Exploring graduate engineering students' reasons for original enrollment and current persistence in engineering master's and PhD programs

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ABSTRACT

The purpose of this research paper is to capture reasons engineering master's and PhD students enroll in and persist through their graduate degrees. Graduate enrollment literature has largely focused on undergraduate students' perceptions of graduate education and has also characterized the factors, including research experience, high self-efficacy, and math proficiency, that contribute to undergraduate students' intentions to pursue a graduate degree. Few studies, however, have explored what reasons motivate students to enroll in master's or PhD programs or whether there are differences based on degree type. Fewer, still, explore what reasons motivate students to persist in their degree once they are already enrolled. Given that enrollment and persistence are critical issues for national competitiveness in industry and academia, it is important to understand why today's engineering master's and PhD students enroll in and persist through their degrees and whether those reasons vary based on different demographic factors. To this end, we report quantitative results of a nationwide survey of n=1084 engineering master's and PhD students across the United States that asked students i) why they chose to enroll in their graduate program and ii) why they are persisting through their program. The descriptive statistics presented here also explore the patterns in this data with regard to gender, race/ethnicity, and year in graduate program. Results indicate that master's and PhD students enroll and persist through their graduate programs for different reasons. Our data also show that participants reasons for persisting in their respective degrees are more varied than their original reasons for enrolling, indicating that students' experiences are causing them to change their perspectives on why they should continue in their degree. This paper is one of the first to explore whether there are differences in enrolling and persisting for master's and PhD students and to understand what the reasons are for persisting.

INTRODUCTION AND LITERATURE REVIEW

While over 40% of engineering undergraduate students consider engineering graduate programs, one study from 2014 found that only approximately 6% enroll in school two years after graduating [1]. However, there is increasing demand for people with advanced engineering degrees to enter the national workforce to keep up with demands for technological advancement [2], [3]. Retaining these students is equally important and can be challenging as 10-year completion rates are between 57-64% depending on gender [4] and attrition rates for students with marginalized identities, like Black students, can be as high as 57% [5]. Because upwards of 70% of students consider leaving their graduate programs in any given month [6], researchers must also understand what motivates students of all identities to eventually persist through their master's and PhD programs. Doing so will not only improve opportunities to support master's and PhD students but can also promote positive graduate school experiences that decrease considerations of or actual attrition. In 2018, the National Academies [7] published a call to action recommending engineering research explore graduate student experiences, among other things, to address high attrition rates in graduate programs. To meet this call, and in order to increase and improve recruitment of talented engineers into master's and doctoral programs, we need to understand what motivates people to enroll in graduate programs. Doing so can help faculty and administrators promote

graduate education and better support students as they consider whether to enroll in master's or PhD programs.

In past work, many researchers have explored students' transitions from undergraduate to graduate school enrollment. Some have studied the undergraduate experiences that can encourage students to enroll in graduate programs. These include participation in undergraduate research opportunities [8]–[14] and frequent, positive interactions with faculty and current graduate students [8], [12], [15], [16]. The majority of researchers, however, have generated models to determine the environmental, psychological, and/or demographic factors that can predict students' enrollment in graduate programs, including college GPA, parental education, socioeconomic status, research self-efficacy, sex/gender, and race/ethnicity [17]–[20]. Research that directly explores why students choose to enroll in graduate programs is limited. The literature that exists on this topic, though, indicates that career aspirations related to higher earning potentials and opportunities to work on challenging or societally impactful projects are students' main motivators for enrolling in graduate school [13], [21], [22].

While many of these studies do not provide information on students' academic disciplines or tend to group students into STEM versus non-STEM categories, some do analyze graduate school enrollment from an engineering perspective. Jiang et al. [11] and Ro et al. [23], for example, found that research experiences for engineering students correlate with interest in engineering graduate programs. Ro et al. [23] also observed that increased pre-collegiate math proficiency and high self-reported leadership skills significantly predicted students' enrollment in engineering graduate programs. In their study, Borrego et al. [16] also explored factors that predicted enrollment in engineering graduate programs. They found that higher self-efficacy increased students' likelihood of planning to enroll in graduate school while career goals and positive interactions with graduate students significantly predicted intentions to enroll. Crede and Borrego [24] are the only study to explicitly ask engineering undergraduate participants what their primary reasons to attend graduate school were. In this study, the three most popular reasons were to learn more, have an advanced degree, and earn more money.

