Factors Influencing Course Withdrawal in Fundamental Engineering Courses in a Research 1 University

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Abstract

Engineering students develop competencies in fundamental engineering courses (FECs) that are critical for success later in more advanced courses and in engineering practice. Literature on the student learning experience, however, associates these courses with challenging educational environments (e.g., large class sizes) and low student success rates. To address this concerns, we are studying why students are not succeeding in large foundational engineering courses by collecting data on the reasons students give for choosing to withdraw from FECs. Findings point to unsatisfactory grades, not understanding the professor, and finding the course challenging among the top reasons cited. We provide analysis by different departments and across specific courses.

Keywords: withdraw, fundamental engineering courses, large classes, feedback loops

Background

Engineering students leaving engineering is a problem that has been of primary importance in the engineering education field. Some students leave engineering because of different structural factors (i.e., academic performance, sense of belonging, perception of success, perception of competence). Many of the students who leave engineering, unfortunately, are academically capable of succeeding [1].

Engineering students develop competencies in fundamental engineering courses (FECs) that are critical for success later in more advanced courses and in engineering practice. Typically, first-year engineering students spend the majority of their time and effort learning fundamental principles (i.e., science, math, foundations of engineering) [2]. However, because of the exponential growth of engineering enrollments, many institutions are required to teach these FECs in large class formats [3][4]. Challenging educational environments are particularly prevalent in large, research-intensive institutions. These challenges have been studied in engineering education to find ways that we can help students overcome those challenges, it becomes relevant to better understand the students learning experience.

Literature on the student learning experience, however, associates these courses with challenging educational environments (e.g., large class sizes) and low student success rates [4][5]. These less than ideal learning environments have a negative impact in persistence in engineering, where a high number of students quit without even “began engineering” [2]. Research suggests that engineering students withdraw from engineering during their first year [2] [3]. Huang and Pierce [7] suggest that students’ frustration with academic performance in FECs is one of the main reasons for students to drop out of engineering. Hence FECs are critical for students’ success in engineering. Some of the issues associated with large class size that impact students’ performance in engineering are (i) the lack of development of mentorship relationships with instructors [8], (ii) lack of active learning [3], and (iii) lack of cognitive engagement [3] (students in large classes lack engagement as they feel invisible). Furthermore, teacher effects on students are directly related to achievement, a positive impact that is easier to develop in small size classes [9].

To address concerns associated with FECs, it is important to understand prevailing educational environments in these courses and identify critical points where improvement and change is needed. Most research focuses on early identification of at-risk students, however, this is not always a good predictor [10]. Moreover, several students who quit engineering do not demonstrate signs of being at risk; similarly, several students who can be considered at risk, persist and are able to graduate with an engineering degree [10]. It becomes more relevant to find sources of information at every point in the process to be able to get the big picture regarding why some students succeed in engineering.

The purpose of this paper is to better understand engineering students' reasons for choosing to withdraw from a FEC. Following this option, a student could spend the bulk of the semester enrolled in a course and then decide to take a W grade in the course, which has no associated grade-point average effect. The research question guiding this study is:

RQ: What are the main reasons that motivate engineering students to withdraw from a fundamental engineering course?

To address the research question, we analyzed course withdrawal data from several academic departments in charge of teaching large foundational engineering courses and institutional transcript data for the Spring 2018 semester. We sought to identify common issues that students expressed to identify potential areas for improvement from a teaching and curricular policy perspective.

Theoretical framework

Work for this paper is part of a larger project that seeks to understand and improve the quality of the educational environment in FECs by engaging with instructors to collaboratively identify problems and develop strategies for continuous improvement. The project is grounded conceptually using the Academic Plan Model (APM) [11], which provides a holistic view of the educational environment and provides context for how the educational environment is shaped. Viewing the FEC educational environment as an academic plan provided a way to critically examine the educational environment, the elements that comprise it, and the factors that influence it.

The Academic Plan Model identified accommodating the "characteristics, goals and abilities" of students (learners) ([11], p. 15) as a key element in decision-making for the educational environment. In considering the FEC learning environment through APM, we acknowledge that students' past educational experiences influence why and how they engage in the learning process, factors that in turn influence the FEC educational environment (Fig 1). Students then form new experiences as they engage in FECs, experiences that consequently influence their decision to persist in that environment.

