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Retention and Graduation of Chemical Engineering Undergraduates at the University of Arkansas

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Retention and Graduation of Chemical Engineering Undergraduates at the University of Arkansas

Abstract

Student retention and graduation rates are important indicators of student success and also serve as viable metrics in assessing the quality of a school. The Ralph E. Martin Department of Chemical Engineering at the University of Arkansas (U of A) has been monitoring undergraduate retention and graduation rates since 2007. The student cohort for the study is defined as the students entering the Introduction to Chemical Engineering class and includes students that had completed the First-year Engineering Program (FEP), new freshmen that chose to take the class because they had satisfied the chemistry prerequisites for the course upon entering the university, students that had transferred from other departments at the university and students who had transferred from another college or university. The students were further classified by gender, math readiness and whether they self-identified as first-generation students.

An analysis of the graduation data showed that transfer students (both inside and outside), first-gen students and non-math-ready students had lower graduation rates from both Chemical Engineering (ChE) and the university when compared to the general ChE population:

- While 71% of all Intro students graduated from ChE (highly significant intercept of 69.571 and $p < 0.001$) and 86% graduated from the university (highly significant intercept of 82.714 and $p < 0.001$), only 69% of the students that transferred from departments inside the university graduated from ChE (a non-significant difference with an estimate = 1.500 and $p = 0.734$) and 85% graduated from the university (a non-significant difference with an estimate = 2.929 and $p = 0.448$). Only 65% of the transfers from outside the university graduated from ChE (a marginally significant difference with an estimate = -7.214 and $p = 0.105$) while only 76% from the university (a non-significant difference with an estimate = -5.500 and $p = 0.156$).
- Only 68% of first-gen students graduated from ChE (highly significant negative estimate of -56.500 and $p < 0.001$), and 71% graduated from the university (highly significant negative estimate of -66.929 and $p < 0.001$). First-gen graduation rates have also been falling in recent years, perhaps as a result of COVID.
- While 76% of math-ready students graduated from ChE and 88% graduated from the university, only 62% of non-math-ready students graduated from ChE (highly significant negative estimate of -54.786 and $p < 0.001$), and 76% graduated from the university (highly significant negative estimate of -64.571 and $p < 0.001$).

A number of activities are proposed in helping transfer students and first-gen students including the development of dedicated activity fairs, target luncheons, special scholarships and enhanced advising activities. Activities for better preparing non-math-ready students for the rigors of engineering include bridge programs, better math placement, the teaching of mathematics inside

the College of Engineering and informing K-12 teachers, students and parents about the importance of math preparation in the study of engineering.

Introduction

Retention and graduation rates serve as important indicators of overall student success at colleges and universities and can be useful to students in assessing the quality of schools that they may wish to attend. Retention and graduation rates will likely become even more important in the near future as the number of college-bound students falls and colleges and universities are forced to compete for fewer students. The Western Interstate Commission for Higher Education (WICHE) predicts that the number of high school graduates will peak at 3.9 million in 2025 and fall to 3.5 million by 2037 due to declining birth rates [1]. Perhaps more importantly, fewer high school students are choosing to attend college, with the rate of college-bound high school graduates falling from 70% in 2016 to 61.4% in 2023, the lowest level in three decades [2].

While overall retention and graduation rates are important, a deeper dive into the factors affecting graduation and retention is important if colleges and universities are to help students who are retained and graduate at lower rates than their peers. Many factors have been examined for their effects on retention and graduation rates including gender, ethnicity, high school preparation, performance in engineering preparatory classes, especially math, and even attitudes about engineering as a career. Without question, the most widely recognized factor in predicting success in engineering is math preparedness, placement and performance [3-9]. Bego *et al.* [3] showed that engineering students who complete the required sequence of four mathematics courses had a 93% graduation rate and Galbraith *et al.* [4] showed that the likelihood of graduation increased with the higher the math class in which the student was initially enrolled. Bressoud [5] cautioned that success with calculus in high school does not necessarily guarantee success in college. Successful college students must also be able to think critically, learn on their own and use techniques for critical analysis of problems. Pembridge and Verleger [10] underscored the importance of math performance for success in engineering but also noted that Physics I course grades appear to also be a predictor of persistence in pursuing a degree in engineering. Budny *et al*. [11] extended this idea to all preparatory math and science classes by stating that doing well in the background courses in math and science is crucial to success in engineering.

A number of solutions for dealing with the lack of math preparedness have been implemented, including:

- Modifying the engineering curricula to remove calculus as a prerequisite for some of the earlier engineering classes and thus delaying the need for calculus in engineering;
- Teaching remedial math classes inside the College of Engineering which also helps to illustrate the importance of math to all engineers; and
- Developing mathematics summer bridge programs.

Ohland *et al.* [12] presented a curriculum change that was made at Clemson University where Calculus I was moved back a semester to the Spring of the freshman year and was made a corequisite to the second first-year engineering course instead of a prerequisite. This change

effectively delayed the need for calculus by a semester and, because it increased retention, was considered a success. Klingbeil and Bourne [13-15] showcased the Wright State model, which was first introduced in 2004 and features an introductory mathematics course with engineering applications which teaches remedial math while also stressing the importance of math in engineering problem solving. The Wright State model was adopted by a number of institutions across the country including the University of Colorado [16], Boise State [17] and the Citadel [18] which makes engineering accessible to students with a wide range of ACT scores. In a related effort, a summer bridge program was developed by faculty at Syracuse University/Linköping University [19], where students took remedial math in the summer before their freshman year. The bridge program proved to be effective in increasing course grades in comparison to those who took traditional summer math courses.

High school preparation can also be a strong indicator of student success in engineering. In a study involving nine institutions and 87,000 students from 1987-2002, Zhang *et al.* [20] found that high school GPA, gender, ethnicity, SAT scores and citizenship status had significant impacts on engineering graduation. Similarly, Redmond-Sanogo and Davis [21] found that performance in high school math and science classes were predictors of success in STEM gatekeeper college courses. Interestingly, Nichol *et al.* [22] found that high school graduation rates and undergraduate STEM major rates were higher when the students' teachers had participated in a RET (research experience for teachers) program.

Not all of the factors for student success are tangible. Besterfield-Sacre *et al.* [23] cautioned that student success in college depends not only on the knowledge and skills learned during the first year in college, but also on the attitudes about engineering that individual students bring with them to college. In related work, Jones *et al.* [24] noted that the students must develop a positive perception of engineering as a career in addition to developing technical expertise.

The purpose of this paper is to present retention and graduation data for students enrolling in the Introduction to Chemical Engineering (Intro) course in the Ralph E. Martin Department of Chemical Engineering at the University of Arkansas (U of A) since 2007. Student data were categorized by factors such as enrollment status, gender, whether they had self-identified as first-generation students, math readiness and performance in the Intro class in an effort to identify trends and the need for additional support for students in each category. Plans for improved student engagement as a result of this study are presented.