Unlike other studies, Peters and Daly [25] and McGee et al. [26] explored reasons for graduate school enrollment from the perspective of students already enrolled in engineering graduate programs. Peters and Daly [25] observed that students returning to graduate school after spending five or more years in industry were motivated to enroll by the prospect of improved career opportunities upon graduation. McGee et al. [26] specifically explored why Black students enrolled in engineering doctoral programs, with one dominant finding being that students indicated they wanted to become mentors for other students.

Although it is highly valuable to understand students' initial reasons for pursuing graduate study, literature is still lacking an understanding of how goals change, what new goals are formed, and what reasons for persistence students are giving, though literature indicates that both "lack of goals" and "change of goals" are part of the attrition consideration process [27]. Existing literature has furthered discussion about graduate students' experiences as they relate to attrition and persistence, addressing environmental and systemic barriers that can challenge students' desires to persist in their programs, including prolonged stress [28]–[31], hidden competencies [32], difficult advisor relationships [33]–[35], and discrimination experiences and unwelcoming academic environments due to race, ethnicity, or gender [36]–[38]. Others have evaluated factors that can encourage graduate students to persist, including promoting graduate student socialization to develop competency and academic identities [39]–[42] and increasing graduate student supports, especially for students with marginalized identities [43], [44]. This literature has helped

the engineering community begin to understand the complexities of graduate students' experiences. It has also led to development of theoretical frameworks, such as the Graduate Attrition Decisions (GrAD) model [27], that can help researchers understand engineering graduate student attrition and persistence more holistically.

However, these studies do not directly capture engineering graduate students' original reasons for pursuing graduate study and how those intentions compare with their current reasons for persisting in graduate school. In addition, few of the studies that explore graduate school enrollment differentiate between master's and doctoral program enrollment interests or predictors [1], [8], [11], [17], [21]–[24]. While there are a few notable studies that specifically explore enrollment in doctoral [26] or master's programs [9], [18], the majority consolidate master's and PhD programs into a singular graduate degree category. Because master's and PhD degrees have differing time constraints, milestones, and end goals, especially in engineering, studies on reasons to enroll and persist must also account for participants' graduate degree programs and consider master's and PhD students separately.

The lack of research on students' reasons to both enroll in and persist through engineering master's or doctoral programs motivates this work. Understanding students' motivations to enroll in and persist through often challenging engineering graduate programs is integral to the development of successful graduate school recruitment and retention initiatives. It is especially important for the recruitment and retention of students with marginalized identities because of the systemic barriers that can increase negative experiences and reduce persistence. To this end, this study seeks to address these gaps by answering the following research questions:

1. Why do master's and doctoral engineering students decide to enroll in their graduate programs?
2. Why do master's and doctoral engineering students persist through their programs?
3. Do students' reasons for enrolling or persisting in master's or doctoral programs vary based on demographic variables?

METHODS

In this work, we seek to explore the reasons engineering master's and PhD students identify for enrolling in and persisting through their graduate programs. To do this, we use frequency analyses of nationwide survey results. We also investigate the trends in enrollment and persistence reasons for a variety of demographic factors. This work is part of a larger NSF-funded, nationwide, longitudinal study to understand graduate student attrition and persistence (see [45] for more information).

Recruitment and Participants. To recruit participants nationwide, we emailed all publicly-contactable graduate student coordinators and department heads of all engineering departments at the top 50 engineering PhD-granting universities in the United States as per ASEE's 2020 Engineering by the Numbers [46]. We asked these administrators and faculty to forward a description of our research study and recruitment survey link to their master's and PhD-student listservs in the Fall 2022 semester. Of the 2,387 students opened the survey link, 1,084 fully completed the survey. All of the 1,084 students were in engineering Master of Science (MS) or PhD programs, which was the only limiting factor for participation in this study. Therefore, we have a total of n=1084 participants for this study.

