ASEE 2022 ANNUAL CONFERENCE
Excellence Through Diversity
MINNEAPOLIS, MINNESOTA, JUNE 26TH-29TH, 2022 ASEE
Paper ID #37246

# Probation and Suspension in Engineering by Major and Matriculation Model

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## Abstract

This full paper will explore rates of academic suspension in engineering disciplines and will build off past descriptive ex post facto analysis. Academic suspension rates at 4-year institutions range from 2% to 10% [1], [2]. We investigated the percentage of students on probation who eventually become suspended within an engineering major. To explore engineering trends across institutions, over time, and contextualized by major, we utilized the Multiple-Institution Database for Investigating Engineering Longitudinal Development (MIDFIELD). MIDFIELD provided institutional record data for all students from partner institutions. This included students' academic standing for each term from most institutions which will be used as the primary data source for our analysis.

We examined the six highest enrolled engineering majors – Computer, Electrical, Mechanical, Civil, Industrial, and Chemical – and disaggregated our results by engineering major, matriculation model, and both major and matriculation model simultaneously. We investigated matriculation models where students were admitted 1) directly to a degree-granting engineering major, 2) to first year engineering programs, and 3) directly to the university. Based on previous research [1], [2], we also examined the major with the highest percentage of students put on probation for equity. Our sample includes over 44,000 students enrolled beginning in 1987 until 2018 from eight institutions in the United States. By engineering major, our results show smaller variations in the percentage of students suspended and larger variations in the percentage of students on academic warning or probation. Of the six engineering majors studied, Electrical Engineering placed the highest rate of its students on academic warning or probation and Black students were overrepresented on academic probation. Students at institutions with direct matriculation to engineering majors also had higher rates of students placed on academic warning or probation compared to institutions with first-year engineering programs.

We recommend engineering programs, professional organizations, student success staff, and diversity, equity, and inclusion staff examine these trends at their own institutions. We also recommended future work to examine comparisons to non-engineering majors and include environmental factors such as mindsets and culture within fields which might play a role in student retention and recovery, particularly for minoritized engineering students. We believe this work will be useful for colleges of engineering to help direct resources for student support and retention. With future work, these results will also be useful to inform academic standing policy and curriculum changes to help students avoid academic probation and suspension in the first place.



Keywords: academic policies, quantitative methodology, academic suspension, MIDFIELD

## Introduction

Within the last decade in the United States, higher education institutions graduated only 60% of students who start in engineering within their intended major [3]. Politicians along with industry employers have called for more engineering graduates and have made an argument that engineering talent, as a human capital, fuels our economic wellbeing. This increased pressure suggests that institutions take a closer look at who they help retain and graduate within engineering. One piece of the large retention and academic success puzzle are students who academically struggle [4], [5]. A retention model specific to one engineering program found that students who were put on academic probation (AP) were likely to leave engineering [6]. This one institution was the University of Michigan, which utilized a first-year engineering (FYE) model, where students complete certain requirements before enrolling in a degree-granting major [7]. No research within engineering education literature further explored academic standing in the context of engineering program matriculation model.

Beyond the typical FYE model, other models are also common – Direct to Department (DtD) and Direct to University (DtU). DtD models expect students to declare a degree-granting engineering major at matriculation even if some common coursework is required. DtU models do not expect students to declare a major until they meet certain requirements or have been enrolled for a specified amount of time. Literature has addressed differences in engineering by matriculation model. For example, one study found that students at institutions with both direct matriculation to a degree-granting engineering major and with first-year engineering programs (FYEPs) have high persistence rates, but FYEPs struggle to enroll transfer students and can be a barrier for students wanting to switch to engineering at the same institution [8]. The same study also showed that students at institutions with FYEPs were more likely to remain in their first engineering major compared to students at other institution types. Other studies have shown similar results and reported that students at direct matriculation institutions enroll in their graduation majors more quickly than students in FYEPs [9]. There are also cultural variations between the engineering disciplines. Godfrey [10], [11] has reported about differences in identity and teaching and learning practices, among other dimensions.