The Student Population

Introduction to Chemical Engineering (Intro) is offered as the first course in Chemical Engineering at the U of A and covers topics such as chemical engineering as a profession, job opportunities, ethics, communication skills, unit conversions, limiting reactant calculations and material balances for reacting and non-reacting systems. Prior to 2013, the course was part of a two-course freshman-level sequence that also included Introduction to Chemical Engineering II (Intro II), which emphasized ideal and real gases, steam table use, humidification and energy balances for reacting and non-reacting systems. When all first-year (freshmen) engineering students at the U of A were required to enroll in Introduction to Engineering classes in Fall 2012,

the Chemical Engineering course sequence (Intro I and Intro II) was moved to the sophomore year. In Spring 2015, Intro II was removed from the Chemical Engineering curriculum when the State of Arkansas mandated a reduction in the number of hours in the curriculum.

Total Enrollment Trends

Figure 1 shows the total number of students enrolled in Intro I by academic year, i.e., 2008 represents the combined enrollment for Fall 2008 and Spring 2009. As is shown, the enrollment steadily increased from 2008 to 2015, reaching a maximum of 116 students in 2015. After 2015, the enrollment steadily fell to 48 students in 2023. The most significant events in tracking enrollment by academic year occurred in 2008, when First-year Engineering (FEP) students first entered the program, and in 2012, when Biomedical Engineering became an academic department and competed for students who, in past years, had previously committed to Chemical Engineering.

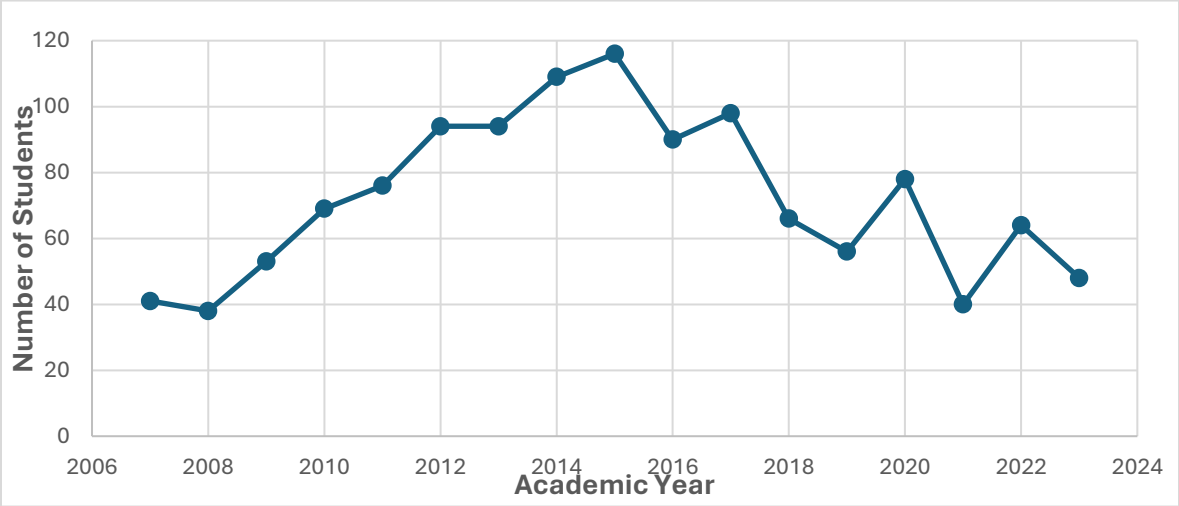

Figure 1. Total Enrollment by Academic Year in Intro to Chemical Engineering

Enrollment Trends by Gender

Figure 2 shows the enrollment distribution by self-identified gender. Overall, the student population was 35% female from 2007-2023. The female population first exceeded 40% in 2020 and has maintained this level. The number of female students per year varied from 10-41 in the overall population, with an average of 25 female students per year. The male population swung more widely from 21-81, with an average of 47 male students per year.

Enrollment Trends by Student Enrollment Classification

Students were classified into four different categories upon entry into the Intro class:

- new freshmen that chose to take the class because they had satisfied the chemistry prerequisites for the course upon entering the university (designated by the letter N in the study),

- students that had completed the First-year Engineering Program (designated by the letter F),
- students that had transferred from other departments at the university (designated by T_D), and
- students who had transferred from another college or university (designated by T_S).

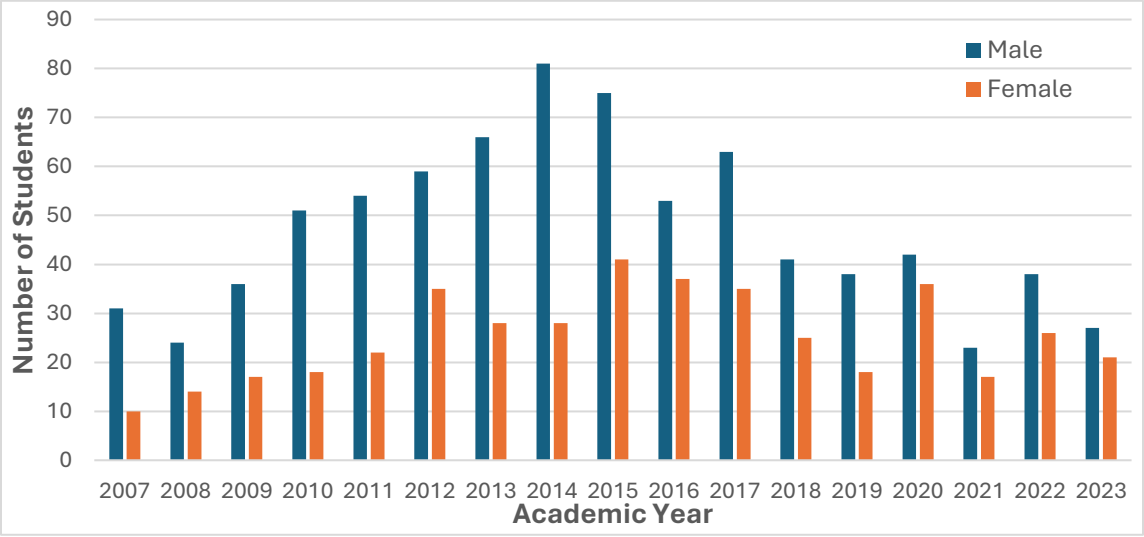

Figure 2. Intro to Chemical Engineering Enrollment by Gender

Figure 3 shows the enrollment by population. In 2008, all of the students entering the program were new freshmen (Category N) or transfer students (Categories T_D or T_S). In 2008, Chemical Engineering received FEP students (Category F) for the first time and, beginning in 2009, FEP students became the major source of students entering Chemical Engineering. Over the course of the study (2007-2023), transfer students made up 31% of the Intro population, with transfers from other departments (T_D) making up 13% of the population and transfers from other universities (T_S) making up 18% of the population. Very few new freshmen (N) entered Chemical Engineering beginning in 2013 when Chemical Engineering faculty no longer participated in the advising of freshmen entering the College of Engineering.