Because we are independently exploring the enrollment and persistence reasons of master's and PhD students, we separate PhD and master's participants' demographic information including number of years in graduate school, citizenship, gender, and race/ethnicity in Tables 1a and 1b. In total, there are n=871 PhD participants and n=213 MS participants in this study. In the citizenship category of Tables 1a and b, domestic students refers to participants who indicated they were U.S citizens or permanent residents. Multiple selected in the race/ethnicity category of Tables 1a and b refers to any participant who selected more than one available racial or ethnic group. While we gathered information on participants' engineering disciplines in the recruitment survey, we used a fill in the blank response setting to gather this information. This response type allowed participants to describe interdisciplinary engineering programs that are becoming increasingly more common but also produces complications when sorting participants by discipline. Because universities departmental cultures can vary (e.g., like how one university can separate Mechanical and Aerospace Engineering programs into two departments while another can have one joint program) we will not include disciplinary information for the participants in this study.

Table 1a. Participant breakdown by years in graduate school, citizenship, gender, and race/ethnicity for n=871 PhD participants

Years in Graduate School	**Number of Participants**
1	185
2	213
3	175
4	150
5	105
6	30
7+	13
Citizenship	
Domestic	610
International	254
Gender	
Women	435
Men	411
Non-binary/third gender	21
another gender	3
Race/Ethnicity	
Latinx	37
Black	30
Asian	262
White	430
Multiple selected	81

Table 1b. Participant breakdown by years in graduate school, citizenship, gender, and race/ethnicity for n=213 MS participants

Years in Graduate School	**Number of participants**
1	131
2	75
3+	7
Citizenship	
Domestic	106
International	101
Gender	
Women	78
Men	128
Non-binary/third gender	2
Another gender	1
Race/Ethnicity	
Latinx	7
Black	3
Asian	109
White	72
Multiple selected	12

Survey instrument development. The recruitment survey asked a variety of questions related to students' experiences and opinions, interest in participating in a larger longitudinal study, and demographic information. This study specifically aims to explore the responses to two of the survey questions which are related to enrollment and persistence. The questions of interest are: "*Why did you decide to enroll in your engineering graduate program? (Please select at least 2 options)"* and *"Why are you persisting through your engineering graduate program? (Please select at least 2 options)."*

An iterative, abductive approach was used to develop the potential responses for these questions. First, we compiled a list of reasons why students enroll in and/or persist through graduate school based on existing literature [13], [16], [21], [24]. Next, we shared this list with the larger research team to extend the list of potential reasons. The first author then conducted 6 cognitive interviews with current engineering graduate students to determine how comprehensive the list was and whether the wording of certain choices was ambiguous or could be improved. The graduate students who participated in these interviews included master's and PhD students, first through fifth-year students, and domestic and international students. The updated lists of reasons to enroll and persist were then presented again to the larger research team and finalized. All the choices for the enroll question were also provided for the persist question in the final survey. However, 4 choices were added to the persist question because they were not appropriate reasons to enroll but could be reasons to persist. These choices are *I don't know why I am still enrolled, I've already put in a significant amount of time, I've worked so hard for this degree,* and *I am so close to graduating*. Because we required participants to select at least 2 options for each question, one of the choices was *no other reason* to avoid participants selecting multiple reasons just to meet the requirement and not because those were truly the reasons they enrolled or persisted. While broad, we do not assume our lists of choices are all-encompassing. We, therefore, also provided an open-response choice to allow participants to share any other reasons they had for enrolling or persisting. In total, there were 22 choices for the enrollment question and 26 choices for the persistence question. The complete list of choices can be found in Appendix A.

Data Analysis. To analyze this data, we conducted frequency analyses in SPSS 29.0. We explored the frequency with which each enrollment and each persistence choice was selected for PhD and master's program participants separately. To do this, we determined the number and percentage of PhD participants who selected each provided choice to enroll and persist and then did the same for the MS participants. Because we also wanted to explore the trends in enrollment and persistence choices for each demographic variable, we determined the number and percentage of PhD and MS participants who selected each choice after sorting participants by number of years in graduate school, citizenship, gender, and race/ethnicity. We compared the five most frequently selected reasons to enroll or persist for PhD and MS participants in each of these categories to the 5 most frequently selected reasons to enroll or persist for all participants in the respective degree program to understand potential trends. We chose to look at the top five reasons because less than 50% of participants selected reasons beyond those five.