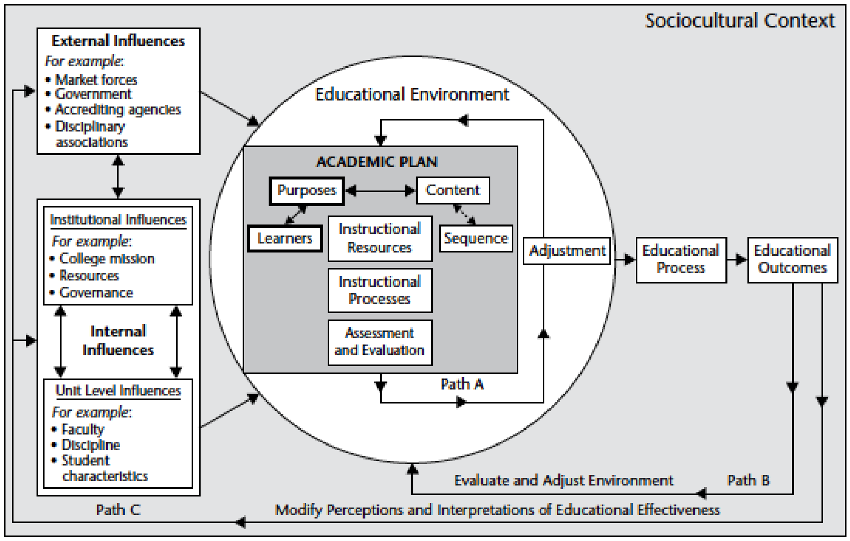

Fig. 1 Academic Plans in Sociocultural Context: Focus on Learners (Lattuca & Stark, 2009, p. 146)

For this paper, we focused on students as learners (as defined in APM) and their motivations for the persistence-related decision to withdraw from a course, guided by the expectancy-value theory of achievement motivation (EVT) [12,13]. EVT explains that persistence-related decisions are influenced by expectancy for success in a task (Am I able to perform this task?) and the value given to the task (Why should I perform this task?). EVT guided the development of the data collection instrument and coding of students' responses during data analysis. Examining course withdrawal decisions contributes to the larger project's overarching goal of understanding the learning environment in FECs by providing insight into a specific aspect of the learners in that environment.

Methods

To address our research question, data were collected qualitatively. We developed a form for departments in charge of teaching large FECs in a research university in the mid-Atlantic that captured reasons for withdrawing from a course. Participating departments required this form to be completed, and IRB approval was secured for this study.

Data collection

Data were collected from 147 engineering students. The course withdrawal form was a requirement and was structured in a way that enabled us to link the course withdrawal dataset to institutional transcript data. The course withdrawal dataset included course descriptor number, final grades that students expected to receive in the course, and the factors that influenced the student's decision to withdraw. Institutional transcript data included demographic information (e.g., gender, major), admissions data (e.g., SAT scores, high school GPA), and institutional academic information (e.g., course grades, cumulative GPA). All data collected were kept confidential and used for research purposes only. The form was made available to students through the advisors in the departments. There was an online version so students could fill out the form before attending a required advising meeting before the official withdraw of the course. In addition, there was a paper form for students who preferred to fill out the form at the moment of the meeting. Students also had the option of discuss the reasons for withdraw with their academic advisor if they wanted to, in addition to filling out the form.

Data analysis

We used thematic analysis methods [14] [15] to analyze the data. Thematic analysis is defined by Clarke and Braun [14] as a method of identifying, analyzing, and reporting patterns within qualitative data. According to Robson and McCartan [15] thematic analysis is a generic qualitative method that allows data to emerge from patterns after doing open coding of the data. Our coding process was guided by Saldana [16] procedures. open coding of all the responses. Pseudonyms were used to ensure anonymity of the participants. Notes taken during the interview were included when analyzing the data to facilitate the development of memos. Codes were developed and two different researchers compared initial codes and agreed on the coding system. Once all parts of the data were coded, codes were grouped based on their similarities. A team of 4 researchers met regularly to discuss the codes, and any discrepancies were discussed and agreed upon. We did not consider the use of qualitative data analysis software as the responses in the form were very short and we were looking for a way to quantify the patterns of the responses as well. Table 1 explains the codebook developed and the definition we assigned to each code.