Enrollment Trends Among First-Generation Students

The Chronicle of Higher Education defines first-generation students as those whose parents did not graduate from college [25]. First-gen students are often faced with significant obstacles in enrollment and their pursuit of college degrees. The University of Arkansas uses the same criteria in classifying students as first-gen. Upon entering the university, students are asked to voluntarily self-identify if their father, mother, neither of their parents or both of their parents graduated from college. Students may respond to the question or choose to leave it blank. Students who state that neither parent graduated from college are considered first-gen students. Figure 4 shows the first-gen students enrolled in Intro in comparison to the overall enrollment from 2007-2023. First-gen enrollment ranged from 20-36% of the annual enrollment with an average enrollment of 24%.

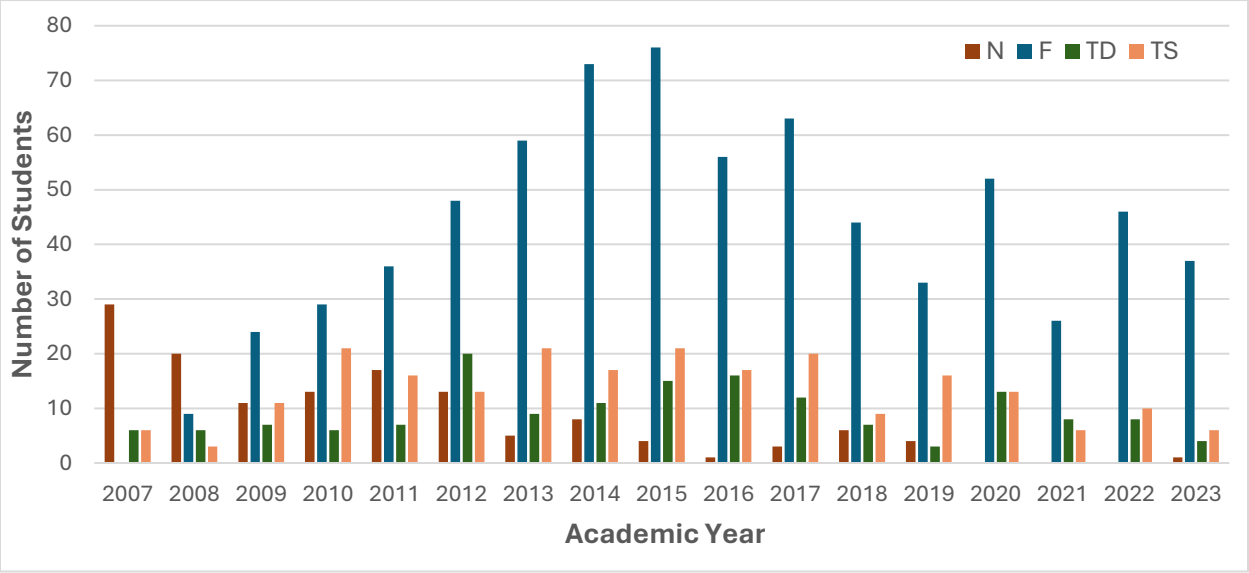

Figure 3. Intro to Chemical Engineering Enrollment by Category

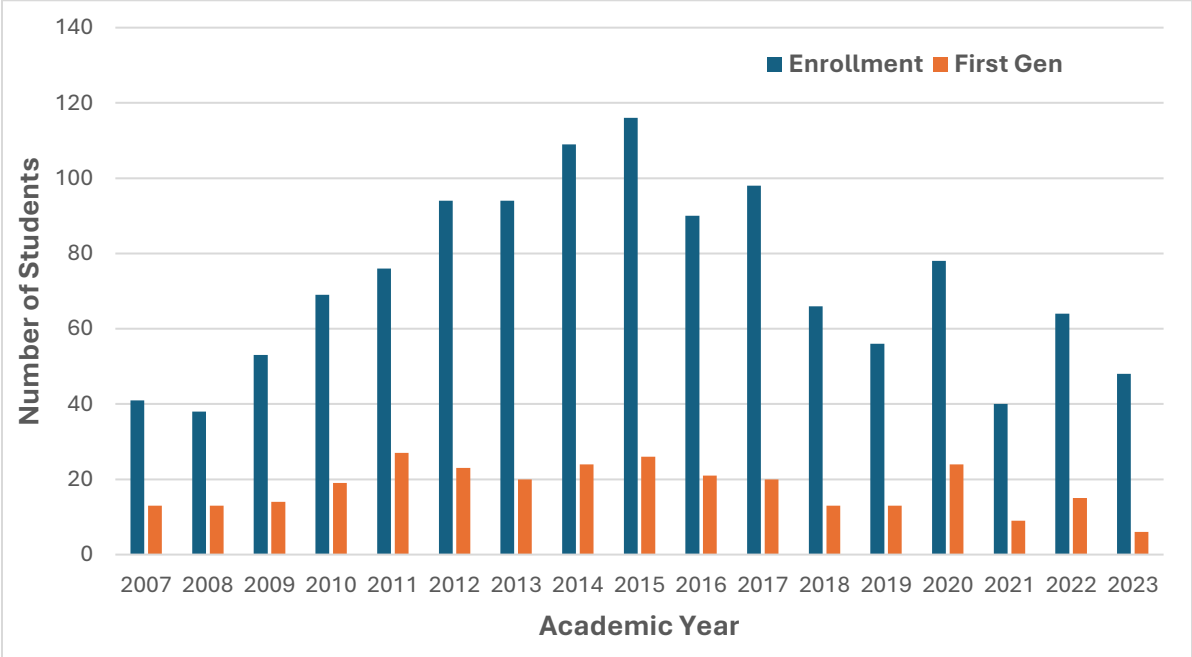

Figure 4. First-Generation Student Enrollment in Intro to Chemical Engineering

Enrollment Trends by Math Readiness

As was noted earlier, math readiness has been shown to be a very important factor in student success. All academic programs in the College of Engineering at the U of A show calculus I as the first required math class that is to be ideally taken in the first semester of each student's freshman year. However, in addition to calculus I, U of A engineering students may also enroll in college algebra, precalculus (or trigonometry), calculus II, calculus III or differential equations

as their first math class, depending upon their prior math courses and placement. Math readiness at the U of A is defined as enrolling in calculus I or above upon entering college.

Figure 5 shows initial enrollment (as freshmen) in each of the math classes for the Intro students by school year. Initial math enrollments for transfer students were obtained from student transcripts from previous colleges and universities upon entering the U of A. Over the course of the study (2007-2023), 144 students (14%) initially enrolled in algebra, 189 students (18%) enrolled in precalculus or trigonometry, 408 students (38%) enrolled in calculus I, 195 students (18%) enrolled in calculus II and 131 students (12%) enrolled in calculus III or differential equations. Thus, 68% of the students were math-ready upon entering their first college or university class. These percentages are very similar to the data for the 11,000 students entering FEP from 2007-2023, which showed that 14% began in algebra, 23% entered precalculus, 40% entered calculus I, 15% entered calculus II and 8% entered calculus III or differential equations [26].