FINDINGS

We present the frequency analyses for participants' original enrollment reasons and current persistence reasons in two separate sections: *Reasons to Enroll in Graduate School* and *Reasons to Persist in Graduate School*. In each section, we first describe participants' reasons for enrolling or persisting based on their degree type (i.e., PhD and MS). Then, we sort participants in each degree type by number of years in graduate school, citizenship, gender, and race/ethnicity to compare the most frequently selected reasons based on each of these categories. This section has accompanying data tables that present the frequency with which participants in PhD and MS programs select each reason to enroll and persist. Because of their length and the limited space in this paper, the frequency tables can be found in Appendix B (Tables 2a-11b). The reasons to enroll

and persist have been abbreviated for spatial accommodation, but they are numbered for ease of reading and consistency (refer to Appendix A for the unabbreviated versions of each reason).

Each table in Appendix B denoted with an "a" provides information for PhD participants and each table denoted with a "b" provides information for MS participants. includes the five most selected reasons to enroll or persist for all PhD participants and the most frequently selected reasons for each subgroup within the specified demographic variable. Each table denoted with a "b" includes the top five most selected reasons to enroll or persist for all MS participants and the most frequently selected reasons for each subgroup within the given demographic variable. Tables comparing the top five reasons to enroll or persist for participants in a specific degree type with the most frequently selected reasons for each subgroup within a given demographic variable include italics, asterisks, and bolding to enhance readability of comparisons between the different groups. Italics indicate a reason that appears for both the total PhD or MS participants and for a given subgroup's most frequent list, but in different orders. For example, international MS participants selected *9. Earn a higher salary* fourth-most-often compared to third-most-often for all MS participants (Table 4b – Appendix B). An asterisk indicates a tie between multiple reasons on the subgroup's five most frequent list. For instance, 57 PhD participants in their 5th year of doctoral study chose both *10. I wanted an advanced degree* and *2. Contribute to society* (Table 3a – Appendix B). Bolding indicates a reason that is included as one of the five most frequent reasons for the subgroup but not for all PhD or MS participants. One example of this is that Latinx MS participants selected *15. Got the opportunity & couldn't pass it up* but this was not as frequently selected by all MS participants (Table 6b – Appendix B).

Reasons to Enroll in Graduate School. Tables 2a and 2b in Appendix B present the 22 provided choices for enrolling in graduate school, from most to least frequently selected, for participants in PhD and MS graduate programs, respectively. All of the five most chosen reasons to enroll for participants in PhD programs were selected by at least half of the participants (Table 2a – Appendix B). However, only the most common reason, *4. Continue learning/gain knowledge*, was selected by close to 80% of participants. For MS participants, four of the five most chosen reasons to enroll were selected by at least half of the participants (Table 2b – Appendix B). Two of these reasons were selected by over 80% of participants: *8. Gain/develop skills* and *4. Continue learning/gain knowledge*. While both PhD and MS participants selected reasons *4* and *8* as the two most common reasons to enroll, they differed in that PhD participants chose *4* then *8* most frequently and MS participants chose *8* then *4* most frequently. We also observe differences in choice selection between these groups when comparing the five most selected reasons for each. PhD participants selected *1. Continue doing research* and *2. Contribute to society* more often while MS participants selected 9. *Earn a higher salary* and *3. I liked engineering/thought it was fun* more often.

Tables 3a-6b in Appendix B present the most frequently selected reasons to enroll in graduate school based on each of four demographic variables: number of years in graduate school, citizenship, gender, and race/ethnicity.

We observe that PhD participants in their 3rd, 6th, and 7th+ year of a doctoral program selected at least one choice that differed from the general PhD participant choices (Table 3a – Appendix B). Participants in all three of these subgroups more frequently chose to enroll because *3. I liked engineering/thought it was fun*. Those in their 6th year of engineering doctoral programs also selected *12. Become a professor/teach at college level*. Participants in their 7th year or beyond differed most from other years in their top choices to enroll. Along with choice *3*, they also selected *9. Earn a higher salary* and *14. Family/faculty encouraged me*. When looking at participants

earning an MS (Table 3b – Appendix B), we found that only students in their 3rd year and beyond differed in their choices to enroll. These participants selected *2. Contribute to society* and *15. Got the opportunity & couldn't pass it up* while others did not.

Tables 4a and 4b indicate that only international students chose other reasons to enroll in graduate school. Domestic students pursuing both PhD and MS degrees chose the same reasons to enroll as the general participants in each of these degree types. International PhD participants, however, more frequently selected *9. Earn a higher salary* (Table 4a – Appendix B) and international MS participants more frequently enrolled in their program to *1. Continue doing research* (Table 4b – Appendix B).