Engineering education literature has been absent regarding those who academically struggle and persist within engineering majors. Literature has broadly defined academic good standing, academic probation, and academic suspension:

> **“Academic Good Standing (AGS)**: a semester (SGPA) or cumulative grade point average (CGPA) that is high enough to avoid all academic penalties.
>
> **Academic Probation (AP)**: an SGPA or CGPA that is lower than is required to be in academic good standing. Students may remain continuously enrolled, perhaps with conditions. Those returning to school after serving an academic suspension may also be on probation until they meet the requirements to be in good standing.
>
> **Academic Suspension (AS)**: requirement to separate from the university for a period of time, usually a semester or an academic year. Students may be suspended more than once” [12].

In addition to these broadly defined policies, some institutions use academic warning as a less severe form of academic probation to demarcate students who were slightly below the standard as compared with those they put on academic probation who were below the standard to a greater extent or as a precursor to academic probation [12]. While academic warning was less formally documented on student transcripts, it was still a form of expecting a student to improve their CGPA. For this reason, we use the term academic probation to interchangeably describe both academic probation and warning.

Because academic probation played a key role in the retention process within one engineering program, we wanted to expand our collective understanding on the rates in which engineering programs put engineering students on academic probation and subsequently, academic suspension. Building off previous research [1], [2], we also wanted to know whether Black students were overrepresented on academic probation within the major. The following questions guided our analysis and choice of dataset.

**Research Questions**

RQ1. What percentage of students by engineering major – Computer, Electrical, Mechanical, Civil, Industrial, and Chemical – did institutions put on academic probation and academically suspend?
RQ2. What percentage of students by matriculation model – Direct to Department (DtD), First-Year Engineering programs (FYE), and Direct to University (DtU) – did institutions put on academic probation and academically suspend?
RQ3. What percentage of students by major and matriculation model did institutions put on academic probation or warning and academically suspend?
RQ4. Within the engineering major with the largest percentage of students on academic probation, were Black students overrepresented among those the major put on academic probation?

**Methodology**

*Data Source*

This study utilized data from the Multiple-Institution Database for Investigating Engineering Longitudinal Development (MIDFIELD), which is comprised of whole student record data for all students at 17 partner institutions from as early as Fall 1987 [13]. The version of the database used in this analysis was “fix9” from the data originally compiled on March 16, 2020.

*Inclusion Criteria*

To be sure that we had sufficiently large samples to draw conclusions when the data was disaggregated, we restricted our sample to only include students studying the largest enrolled engineering majors – Chemical, Civil, Computer, Electrical, Mechanical, and Industrial. The determination of a students’ major was made during their third term at the institution. We selected the third term because on-time students at FYE institutions would have had an opportunity to declare a degree granting major and prior work has shown that over 85% of students are enrolled in their graduation major by this timepoint [9].

Students also had to have a sufficient amount of data available in MIDFIELD to be included. Students who had earned a degree were included regardless of the amount of data available. First-time-in-college students who had not yet graduated were only included if they had six years of data available in MIDFIELD. Transfer students who had not yet graduated were only included if they had three years of data available in MIDFIELD.

*Assigning Matriculation Models*

Our sample included institutions with the three most common matriculation models:

1. FYE – a First-Year Engineering Program where students are designated as first-year engineering students and must complete certain requirements before enrolling in a degree-granting major,
2. DtD – Direct to Department where students may declare a degree-granting engineering major at matriculation even if some common coursework is required, and
3. DtU – Direct to University where students are not required to have a major until they meet certain requirements or have been enrolled for a specified amount of time.

The process to classify the MIDFIELD institutions into these matriculation models was accomplished using the policy summaries [14] provided with the database and the Chen *et al.* Taxonomy [7]. Of the eight institutions used in this study, two are classified as FYE, five are classified as DtD, and one is classified as DtU.

*Academic Warning, Probation, and Suspension*

Institutions provide MIDFIELD student record data, which include whether the institution put a student on academic probation or suspension. Past research [6] looked at academic probation narrowly in the first year. Due to the complexity of major switching and longitudinal data, we made the decision to record the major of the student in their third term and examine if they were put on academic probation within that major. If students changed majors before or after their third term, academic warning or probation in any other major was not recorded so that students were not double counted in multiple majors. Based on whether students were ever placed on academic warning or probation while enrolled in their third term majors, binary markers are attached to their records to indicate their status. This process was repeated for academic suspension.