Table 1: Coding Categories and Description

Code	Description
Class Performance/Performance Grade	Student indicated on the poor performance throughout the course including- assignments, quizzes, exams, final projects, etc
Grade	Student's prime concern was the outcome of the grade in the course
Time management	Difficulty in managing time for the course
Instructor	Blaming the instructor's poor teaching and management of the course
Personal	Nothing directly related to grade, class performance or teaching of the particular course, student's personal choice in dropping the course
Undisclosed/No reason	No particular reason mentioned
Challenging	Indication of the course (materials, activities, exams, etc.) being overwhelming and/or difficult

Research quality

To ensure the trustworthiness of the process of data analysis, two members of the team analyzed the data individually and created several themes from the data. The themes were then compared and analyzed to establish a final set of themes agreed by the larger team. A codebook as shown in Table 1 was established by creating a category of codes corresponding to each of the themes. Codes definitions were discussed and also agreed upon. To ensure inter-coder reliability, initially, each member of the team coded the data individually, then the codes were compared among the team members, in instances when codes did not match, researchers discussed the codes until an agreement was reached.

There were several limitations during the data collection process of course withdrawal in this institution. First of all, several departments in the institution did not mandate their students to respond to the form during the withdrawal process. Hence, data collection was only limited to the departments which agreed to use the form as a part of the course withdrawal process. Secondly, the questions in the course withdrawal form itself had limitations in data the data was provided. Students were asked to give a short reason as to why they were withdrawing a course without giving them more specific and guiding questions which resulted in some vague responses like "I might fail" and "doesn't want the grade". Specific and guiding questions would have enabled the students to articulate their responses with clearly defined reasons.

Results

A total of 147 engineering students reported the reason for course withdrawal in different courses across the institution. Several key patterns emerged across the students responses on course withdrawal. Across the responses, the top three categories for course withdrawal reason were (1) Grade, (2) Personal, and (3) Class Performance/Performance Grade. Figure 2 summarizes the number of responses on course withdrawal from the major categories.

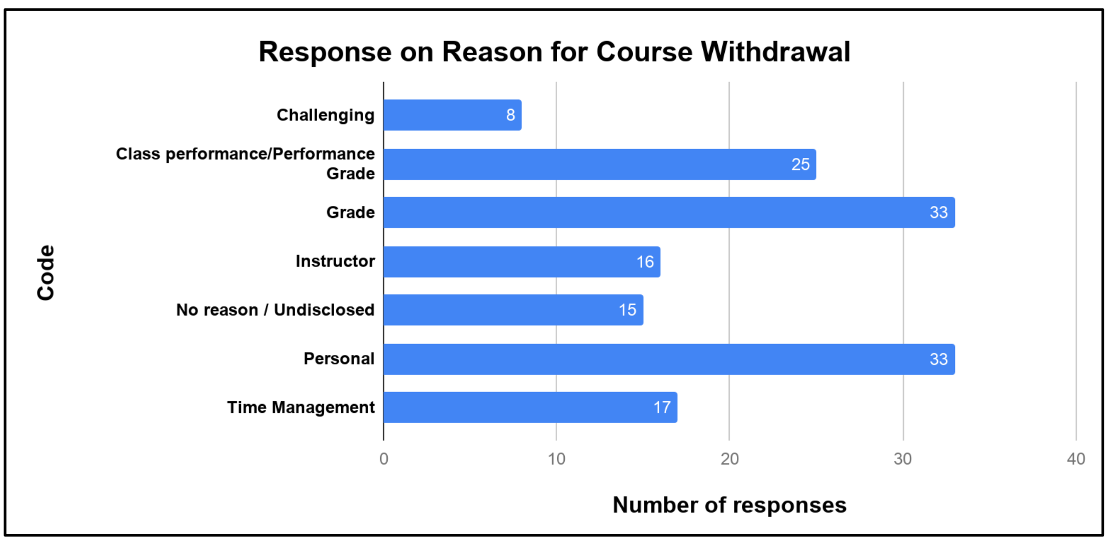

Fig. 2: Types of Responses on Course Withdrawal

From the coding pattern it was found that the majority of the students had concerns on either their class performance on the particular course or the fear of failing or ending up with poor grades as the major deciding factor for them to drop the course. Figure 2 suggests that almost 40% of the total student responses had the class performance and grade as their primary reason for dropping a course. While most students reported grading and class performance as their primary concern, some students had chosen to drop a particular course due to personal reasons. Students who were either exploring a particular course which was not part of their major or students who had health or other personal reasons chose to withdraw that particular course.