Only women PhD participants selected the same five most frequent reasons to enroll as all PhD participants (Table 5a – Appendix B). Instead of selecting *2. Contribute to society* more frequently, men chose *3. I liked engineering/thought it was fun*. Non-binary PhD participants also did not select *2* more frequently and instead more often chose *12. Become a professor/teach at college level* and *13. Degree necessary for career/job I want*. PhD participants identifying with another gender differed the most in their most frequent reasons to enroll in doctoral programs, though their sample size was very small. Like the men participants, these participants selected *3. I liked engineering/thought it was fun* but also selected *9. Earn a higher salary* and *7. Be a role model for others with similar identities*. Because of the small sample size for this group, 5 reasons were tied for 2nd most frequently selected. Only men MS participants selected the same five most frequent reasons to enroll as all MS participants (Table 5b – Appendix B). Women MS participants selected *1. Continue doing research* instead of *3. I liked engineering/thought it was fun*. The single MS participant who identified with another gender selected seven reasons for enrolling in their MS, including *7. Be a role model for others with similar identities, 2. Contribute to society, and 11. Switch fields*, which all differed from the overall MS participants. The two non-binary MS participants differed most from all MS participants. Both participants selected *2. Continue doing research, 3. I liked engineering/thought it was fun,* and *4. Continue learning/gain knowledge* as reasons to enroll in their MS degree. One of them also selected at least one of 5 other reasons to enroll in an MS that differed from the general participants, including *2. Contribute to society, 15. Got the opportunity & couldn't pass it up, 5. Challenge myself, 7. Be a role model for others with similar identities,* and *20. Didn't know what else to do.*

Latinx and Black PhD participants more frequently selected *9. Earn a higher salary* as a reason to enroll in the doctorate (Table 6a – Appendix B). Asian participants also differed from all PhD participants in that they selected *3. I liked engineering/thought it was fun* more frequently than *2. Contribute to society*. Only MS participants with marginalized racial/ethnic identities in engineering (i.e., Latinx and Black) and MS participants who identified with multiple races/ethnicities selected reasons to enroll that differed from all MS participants (Table 6b – Appendix B). In addition to the 5 most frequent reasons for all MS participants, four of the seven Latinx participants selected *15. Got the opportunity & couldn't pass it up.* All three Black MS participants selected *16. Assumed was the right thing to do for someone like me* while at least two of them selected *1. Continue doing research, 2. Contribute to society,* or *13. Degree necessary for career/job I want*. MS participants with multiple racial/ethnic identities selected three differing reasons to enroll: *5. Challenge myself, 1. Continue doing research,* and *2. Contribute to society.*

Reasons to Persist in Graduate School. Tables 7a and 7b in Appendix B present the 26 provided choices for persisting in graduate school, from most to least frequently selected, for PhD and MS participants, respectively. Three of the most frequent reasons for persisting through the doctorate are also in the most common reasons for enrolling: *4. Continue learning/gain knowledge, 1. Continue doing research,* and *8. Gain/develop skills* (Table 7a – Appendix B). However, PhD participants also choose to persist due to sunk cost effects like reasons *24. Already put in significant amount of time* and *25. Worked so hard for this* more frequently. For MS participants, four of the most popular reasons to persist are the same as the most popular reasons to enroll: *4. Continue learning/gain knowledge, 8. Gain/develop skills, 9. Earn a higher salary,* and *3. I like engineering/think it's fun.* MS participants also more frequently choose to persist to *1. Continue doing research* (Table 7b – Appendix B). While reason *4* is the most common reason to persist for both PhD and MS participants, it is selected by 20% less participants for each degree type than as a reason to enroll. For both PhD and MS participants, there was more spread in the reasons to persist compared to reasons to enroll.

Tables 8a-11b in Appendix B present the five most selected reasons to persist in graduate school based on the same demographic variables as for enrollment: number of years in graduate school, citizenship, gender, and race/ethnicity.