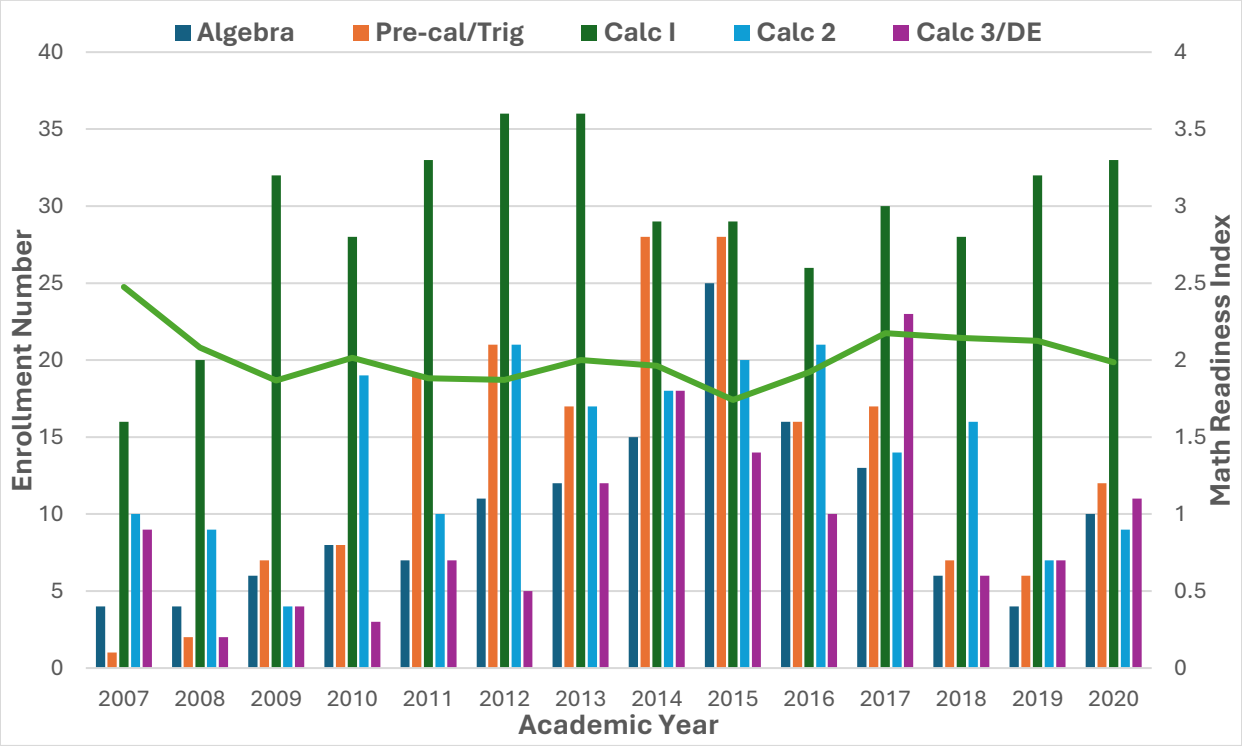

Figure 5. Enrollment in Intro to Chemical Engineering by Initial Math Placement

To further examine the enrollment trends, a math readiness index was created which assigns zero points for students entering algebra, one point for entering precalculus or trigonometry, two points for calculus I, three points for calculus II and four points for calculus III or differential equations. The readiness index was then calculated by summing the product of the number of students and the appropriate factor (0, 1, 2, 3 or 4) and then dividing the total by the number of students. As is noted by the curve in Figure 5, the math readiness index averaged 2.0, but ranged from a high of 2.5 in 2007 (the year prior to participation in FEP) to 1.7 in 2015 (the year of highest Intro enrollment). It is interesting to observe that in 2014 and 2015 (the two years of

highest enrollment in Chemical Engineering) the number of precalculus students and calculus students were about equal.

Variables Affecting Graduation

The percentage of students graduating from Chemical Engineering and the university, as well as the graduation percentages by category (gender, enrollment classification, first-gen status, initial math placement and performance in the Intro class) were analyzed to determine if there were visible trends in the data. Figures 6 and 7 show the overall graduation percentages from Chemical Engineering and the university for students entering Intro in 2007-2020. Over the course of the study, 71% of the students enrolled in Intro graduated with a degree in Chemical Engineering and 83% graduated from the university. The lowest graduation percentages from Chemical Engineering and the university were for students entering Intro in 2008, the first year Chemical Engineering participated in FEP. Beginning with the 2013 Intro cohort, the annual percentage of Chemical Engineering graduates has remained relatively steady at 74% while the annual percentage of university graduates has averaged 82%.

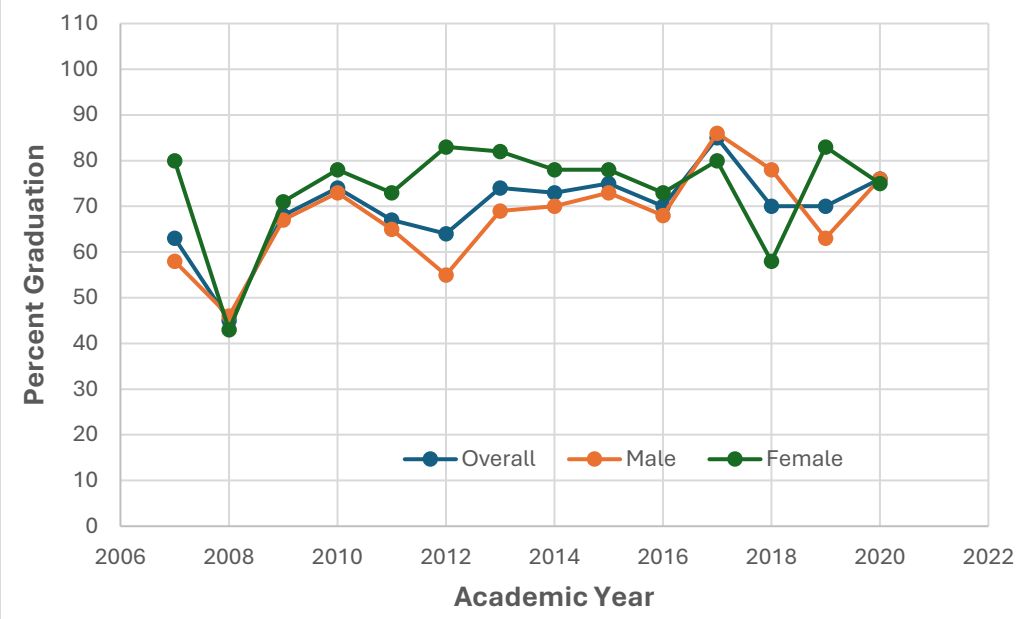

Figure 6. Percent Graduation in Chemical Engineering, Overall and by Gender

Effect of Gender on Graduation

Also shown in Figures 6 and 7 are the effects of gender on graduation from Chemical Engineering and the university. For the entire 2007-2020 cohort, 493 males and 273 females graduated in Chemical Engineering from the U of A. Thus, 36% of the 2007-2020 cohorts were female, a percentage that is not far below the 39.9% reported for all Chemical Engineering programs in 2022 [27]. Overall, 69% of the male students and 75% of the female students that were enrolled in Intro graduated from Chemical Engineering while 81% of the male students and 87% of the female students graduated from the university.