While MIDFIELD maintains records for academic warning and academic probation separately, we treated the statuses identically in our analysis. The two policies rely on academic good standing, which is a standard set by the institution to avoid all academic penalties. Of the eight institutions used in this study, all use academic probation, five use academic warning, and all use academic suspension.

*Sample Demographics*

Our sample contains 44,316 students from eight institutions. As reported in institutional records, the sample is 70.3% White, 8.3% Black, 5.7% Asian, 2.8% Hispanic, and 0.7% Native American. Race and ethnicity data was not available for the remaining 12.1% of the sample. The sample is 17.6% female and 82.4% male.

Using students' majors in their third terms, Table I was created to disaggregate the sample by engineering major. Within the table, students' academic standing is also included. Students were considered to be in Good Standing if they were never placed on Academic Warning, Probation, or Suspension. Students are counted in the Probation column if the student had one or more terms with that standing but were never placed on Academic Suspension. Finally, to avoid counting students multiple times, students in the Suspension column were placed on Academic Suspension for at least one term and were not counted in the Probation column even if they had that standing prior to or after suspension.

TABLE I
COUNT AND PERCENT ACADEMIC STANDING AND ENROLLED BY LAREGEST ENGINEERING MAJORS AND ACADEMIC STANDING IN MIDFIELD (1987 – 2018)

| | Good Standing | | Probation | | Suspension | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Count | Percent | Count | Percent | Count | Percent | Count | Percent |
| All | 36,961 | 83.4% | 4,701 | 10.6% | 2,654 | 6.0% | 44,316 | 100.0% |
| ME | 12,270 | 82.7% | 1,756 | 11.8% | 813 | 5.5% | 14,839 | 100.0% |
| EE | 7,053 | 80.4% | 1,071 | 12.2% | 650 | 7.4% | 8,774 | 100.0% |
| CIV | 6,476 | 83.2% | 917 | 11.8% | 390 | 5.0% | 7,783 | 100.0% |
| CHE | 4,781 | 89.1% | 272 | 5.1% | 313 | 5.8% | 5,366 | 100.0% |
| CPE | 4,101 | 82.5% | 521 | 10.5% | 346 | 7.0% | 4,968 | 100.0% |
| IE | 2,280 | 88.2% | 164 | 6.3% | 142 | 5.5% | 2,586 | 100.0% |

**Results and Discussion**

The first metric we investigated was percentages of students placed on academic warning or probation, followed by students academically suspended. We disaggregated by students' third term engineering major. The results, illustrated in Figure 1, show relatively similar levels of academic suspension among the largest six enrolled engineering majors but greater variation among rates of academic warning and probation. The highest level of academic warning and probation was in Electrical Engineering (12.2%) and the highest level of academic suspension was also in Electrical Engineering (7.4%).