PhD participants in every year of their doctoral program except the 3rd year more frequently selected at least one reason that differed from the general PhD participant choices (Table 8a – Appendix B). Neither 1st nor 2nd year PhD participants selected any sunk cost reasons like *24* or *25.* Instead, both these groups more frequently persisted because *3. I like engineering/think it's fun* among other reasons. From years 3-6, PhD participants' most common reason for persisting was *24. Already put in significant amount of time*. PhD participants in year 5 or beyond more frequently chose *26. So close to graduating*, with all participants in years 7 and above selecting this reason. MS participants in all years selected at least one reason to persist that differed from the most frequent of all MS participants. (Table 8b – Appendix B). Interestingly, 2nd and 3rd+ year MS participants selected a sunk cost reason, in this case *24. Already put in significant amount of time*, as one of the most frequent reasons to persist. Two MS students in their 3rd year and beyond selected 6 additional reasons to persist compared to all MS participants.

International student PhD participants were the only subgroup that more frequently selected the same five reasons as all participants in their degree type. Domestic student PhD and MS participants and international student MS participants each selected one reason that differed from the general participants in their degree type. Domestic student PhD participants more frequently persisted in the doctorate because *13. Degree necessary for career/job I want* (Table 9a – Appendix B). Interestingly, both domestic and international student MS participants selected *10. I want an advanced degree* as the fifth most frequent reason to persist in their master's program (Table 9b – Appendix B).

Women, again, were the only PhD participants to select the same five reasons most frequently as all PhD participants (Table 10a – Appendix B). Men more frequently chose *3. I like engineering/think it's fun* as a reason to persist. Neither non-binary PhD participants nor participants who identified with another gender more frequently selected the sunk cost reasons (*24* and *25*) that the general PhD participants selected. Non-binary participants, instead, frequently selected other reasons including *12. Become a professor/teach at college level* and *5. Challenge myself* among others. For the three PhD participants who identified with another gender, only *4. Continue learning/gain knowledge* was selected by everyone. For the MS participants, men were the only subgroup to most frequently all the same reasons as the general MS participants (Table

10b – Appendix B). Women MS participants more frequently persisted in their master's program because *10. I want an advanced degree* instead of *3. I like engineering/think it's fun*. Both non-binary MS participants identified *24. Already put in significant amount of time* and *10. I want an advanced degree* as reasons to persist which differed from the general MS participants. The participant who identified with another gender selected 3 additional reasons to persist in the Master's, including *2. Contribute to society, 13. Degree necessary for career/job I want,* and *7. Be a role model for others with similar identities.*

Asian PhD and MS participants were the only race/ethnicity group to more frequently select the same reasons to persist as the larger participants in their respective degree programs. Interestingly, Latinx and Black PhD participants were the only subgroups to select *9. Earn a higher salary* as one of the five most frequent reasons to persist (Table 11a – Appendix B). Instead of persisting because *25. Worked so hard for this*, White PhD participants more frequently persisted because *13. Degree necessary for career/job I want*. PhD participants with multiple racial/ethnic identities more frequently selected *3. I like engineering/think it's fun* and *10. I want an advanced degree* as reasons to persist. Latinx, Black, and White MS participants selected *24. Already put in significant amount of time* as one of the most frequent reasons to persist (Table 11b – Appendix B). Latinx MS participants' most frequently selected reasons to persist in master's programs differed from all MS participants, as only *8. Gain/develop skills* was one of the most common reasons for both groups. At least one of the three Black MS participants selected one of 9 differing reasons to persist compared to the most frequent reasons for MS participants.

DISCUSSION

In this work, we explored the motivations that led engineering PhD and master's students to enroll in and persist through their graduate programs. Results demonstrate that PhD and MS students' main reasons to enroll and persist varied based on their degree program. Participants' reasons for persisting in their PhD or MS programs also varied based on their gender, race/ethnicity, and number of years in graduate school. The two main discussion points that this analysis offers to the engineering education community are that (1) there are differences between MS and PhD students to enroll and persist in graduate school that have not been captured in literature and (2) there is much more variation in the reasons that engineering graduate students give for persisting than in the reasons they give for enrolling in graduate programs.