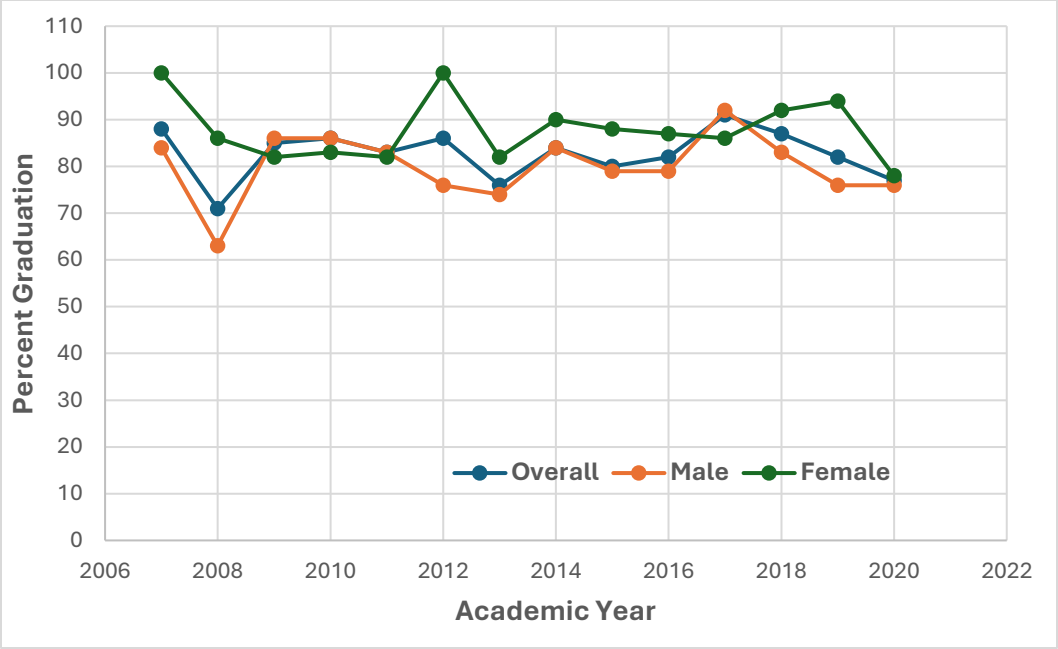

Figure 7. Percent Graduation at the University, Overall and by Gender

Effect of Student Enrollment Classification on Graduation

Figures 8 and 9 show Chemical Engineering and university graduation by academic year of entry to Intro based on enrollment classification (N, F, T_D or T_S). Over the course of the study, 59% of the new freshmen (Category N) graduated from Chemical Engineering and 80% graduated from the university. By contrast, 77% of the students from FEP (Category F) graduated from Chemical Engineering and 86% graduated from the university. Sixty-nine percent of the transfer students from other university departments graduated from Chemical Engineering and 85% graduated from the university. Finally, 65% of the transfers from other universities graduated from Chemical Engineering and 76% graduated from the university. From these data, it appears that new freshmen (N) have the necessary abilities to succeed at the university (86% university graduation) but perhaps are not always as ready for the rigors of Chemical Engineering as their counterparts or perhaps had not really decided on a major upon entering the university. Since the department has only enrolled 31 students in Category N since 2013, this may not be a necessary concern for the future. However, it does seem to suggest that an engineering preparatory program such as FEP helps with enrollment stability toward graduation.

A lower percentage of transfer students graduated from Chemical Engineering in comparison to those entering Intro from FEP. Transfer students have little background in engineering upon entering Intro and often have harder courseload requirements because they have often already taken background courses in math, science, humanities and social sciences prior to enrolling in Chemical Engineering. Students transferring from community colleges and non-engineering schools may have faced less rigorous coursework requirements in their engineering preparatory courses than FEP students. Transfer students may thus represent a category for additional support.