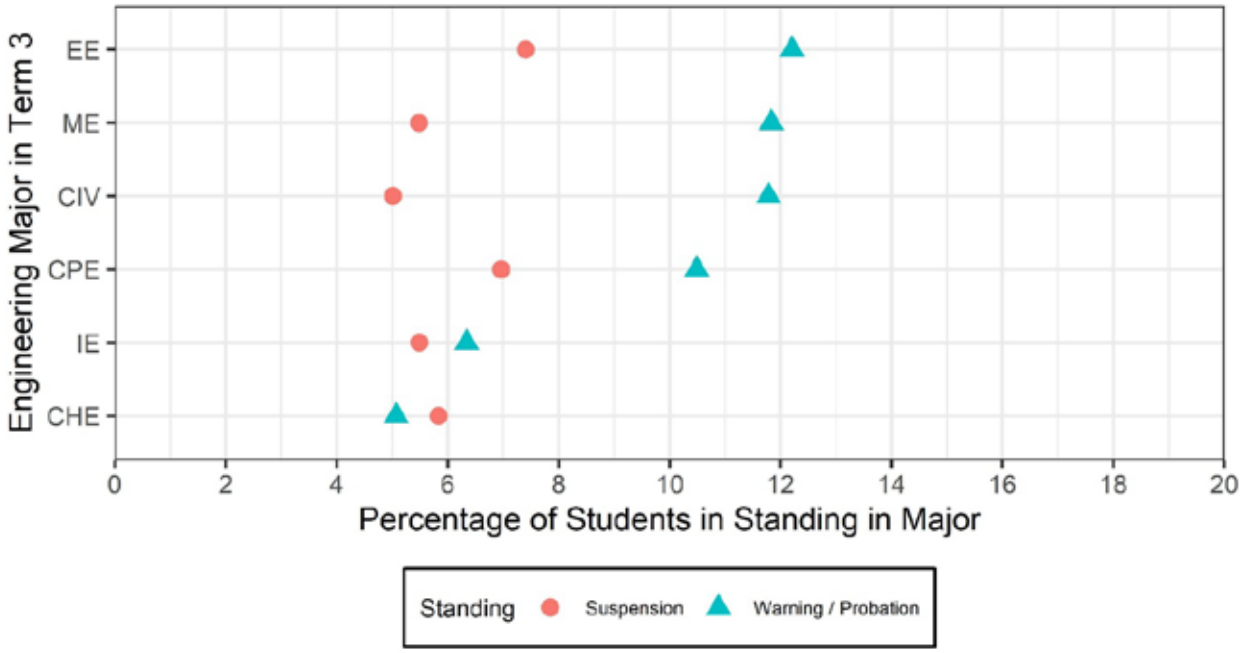


**Figure 1**: The percentage of students ever placed on academic warning or probation or ever academically suspended from their third term engineering major at the institution disaggregated by engineering major. The figure is sorted by decreasing rates of warning / probation.

Based on previous findings that minoritized students faced additional burdens when academically recovering, we further examined percentages of Black engineering undergraduates. We found EE programs put 20.3% of Black students on academic warning or probation. Literature reported that Black students enroll in EE at higher rates than all students [15]. For our sample, Black students account for only 14.0% of EE students and therefore account for nearly one and a half times their share of students placed on an academic warning or probation. These results highlight a need to further investigate the experiences of Black students in Electrical Engineering. Black, Hispanic, and Native American students are also overrepresented in academic warning and probation in CIV, CPE, ME, and CHE.

Because there are multiple matriculation models present in engineering [7], we also disaggregated our sample based on the matriculation model used at the students' institutions at the time of their matriculation. The classification of matriculation models was completed using the MIDFIELD Policy Summaries [14]. These results, illustrated in Figure 2, show that institutions where students matriculated directly into an engineering major, DtD, had higher rates (14.4%) of putting students on academic warning or probation compared to the other two matriculation models.

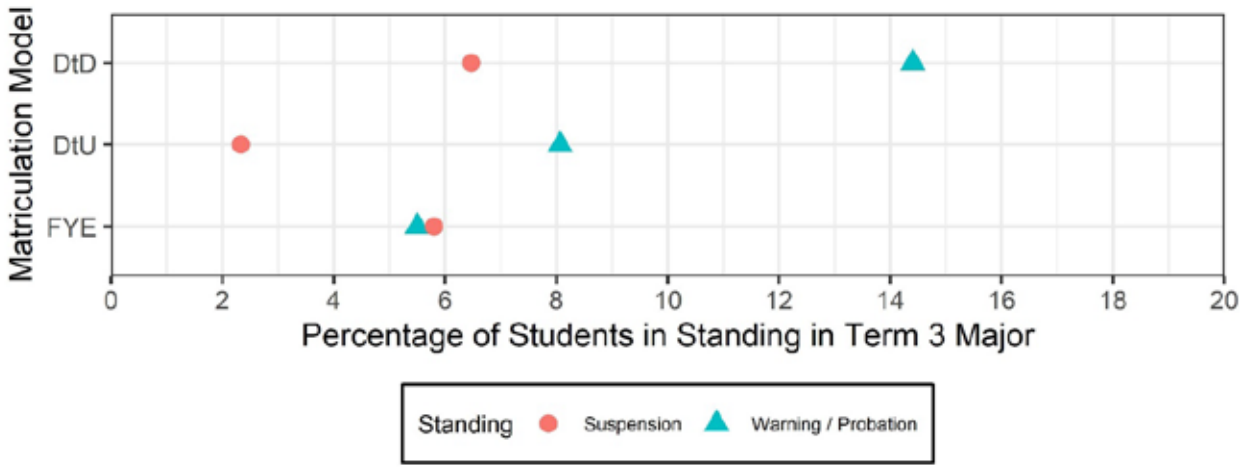


**Figure 2**: The percentage of students ever placed on academic warning or probation or ever academically suspended from their third term engineering major at the institution disaggregated by the institutions' matriculation model for engineering. The figure is sorted by decreasing rates of warning / probation.