Since the students' course withdrawal responses came from several departments in the Institution, course withdrawal responses were also analyzed department-wise. Figure 3 summarizes the analysis on student withdrawal responses from 18 different departments and the results show that fundamental courses in Mechanical Engineering (ME) and Engineering Science and Mechanics (ESM) have the highest number of course withdrawal which accumulates to 61.2% of the total course withdrawal response. A total of 10 of the 18 departments including Geosciences, Fine Arts, Chemistry, etc. which individually accounted for less than 3 course withdrawals were collapsed and presented as 'Others' in Figure 3 and Figure 4 respectively. While analyzing the reasons for course withdrawal in the different departments as shown in Figure 4, most of the fundamental engineering core courses have responses of course withdrawal due to grade and class performance, and most of the non-engineering courses have withdrawal responses due to students' personal issues. For instance, 44.2% of students taking ME courses have mentioned either grade or class performance as their reason for withdrawing. Courses in ESM had 42.1% of the withdrawal responses which were also due to grade or class performance.

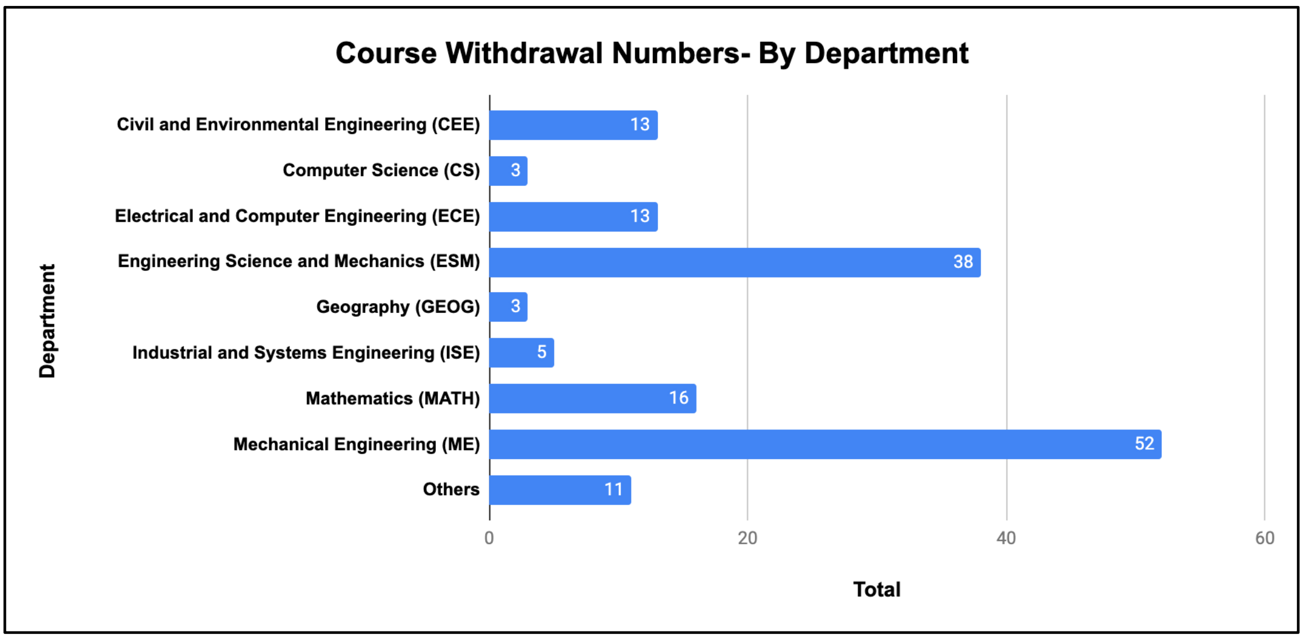

Fig. 3: Course Withdrawal Response Numbers- Department wise

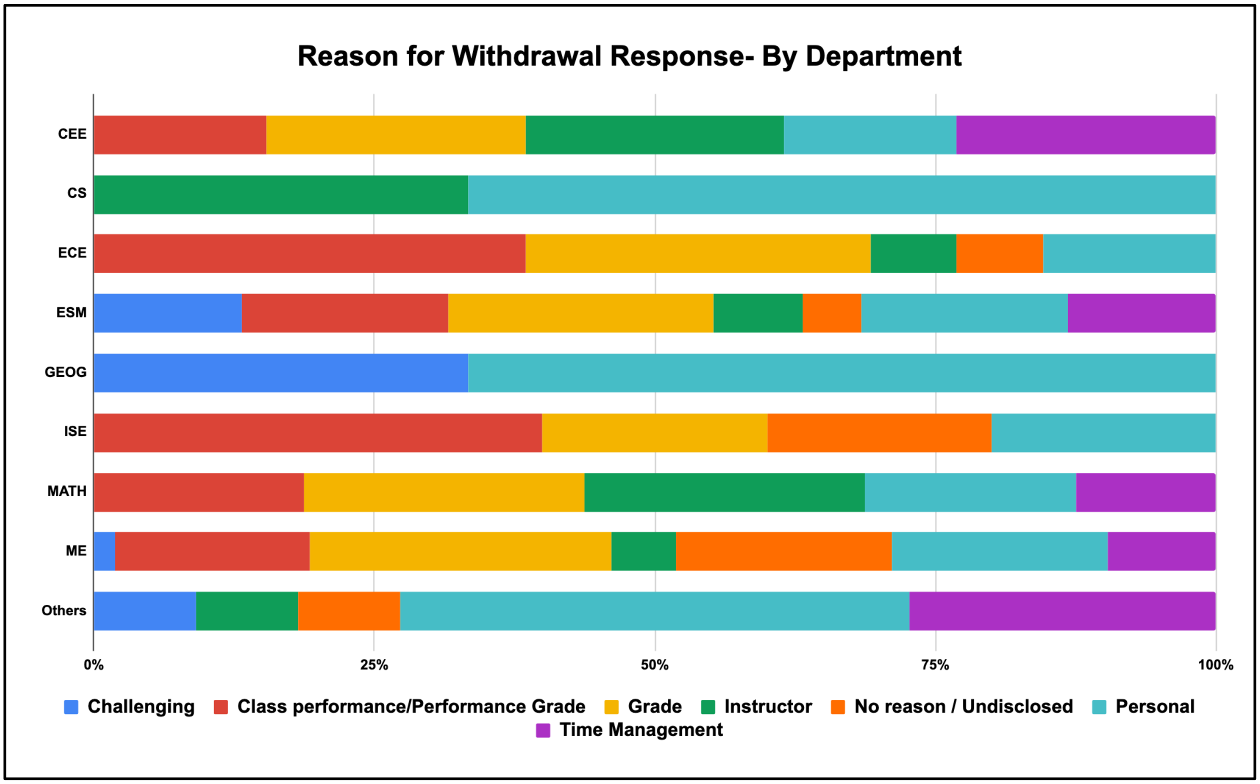

Figure 4: Reason for Withdrawal Response- Department wise

Qualitative results:

For a better understanding of the results, students' responses on why they decided to withdraw the course were coded and grouped into seven categories. The coding categories which are discussed below include: Challenging; Class Performance/Performance Grade; Instructor; Personal; Time Management; and Undisclosed.

<u>Challenging</u>

Challenging accounts for responses that manifested that the course (i.e. course materials, activities, exams, tests, etc.) was overwhelming for students so they decided to withdraw. The students described the course as having a lot of work, being difficult to understand, and being unable to pass it. For example, one student indicated: *"too much work, overwhelmed, taking over in the summer.*" Similarly, another student indicated: "*taking a tech elec when I shouldn't have been- already too much on my plate.*"

