changes in EGR 215 due to Pandemic

The pandemic interrupted the Spring 2020 semester for everyone. With the uncertainty of what the Fall semester would bring, one of the FYE faculty developed a new project for EGR 103

related to water sewage sampling for COVID-19 detection. It was decided that EGR 215 students would also complete the same project and thus the close collaboration began between EGR 103 and EGR 215 faculty.

Aside from the design project, students are also encouraged to explore the engineering majors and develop engineering skills. Most transfer students have already made an informed decision of their major when they enroll, but there is still value in them learning about the other disciplines, so they are required to participate in at least two engineering information sessions led by the departments in the College. Some of the engineering skills students are introduced to include reverse engineering, mechanical drawings, basic statistical analysis, unit conversions, and coding in MATLAB.

Course Revisions - Student Success & Professional Development

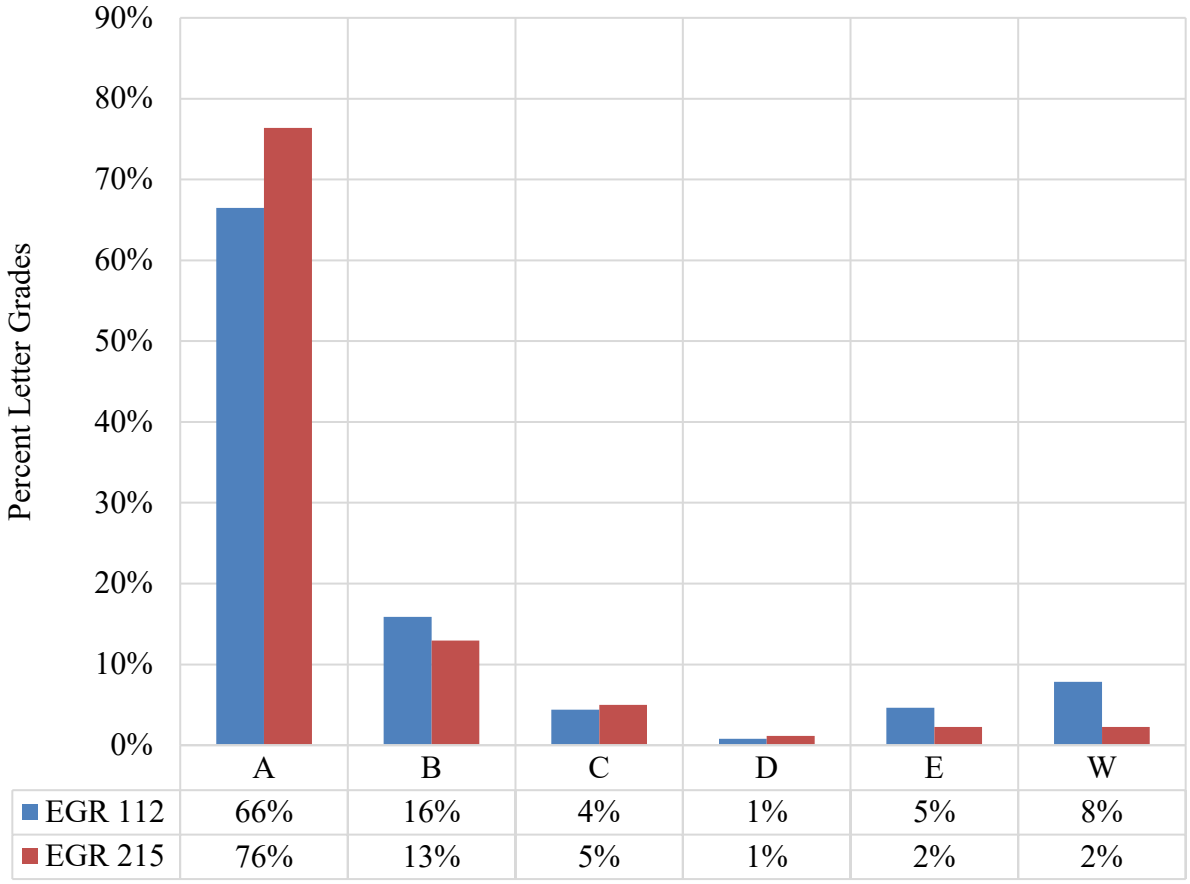
EGR 215 was structured to increase a supportive personal network for transfer students. Transfer students are in their own population for this one course and can more easily ask each other for help. They understand better each other's struggles.

Since Fall 2018, a student success advisor has been coming to talk to EGR 215 students 3-4 times each semester for roughly 15 min each class period at strategic times to introduce study skills, University resources such as tutoring centers, academic coaching, and other academic advising announcements. These visits introduce students to an advisor in the College that is available to answer questions and encourage their success, as transfer or non-degree seeking students in many cases can fall through the cracks.

The professional development component created for EGR 112 has been maintained. Students write resumes and cover letters, have them reviewed by the career development office, participate in a mock interview, attend the career fair, and up until COVID, they interviewed a professor or researcher in their department. These activities encourage transfer students to be more intentional with their time at the University of Kentucky so that when they graduate, they are situated well to get the job they want. Many students have reported to FYE faculty that they would not have pursued an internship or coop had it not been for EGR 215, and many students have been offered coops while taking EGR 215.

The data show that with transfer students taking EGR 215, the withdrawal rate has significantly decreased from 8% to 2%. The grade distribution also shows an increase in the number of A's earned between EGR 112 and EGR 215 (66% versus 76%). Transfer students leaving EGR 215 are well equipped to enter into their major departments and be successful.