Previous work has shown that students at DtD institutions enroll in what becomes their graduation major more quickly after matriculation than students at FYE institutions [9]. However, the same work showed that students at FYE institutions enroll in what will become their graduation major sooner after their first opportunity to do so compared to students at DtD institutions. The results shown here could provide a possible explanation that more students who are unhappy in their first-choice major at DtD institutions are likely to struggle academically, which may lead to a change of major.

Our final disaggregation was by both engineering major and matriculation model. The results, illustrated in Figure 3, show that the highest rates of both academic warning or probation and of academic suspension are in Electrical Engineering at DtD institutions. Given that DtD institutions had a rate of students placed on academic warning or probation nearly twice as high as either FYE or DtU institutions, seeing DtD institutions with the highest rates in this disaggregation is not surprising. The differences among the majors within any of the given matriculation models was somewhat surprising though, especially among the rates of academic warning or probation which range from 16.9% in CIV at DtD institutions to 3.9% in CHE at DtD institutions.

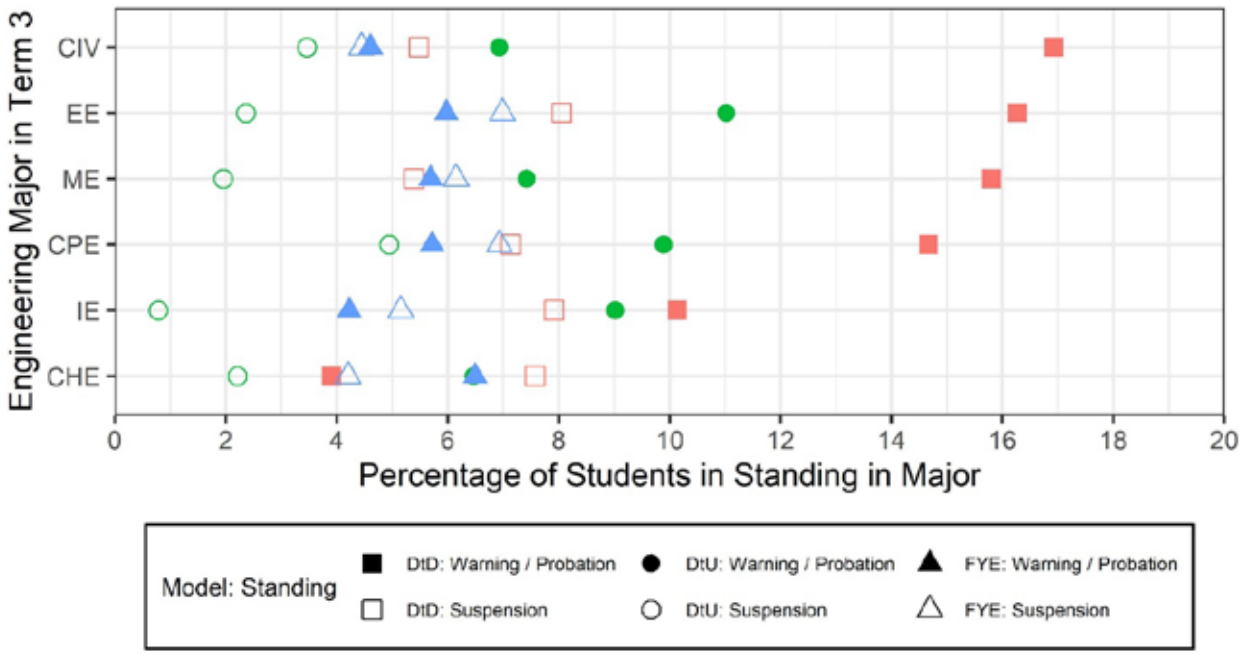


**Figure 3**: The percentage of students ever placed on academic warning or probation or ever academically suspended from their third term engineering major at the institution disaggregated by the institutions' matriculation model for engineering and engineering major. The figure is sorted by decreasing rates of warning / probation at institutions with a DtD matriculation model.