<u>Class Performance/Performance Grade</u>

Class Performance/Performance Grade represents responses of students' description of their poor performance throughout the course including inability to submit assignments, pass quiz, and or failure to to complete or pass their final projects which would have affected their grades. Responses within this coding category manifest that students failing grades or concerns with their grades were based on their own performance during the course. Students were failing and they did not want the failing grade. A student indicated: "*I am not good at Math and I took calculus one year ago. I forgot most equations for the test, I did not get a good grade. I will get an F for this class if I don't withdraw*." Similarly, another student indicated: "*I will be applying for grad school next semester so I need my GPA as high as possible this semester. The lecturer was great and I learned much I just couldn't do well in the exams for some reason.*"

Grade

Grade represents students' responses that described grades as the primary factor for course withdrawal. Students' major concern was with their grades being unsatisfactory. While grade includes responses of students who were failing, it does not necessarily accounts for failing. It is a holistic account of students' responses of dissatisfaction with their grades. Some students wanted to improve their GPAs for which they wanted to have a better grade than the low passing grades which they could not accept or cope with. In providing reason for withdrawal, one student responded: "*I am right at the boundary of graduating magna cum laude and this course would potentially drop me below that distinction.*" A second student responded in this manner:

> *I need a C- for next semester's pre reqs, and would be going into the final with a low C-, which would be too risky for me personally. I'd rather retake the class for a better understanding then risk it.*