Successes - Academic Performance During Course Change



	A	B	C	D	E	W
EGR 112	66%	16%	4%	1%	5%	8%
EGR 215	76%	13%	5%	1%	2%	2%

Figure 2 – Changes in grade distributions between EGR 112 and EGR 215

Changes to grade distributions after switching to the EGR 215 format from EGR 112 can be seen in Figure 2. These changes can be discussed in terms of 'thrive,' 'survive,' and 'did not complete' corresponding to final absolute grades of A/B, C, and D/E/W respectively. 'DEW' grades reflect students that either did not receive a score high enough to meet standards for the course or withdrew from the course. As shown, students in the 'thrive' category increased by 6% (82% to 88%) after the switch to EGR 215. Of particular interest is the 'DEW' rate. These grades indicate students that either withdrew from the course, and subsequently engineering, or did not have an absolute passing grade. The 'DEW' rate dropped from 13% in EGR 112 to 6% in EGR 215, effectively cutting in half the number of students that likely no longer pursued engineering studies at UK. This does not include the effects of students retaking the course for credit in subsequent semesters.

Successes - Updated Retention Information

Previously discussed is the increased academic performance and a reduction in the withdrawal rate after the change from EGR 112 to EGR 215. The first semester after the introduction of EGR 112 in Fall 2016 did not yield positive results in terms of retention and graduation of

transfer students. By Spring of 2018, 24.4% of students that took EGR 112 in Fall 2016 earned a GPA below 2.0 or withdrew from the College of Engineering [7].

A review has been made of students that completed EGR 215 in the Fall semester of 2018, 2019 and 2020. Both tracking of these students and defining retention is difficult. Progress of each individual student was made by assessing each student's most recent enrollment in the College of Engineering. For example, each individual student record from these three semesters was reviewed. If a student continued to be enrolled in the College of Engineering in the semester subsequent to their enrollment in EGR 215, we can make a preliminary assumption of retention. That student has continued positive degree progress within some specialization in the College of Engineering with a GPA suitable for continued progress. Additional time will need to pass to assess graduation rates of these students. As shown in Table 1, in each of the three semesters reviewed, students were retained in the College of Engineering at high levels. This indicates success in retaining these transfer students in the College of Engineering and demonstrates positive progress towards the College's enrollment and diversity goals.

Table 1. Student Retention Evaluation of Those Enrolled in EGR 215

EGR 215 Term Taken	Number of Students Evaluated	Retention*
Fall 2018	142	88.0%
Fall 2019	115	92.2%
Fall 2020	59	88.1%

*Retention as defined by continuing to be enrolled in the College of Engineering in the subsequent semester

Conclusions

The significance of developing, implementing, and maintaining a well thought out pathway into the College of Engineering for transfer students cannot be understated as an indispensable aspect of achieving the goals laid out for enrollment and retention in the College's Strategic Plan. The shift from a two-semester introductory experience into one semester and providing the opportunity for a personal network for transfer students in EGR 215 have proven to be foundational to the methodology of integrating transfer students into the College, evidenced by the decrease in DEW percentages, and the increased retention numbers. Particularly useful to the transfer students have been the increased use of solid modeling, 3D printing, coding, and teamwork skills. By learning or improving skills in these areas, transfer students are more confident and better prepared for their discipline's major courses in the following semesters at the University of Kentucky.

References

[1] S. Fayer, A. Lacey, and A. Watson, "STEM Occupations: Past, Present, And Future." Bureau of Labor Statistics, 2017. [Online]. Available: https://www.bls.gov/spotlight/2017/science-technology-engineering-and-mathematics-stem-occupations-past-present-and-future/pdf/science-technology-engineering-and-mathematics-stem-occupations-past-present-and-future.pdf

[2] "Fall 2010 through Fall 2019, Completions Component," *U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System (IPEDS)*, 2020. https://nces.ed.gov/ipeds/use-the-data

[3] "2012-17 Beginning Postsecondary Students Longitudinal Study," *National Center for Education Statistics (NCES)*, Oct. 31, 2019. https://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2020504 (accessed Jan. 03, 2022).

[4] J. R. Hills, "Transfer Shock: The Academic Performance of the Junior College Transfer," 1965, Accessed: Jan. 03, 2022. [Online]. Available: https://eric.ed.gov/?id=ED010740

[5] K. A. Davis, A. M. Ogilvie, and D. B. Knight, "Easing engineering transfer students' transitions: Recommendations from students who successfully navigated the transfer pathway," presented at the 2017 ASEE Annual Conference & Exposition, Jun. 2017. Accessed: Jan. 03, 2022. [Online]. Available: https://peer.asee.org/easing-engineering-transfer-students-transitions-recommendations-from-students-who-successfully-navigated-the-transfer-pathway

[6] H. Hartman, S. Lezotte, R. A. Dusseau, T. R. Forin, and S. Farrell, "Transfer Students in Undergraduate Engineering," presented at the 2020 ASEE Virtual Annual Conference Content Access, Jun. 2020. Accessed: Jan. 03, 2022. [Online]. Available: https://peer.asee.org/transfer-students-in-undergraduate-engineering

[7] J. K. Lumpp, W. C. Blackburn-Lynch, J. L. Lovely, L. M. Letellier, J. G. Whitney, K. W. Anderson, and S. Herrick, "Helping Transfer Students Succeed: Establishing Pathways to Include Transfer Students in a First Year Engineering Program." presented at the 2019 FYEE Conference, Jul. 2019. Accessed: Feb. 10, 2022. [Online]. Available: https://peer.asee.org/helping-transfer-students-succeed-establishing-pathways-to-include-transfer-students-in-a-first-year-engineering-program