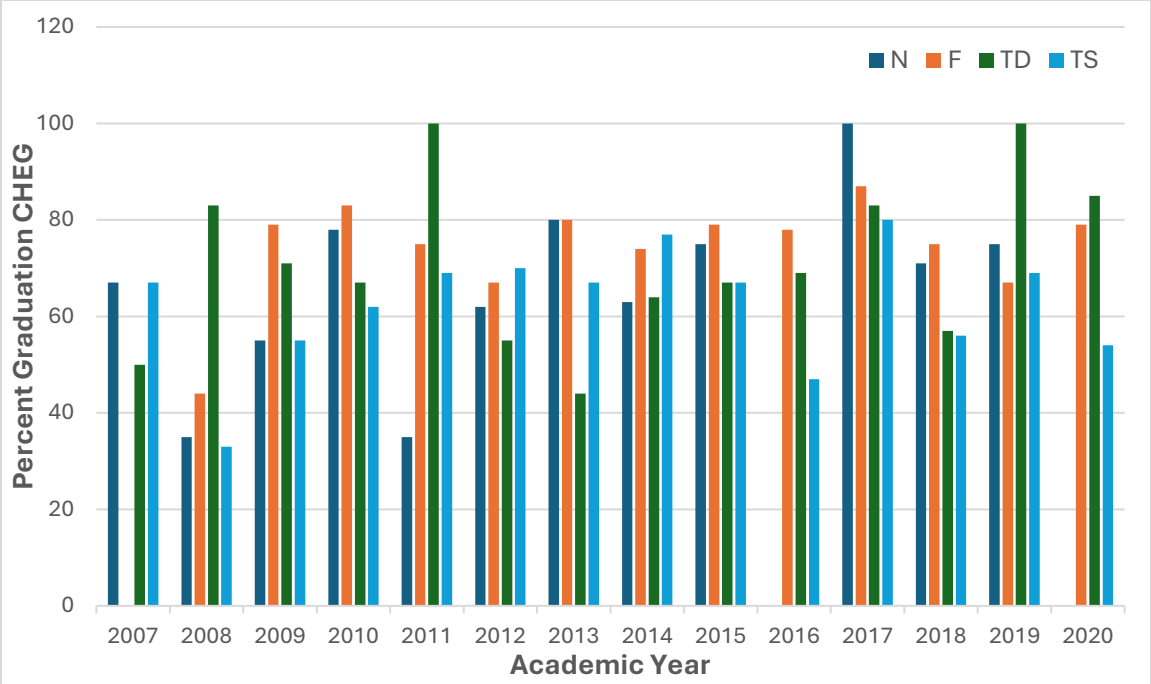

Figure 8. Chemical Engineering Graduation by Enrollment Classification

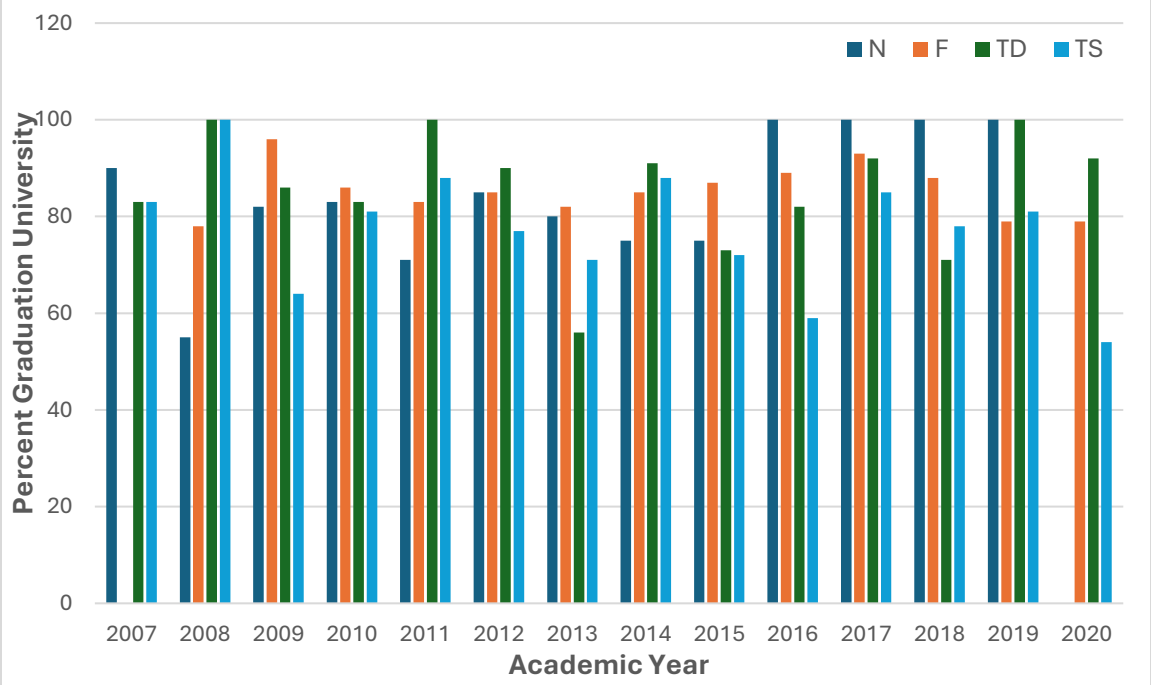

Figure 9. University Graduation by Enrollment Classification

Effect of First-Gen Status on Graduation

First-gen students are often faced with significant obstacles in enrollment, pursuit of college degrees and preparation for the job market. Figure 10 shows the percent graduation in Chemical Engineering and the University of Arkansas for declared first-gen students. An average of 68%

of the first-gen students graduated from Chemical Engineering, while 71% graduated from the university. The average for all Intro students was 71% and 83%, respectively. These differences, and particularly the difference in the graduation from the university, show that there is room for improvement in providing first-gen students with the tools they need to succeed at the university. Chemical Engineering graduation for first-gen students appears to have steadied at about 75%, beginning with the 2014 cohort, and at roughly 80% for graduation at the university. The severe dip in graduation in 2008 was the first year that ChE accepted FEP students. The downward trend in university graduation beginning with the 2018 cohort may also be of concern as the students matriculated through the COVID years. It will be interesting to see if the trend continues.

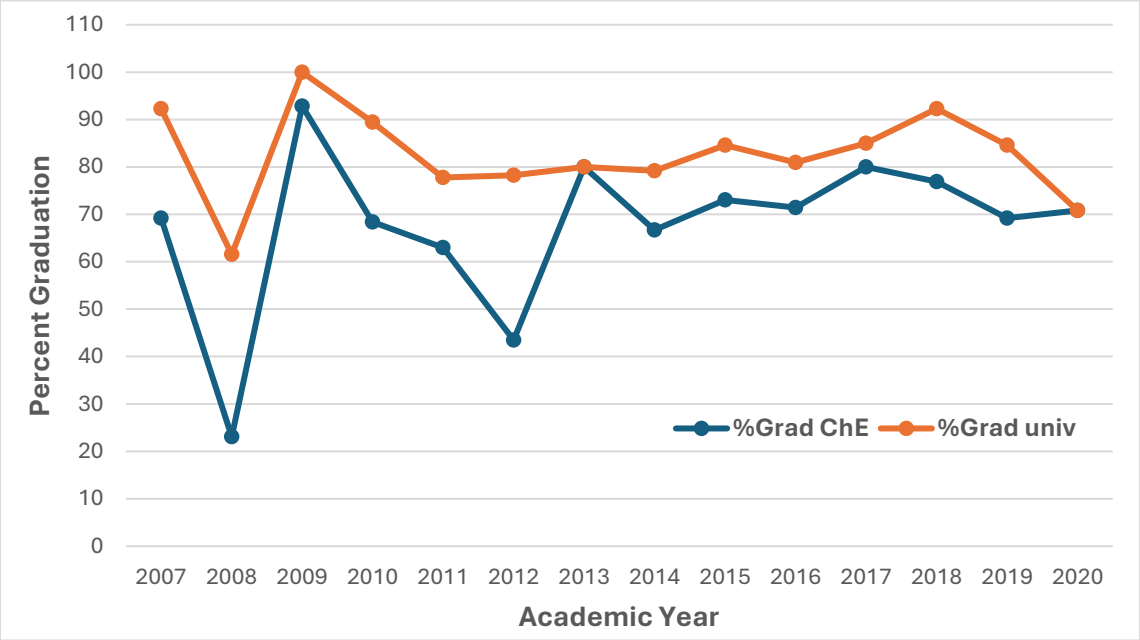

Figure 10. Percent Graduation by School Year by First-Gen Status

Effect of Math Readiness on Graduation

Math readiness is a significant factor in student success as was discussed above. Figure 11 shows the effect of math readiness on graduation in Chemical Engineering and at the university. Seventy-six percent of the Intro students who were math-ready (able to take calculus I or above) graduated from Chemical Engineering and 88% graduated from the university. Only 62% of the Intro students who were not math-ready (taking algebra, precalculus or trigonometry) graduated from Chemical Engineering and 76% graduated from the university. Interestingly, 57% of the students initially placed in algebra graduated from Chemical Engineering and 72% graduated from the university, while 66% of the precalculus students graduated from Chemical Engineering and 79% graduated from the university. Table 1 compares data from the Intro cohorts with data from all students entering FEP from 2007-2018 [26]. Although the overall trends were the same, the students in the ChE Intro cohorts graduated at a higher percentage from both the college and university, regardless of initial math placement.