Instructor

Instructor is a category that puts students' decision for course withdrawal squarely on the instructor. Instructors could not be understood by students during the course. Students' responses indicate that instructors' quality of teaching, presentation of materials, management of the course, course mode of delivery, etc. was terrible and poor. For example, a student mentioned: "*the teacher did not do good job teaching the class. Had a bad time in class. Poor teaching. Felt the material wasn't given properly. Poor schedule. Was not clear with topics.*" A second student indicated that:

> *Class structure did not cater to my schedule. In class assignments were given between Monday and Wednesday (my two busiest days). All assignments were graded through a script that would result in consistent grading errors making it very frustrating to try and rectify. Professor presented the notes in a very strange manner, he would often gloss over the small details but this is an introductory level course.*

Personal

Personal accounts for students' withdrawal based on personal reasons. It incorporates reasons associated with health, postponement to a later semester and/or substitution for a different course and reason that were not associated with any of the other coding categories (i.e grade, instructor, challenge). For example, one student indicated: "*tech elective that wasn't a "must" so will move it to senior year to concentrate on the junior in-major courses.*" A second student mentioned: "*the course had electronic submissions and a problem occurred for me for one of the projects* *and assignment was never submitted. Additionally due to health reasons I struggled throughout the semester to stay on top of my work load*."

Time Management:

Time management primarily represents difficulty in the management of time on the part of students for the course. It accounts for failure to attend classes due to engagement with other classes; poor time management of schedules and class activities for which they decided to withdraw from the course. One student mentioned: "*did not leave enough time to study for this course along with other junior 2nd semester courses.*" In responding, a second student mentioned:

> *During the semester I just haven't had enough time to focus on it like I should. It's also material that I haven't seen since freshman year and Honestly I don't like chemistry but I just need more time to focus on it mainly. So a better time than right now would be more useful.*

Undisclosed:

Undisclosed represents students who withdrew courses but did not provide exact reasons as to why they withdrew courses. They provided no reasons, however, they indicated that they were withdrawing.

Discussion

Of the total study participants, 22.4% of participants directly reported grades as the reason for course withdrawal whereas 17 % reported class performance/performance grade as the reason for withdrawal. While the two descriptors were separated for a distinctive understanding of grade as a direct reason for course withdrawal and poor class performance associated grades as reasons for withdrawal; unsatisfactory grade outcomes as reflected in the two descriptors totals to 39.4 % and represents the primary reason for students' course withdrawal. Personal reasons, inclusive of health issues and course not having any significant impact on the students' academic progress also represented 22.4 % of total study participants. The indication is that a sizable portion of participants also withdrew courses for reasons that were not of the instructor, course design, time management, and/or grade. Additionally, 5 % of participants reported the course as challenging for reasons of withdrawal; 11 % reported the instructor as being the reason for withdrawal; 12 % reported time management as the reason for withdrawal; and 10.2 % did not disclose the reason for withdrawal. The indication here is that instructor and instruction related issues, course design and course materials challenges do not represent a major reason why students chose to withdrawal courses. Overall, the fear of bad grades and failure in the course/unsatisfactory grades was the primary reason why students chose to withdraw; and this was not found to be a major attribute of professors' inability to adequately deliver the course or not understanding the professor and/or as a result of being overwhelmed with work. Students' own inabilities to manage their time well and perform in exams, tests, and class projects were the standing attributes.

These results join a litany of literature that shows how students are motivated by grades. It seems like from this source of information grades have a heavy weight in students' decision making. Understanding how this perception affects students motivation is important as expectations of the value will directly affect performance [12, 13]. Furthermore, instructors can use grades and perceptions of performance as a positive reinforcer to engage students in their own learning process. In addition, we think results from this study should be considered by administrators to analyze enrollment management and curricular policies. It becomes important to better understand the impact that different policies are having in the behavior that students demonstrate and prevent the system to promote actions in the students that are problematic and hinder their success in engineering.

Future work

We expect to continue this work in two phases. First, we want to expand the withdraw form and use the results of this study to provide an online form where students have several options and also have the opportunity to expand their responses on the reason for withdraw. For example, if the reason a student provide to withdraw the course is that is not "doing well" in the class, we will have a follow-up question asking details of why the student consider is not doing well. The second phase will be to conduct semi-structured interviews with students that withdraw a FEC course to be able to obtain rich and deep information about the reasons for their decision. We hope to also be able to have access to interview students dropping out of engineering, since they could provide information from a more complex perspective.

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