## Conclusions and Recommendations

Based on the overall trends of probation and suspension within engineering majors, we recommend engineering programs examine how well they support students in their majors with academic recovery, prioritizing Electrical and Computer Engineering. Disaggregating by matriculation model, it is clear from our results that most engineering schools should still prioritize examining EE and CPE. Along with engineering programs, professional organizations might want to take an interest in examining how to increase the number of students who academically recovery. To advance this topic nationally, conferences such as the Institute of Electrical and Electronics Engineers (IEEE) and Frontiers in Education (FIE) could hold data-sharing workshops, curate goals and best practices to improve academic recovery among its undergraduates and publicize the successes. National and regional organizations have a responsibility to grow their professions.

Learning from failure and prototyping should be lauded within engineering. Educators within engineering departments, especially EE and CPE, should also invest time within their pedagogy to create a culture of resiliency and a growth mindset. Mindset research has found to help all students and especially those who are minoritized within selective majors [16]. Based on a number of studies within and outside engineering, institutions must also take a hard look at who they most often put on academic probation and suspension. Research has found that institutions put a disproportionate amount of minoritized students on academic probation and suspension [2], [17].

In addition to engineering programs and professional organizations taking responsibility for motivating more academic recovery, student success and diversity, equity, and inclusion staff also need to further examine trends within their institutions. One study within engineering found that embedding a professional staff from the central Dean of Students Office increased the number of contacts with students in crisis and improved the academic outcomes among the students who experienced the partnership model [18]. A few institutions have hired student success professionals within the last decade and are beginning to track any association with improved academic outcomes, acknowledging the need for improvement especially among minoritized engineering students [2].

**Future Research**

Multilevel modeling (MLM) or hierarchical regression has also been used to interrogate who institutions best empower to academically recover following academic probation [19]. Further use of MLM could also include environmental factors such as student and faculty composition, academic policies, and resources available to students. Many equity-minded scholars would encourage programs to not only look to the students as the deficit needing remediation, but also the culture, pedagogy, and advising within each department [20]. For example, literature suggested more research is needed to examine course forgiveness and its role in how students academically recovery [12].

Previous Engineering Education literature has also compared engineering majors to non-engineering majors to describe any difference in student success [6]. Based on the major categories in the Classification of Institutional Programs [21], future research could compare engineering majors to students in the Physical Sciences, Biological and Biomedical Sciences, and Mathematics and Statistics, among other fields.

**Limitations**

Our results are subject to some limitations. While MIDFIELD is a great resource, the data is historical. For some institutions, it is very recent historical data, but other institutions only have older data available in the database. The median first term for students in our sample is the Fall 2000 term. Additionally, because this study relied on data from many institutions across a period of over 30 years, there are differences between the institutional policies related to academic warning, probation, and suspension both within an institution across the time period and across institutions [12], [22].

Our results rely on students' majors during their third term at the institution. For transfer students, this could possibly be the beginning of their last year at their institution. However, we did not have data or literature to support another decision, like their first major, but this is an area for future research. Additionally, because we use the third term major for all students, we are assuming there are no major changes. For students who switch majors, only terms in the major they had during their third term are evaluated, but students could be placed on academic warning, probation, or suspension after switching majors as well. Future research should look at major switchers academic standing within engineering as well as switching to outside of engineering. Those instances are not included in these results as we focused on students who

persisted in the engineering major where the program could have prolonged contact with the student and feel a sense of responsibility for their academic recovery. Finally, students always have the option to voluntarily depart from an institution. Students who choose to leave prior to being academically suspended are not included in this data because they are no longer enrolled at their institutions.

**Acknowledgement**

This material is based upon work supported by the National Science Foundation (NSF) under Grant No. 1545667. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the NSF.

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