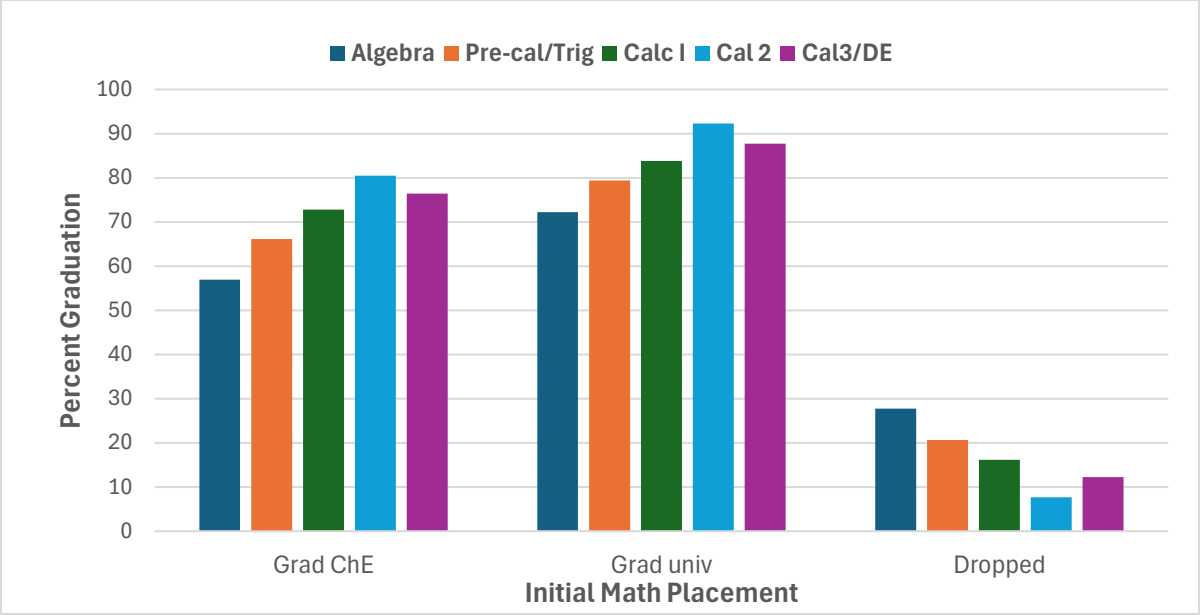

Figure 11. Percent Graduation by Initial Math Course

Table 1. Graduation Comparison of ChE Intro Students with All College of Engineering (COE) FEP Students [26]

Initial Math Placement	% Graduation, Intro Cohort		% Graduation, COE Cohort	
	ChE	University	Engineering	University
Algebra	57	76	19	40
Pre-calculus	66	79	38	60
Calculus I	72	84	57	74
Calculus II	81	92	71	81
Calculus III/ Differential Equations	76	88	76	85

Figure 11 and Table 1 clearly show that initial math placement strongly affects the probability of graduation, as was stated by Galbraith *et al.* [4]. Also of interest is the reverse trend shown in Figure 11 for students dropping out of the university and thus not finishing a degree. Students who are not math-ready are twice as likely to drop out of the university and not complete a degree than students who are math-ready. Clearly, there is room for improvement in providing students who are not math-ready with the tools they need to succeed at the university.

Effect of Intro to Chemical Engineering Performance on Graduation

The effect of Intro performance on graduation was also studied and is reported in Figure 12 as the effect of the grade received in Intro (A, B, C, D, F, W) on graduation from Chemical Engineering and the university. For the duration of the study, 624 students received an A in Intro, 411 received a B, 110 received a C, 9 received a D, 21 received an F and 49 received a W, which indicate the students dropped the course after the first week of classes. As might be

expected, 85% of the students receiving an A in Intro graduated from Chemical Engineering and 95% graduated from the university, while 72% of the students receiving an B in Intro graduated from Chemical Engineering and 83% graduated from the university. While only 40% of the students who received a C graduated in Chemical Engineering, 62% graduated from the university. Fifty-six percent of the students receiving a D, 67% of the students receiving an F and 67% of the students receiving a W did not graduate from the university. The only good news with this latter group of students is that only 79 students (7% of the total) received a D, F or W in Intro from 2007-2020.

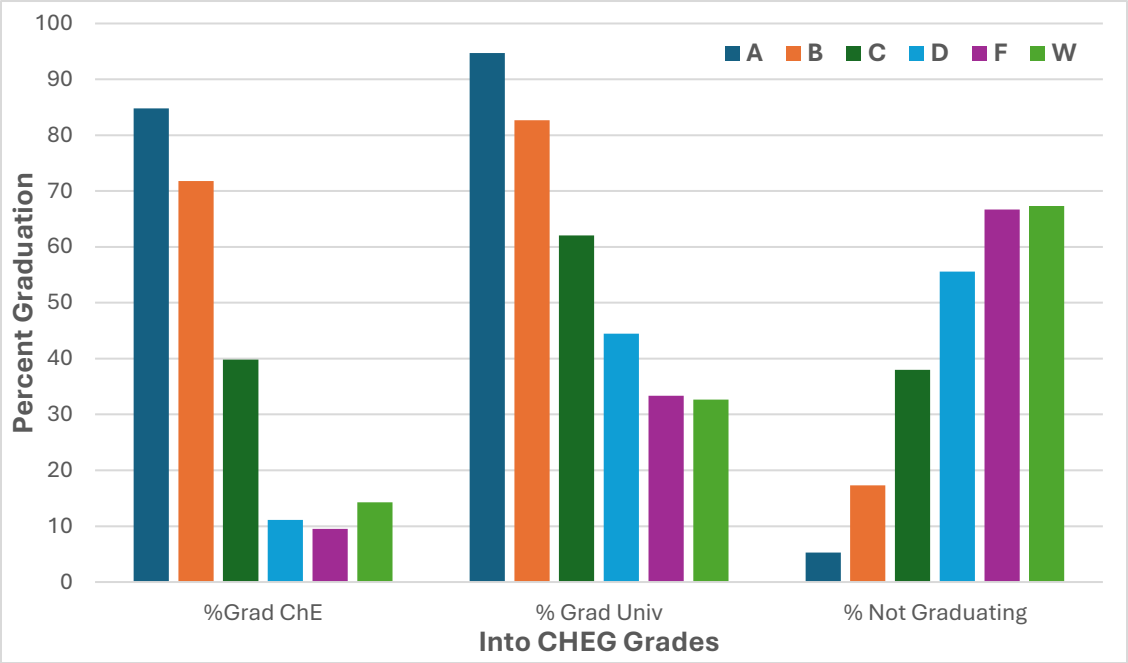

Figure 12. Percent Graduation by Intro to Chemical Engineering Grade

Combined Effects of Math Readiness, First-gen and Transfer Status on Graduation

Students who were not math ready or were first-gen or transfer students graduated at lower rates than all other Intro students. Figure 13 shows a comparison of the graduation rates of these groups while also realizing that non-math ready students can also be first-gen or transfer students. The data show that math placement in algebra or precalculus is a more important indicator in predicting graduation from either ChE or the university than either first-gen or transfer status, although first-gen algebra students showed impressive graduation rates.

Intro Students Leaving Chemical Engineering

Over the course of the study from 2007-2020, 29% of the students that enrolled in Intro left Chemical Engineering. Of these students 68% left within a year of taking Intro and either enrolled in another program and ultimately graduated from that program (31%), enrolled in another program but did not graduate (9%) or left the university (18%). The other 32% of the students leaving Chemical Engineering left after more than one year in the program and either enrolled in another program and ultimately graduated from that program (14%), enrolled in

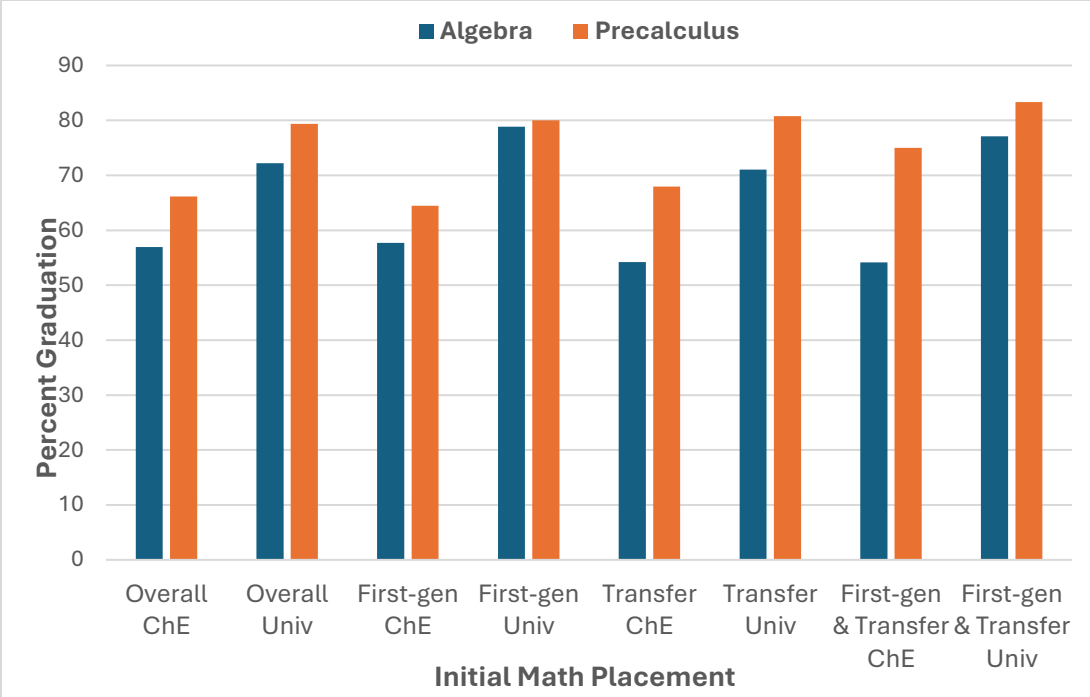

Figure 13. Graduation of Algebra and Precalculus Students Who are Also First-gen or Transfers

another program but did not graduate (9%) or left the university (20%). The University of Arkansas does not track students upon leaving the university but the leading reasons that students leave any university include financial issues, personal or family issues, poor grades, homesickness or a desire to live elsewhere, or realizing that they are not on the right track for their future.

Table 2 shows a list of the U of A degree programs that the former Intro students graduated from and the number of students that graduated from these programs since 2007. As is noted Chemistry, Biology, Biomedical Engineering, Electrical Engineering, Industrial Engineering and Business topped the list of destinations.

Table 2. Destination Degrees Earned by Students Who Transferred from Chemical Engineering

Major	No. of Students	Major	No. of Students	Major	No. of Students
Chemistry	18	Biology	15	Biomedical Engr	11
Electrical Engr	10	Industrial Engr	10	Business	10
Physics	8	Comp Sci/Eng	8	Biological Engr	5
Mechanical Engr	5	Social Mgmt	5	Food Science	4
Criminal Justice	3	Civil Engr	3	Accounting	2
Communication	2	English	2	Finance	2
Mathematics	2	Animal Science	2	College Business	2
Environ Science	1	Geology	1	Info Systems	1
Political Science	1	Journalism	1	CMPE	1
Economics	1	Statistics	1	Exercise Science	1

Nursing	1	Rec Science	1	Marketing	1
Data Science	1	Psychology	1	History	1
Journalism	1	IDST	1		

Initiatives for Helping Students

Several groups of students were identified in this study that could potentially benefit from additional support in their studies and thereby improve their chances of graduation. The graduation rates of transfer students from both inside and outside the university, first-gen students and students who are not math-ready are lower than the graduation rates of the overall population of Intro students. Table 3 summarizes these groups that may have special needs, the graduation percentages from these groups and possible initiatives for helping the students.

Table 3. Identified Groups for Special Consideration and Possible Initiatives

Group	Problems/indicators	Possible Initiatives
Transfer students	FEP students graduate 77% from ChE and 86% from university. Inside university transfers graduate 69% from ChE and 85% from university. Outside university transfers graduate 65% from ChE and 76% from university.	Activity Fair, targeted luncheon, targeted scholarships, specialized advising
First-gen students	Overall Intro students graduate 71% from ChE and 83% from university. First-gen students graduate 68% from ChE and 71% from university. First-gen graduation may be falling (COVID).	Activity Fair, first-gen mentoring, targeted scholarships, specialized advising
Lack of math readiness	Math-ready Intro students graduate 76% from ChE and 88% from university. Non-math-ready students graduate 62% from ChE and 76% from university. This problem is worse for all COE FEP students.	Better math placement, K-12 interactions with students, teachers, parents; engineering math classes; summer bridge programs

Although transfer students and first-gen students are not the same, the needs of students in these groups are quite similar. Both groups are unfamiliar with the department and could benefit from a welcoming atmosphere that goes beyond the welcoming of all students. The Chemical Engineering Department hosts an Activity Fair for all Chemical Engineering students each fall where students and faculty showcase opportunities in student organizations, research and Honors programs. Efforts could be made to better connect with transfer and first-gen students prior to and during the Fair, including specifically inviting these students to the Fair to make them feel more welcome. A first-gen mentoring program has been proposed in the department to connect first-gen students with faculty that are also first-gen. A portion of the departmental scholarships that are offered each year could be specifically earmarked for qualified first-gen and transfer

students. Finally, the advising process could be modified to make first-gen and transfer students feel more at ease with their course loads and the advising process.

Math deficient students are in a different category. The best way to prepare students for engineering is to contact the teachers, students and their parents about the need for good math preparation while the students are in middle school, junior high and high school. Efforts are underway in this area in the college. A better math placement system is being discussed using ALEKS instead of ACT scores, which are not meant for math placement. The COE has experimented with math bridge programs and the teaching of math (and science) courses inside the college but pilot efforts in these areas have not been very successful.

Conclusions

The Ralph E. Martin Department of Chemical Engineering at the University of Arkansas has been monitoring undergraduate retention and graduation rates since 2007 using annual enrollment in Intro to Chemical Engineering as academic year cohorts. The students in the cohorts were further classified by gender, enrollment classification, whether they self-identified as first-gen students and math readiness, and retention and graduation data were collected. The graduation data showed that the graduation rates of transfer students from both inside and outside the university, first-gen students and students who were not math-ready were lower than the overall population of ChE students. Strategies to provide additional support for these students were proposed. While this study was carried out with data from only one Chemical Engineering Department at one university, it presents information that will very likely apply to other universities and engineering degree programs.

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