PhD and MS students both frequently enrolled in their graduate programs to gain skills, continue learning, and because they wanted advanced degrees, which are consistent with enrollment reasons in previous findings [24]. However, there were other motivators to enroll that were more popular for each specific degree type. For example, MS students more frequently indicated that they enrolled in their master's to earn a higher salary and because they liked engineering while PhD students more frequently enrolled in their doctorates to contribute to society and continue doing research. Students enrolled in their PhD programs for similar reasons regardless of their race/ethnicity, gender, or the number of years they had spent in graduate school. The same was observed for students in MS programs. This is significant because undergraduate engineering literature indicates that there are factors that can specifically contribute to students with marginalized race/ethnicity or gender identities' intentions to enroll in graduate programs [17], [19]–[22].

Like with their enrollment reasons, PhD and MS students frequently chose to persist through their respective degrees to continue learning and gain skills. They also both frequently persisted to continue doing research. There were key differences in their most frequently selected

reasons to persist, though. MS students more frequently persisted for the same reasons they enrolled, including to earn a higher salary and because they liked engineering. PhD students, however, more frequently persisted in their doctorates because of sunk cost motivators including already putting in a significant amount of time into and working so hard for their degrees. These findings agree with previous literature that has found that sunk cost can motivate PhD students to persist in graduate school through difficult experiences including mental health troubles and discrimination [6].

Not only did we find differences in reasons to persist when comparing MS and PhD students, but we also observed differences when comparing between the MS or between the PhD students based on demographic variables. For example, we found that PhD students in their 3rd year and beyond most frequently persisted because of sunk cost reasons but these were not in the five most frequent reasons for 1st and 2nd year PhD students to persist. Interestingly, we also found that MS students in their 2nd year and beyond more frequently persisted because they believed they had put in a significant amount of time into their degree, but 1st year MS students did not consider this as a popular reason to persist. Observations of sunk cost motivators are surprising in MS students because their programs are completed in a much shorter time frame compared to PhDs. Both MS and PhD students with marginalized gender or race/ethnicity identities were more frequently motivated to persist for reasons that differed from the popular reasons to persist in their degree type. For example, non-binary PhD students more frequently persisted to be able to teach at the college level and contribute to society which were not the more frequent reasons to persist for the general group of PhD students. Overall, students' reasons for persisting fluctuated more than their reasons for enrolling in both doctoral and master's programs.

The observed differences between PhD and MS participants' reasons to enroll and persist indicate that there are motivational differences based on degree type. While existing literature on engineering graduate school currently groups all students into one large pool of graduate students, we believe separating MS and PhD students in different categories and studying them individually can also provide insight for the engineering education community. The greater variation in students with marginalized identities' reasons to persist regardless of degree type could result from how they experience graduate school once they are enrolled and aligns with existing literature that observes that students with marginalized identities have more challenging graduate school experiences [36], [38], [43], [47], [48]. Because students' motivations for persisting varied more, future work should explore how experiences in graduate school can influence motivation.

CONCLUSION

In this study, we explored the reasons engineering doctoral and master's students enrolled in and are persisting through their degrees. We found that PhD and MS students enrolled for differing reasons but that the reasons for enrolling did not vary as much among participants. PhD and MS students also persist for different reasons, including sunk cost motivations for PhD students and higher salary potential for MS students. We also explored whether there were differing reasons to enroll among PhD students and among MS students based on the number of years they had been in school, their citizenship, their gender, and their race/ethnicity. Our findings indicated that reasons to persist varied more for people with marginalized identities. These changes in reasons to persist could result from students' experiences while in graduate school and future research should separate PhD and MS students' experiences and explore how experiences and motivation influence each other.

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APPENDIX A: Unabbreviated choices for reasons to enroll and persist in a graduate program

Reasons to enroll:

1. Continue doing research
2. Contribute to society
3. I liked engineering/thought it was fun
4. Continue learning/gain knowledge
5. Challenge myself/grad school was a good challenge
6. Follow in the footsteps of someone I admire
7. Be a role model for others with similar identities
8. Gain/develop skills
9. Earn a higher salary
10. I wanted an advanced degree
11. Switch fields
12. Become a professor/teach at college level
13. Degree necessary for career/job I want
14. Family/faculty encouraged me
15. Got the opportunity & couldn't pass it up
16. Assumed was the right thing to do for someone like me
17. Felt pressured
18. Close friends, peers, partner also enrolling
19. Have a student visa and stay in country
20. Didn't know what else to do
21. No other reason
22. Something else (Fill in blank)

Reasons to persist:

1. Continue doing research
2. Contribute to society
3. I like engineering/think it's fun
4. Continue learning/gain knowledge
5. Challenge myself/grad school is a good challenge
6. Follow in the footsteps of someone I admire
7. Be a role model for others with similar identities
8. Gain/develop skills
9. Earn a higher salary
10. I want an advanced degree
11. Switch fields
12. Become a professor/teach at college level
13. Degree necessary for career/job I want
14. Family/faculty encourage me to persist
15. Have the opportunity & feel I can't pass it up
16. Assume it's the right thing to do for someone like me
17. Feel pressured
18. Close friends, peers, partner also enrolled
19. Have a student visa and stay in country
20. Don't know what else to do
21. No other reason
22. Something else (Fill in blank)
23. Don't know why I'm still enrolled
24. Already put in significant amount of time
25. Worked so hard for this
26. So close to graduating

APPENDIX B: Frequency tables showing reasons to enroll and persist for PhD and MS participants, including demographic breakdowns by number of years in graduate school, citizenship, gender, and race/ethnicity

Table 2a. PhD participants' reasons to enroll from most to least frequent.

PhD participants (n=871)	
Reasons to Enroll	n (%)
4. Continue learning/gain knowledge	688 (79.0%)
8. Gain/develop skills	599 (68.8%)
1. Continue doing research	572 (65.7%)
10. I wanted an advanced degree	478 (54.9%)
2. Contribute to society	467 (53.6%)
3. I liked engineering/thought it was fun	435 (49.9%)
13. Degree necessary for career/job I want	412 47.5%)
9. Earn a higher salary	388 (44.5%)
5. Challenge myself	361 (41.4%)
12. Become a professor/teach at college level	326 (37.4%)
15. Got the opportunity & couldn't pass it up	216 24.8%)
14. Family/faculty encouraged me	203 23.3%)
16. Assumed was the right thing to do for someone like me	171 (19.6%)
7. Be a role model for others with similar identities	167 19.2%)
6. Follow in the footsteps of someone I admire	123 (14.1%)
11. Switch fields	107 12.3%)
20. Didn't know what else to do	74 8.5%)
18. Close friends, peers, partner also enrolling	73 8.4%)
17. Felt pressured	43 (4.9%)
19. Have a student visa and stay in country	29 (3.3%)
22. Something else (Fill in blank)	28 (3.2%)
21. No other reason	1 (0.1%)

Table 2b. MS participants' reasons to enroll from most to least frequent.

MS participants (n=213)	
Reasons to Enroll	n (%)
8. Gain/develop skills	174 (81.7%)
4. Continue learning/gain knowledge	172 (80.8%)
9. Earn a higher salary	131 (61.5%)
10. I wanted an advanced degree	130 (61.0%)
3. I liked engineering/thought it was fun	105 (49.3%)
1. Continue doing research	94 (44.1%)
5. Challenge myself	82 (38.5%)
2. Contribute to society	81 38.0%)
13. Degree necessary for career/job I want	70 32.9%))
16. Assumed was the right thing to do for someone like me	61 28.6%)
15. Got the opportunity & couldn't pass it up	50 (23.5%)
14. Family/faculty encouraged me	33 (15.5%)
11. Switch fields	32 15.0%)
7. Be a role model for others with similar identities	21 (9.9%)
12. Become a professor/teach at college level	19 (8.9%)
6. Follow in the footsteps of someone I admire	18 (8.5%)
17. Felt pressured	14 (6.6%)
18. Close friends, peers, partner also enrolling	13 6.1%)
20. Didn't know what else to do	12 (5.6%)
19. Have a student visa and stay in country	10 (4.7%)
22. Something else (Fill in blank)	8 (3.8%)
21. No other reason	-

Table 3a. The most frequently selected reasons to enroll for PhD participants sorted by number of years in graduate school.

Total PhD participants (n=871)		1st year in grad school (n=185)		2nd year in grad school (n=213)		3rd year in grad school (n=175)		4th year in grad school (n=150)	
Reasons to Enroll	n (%)		n (%)		n (%)		n (%)		n (%)
4. Continue learning/gain knowledge	688 (79.0%)	4. Continue learning/gain knowledge	152 (82.2%)	4. Continue learning/gain knowledge	169 (79.3%)	4. Continue learning/gain knowledge	140 (80.0%)	4. Continue learning/gain knowledge	120 (80.0%)
8. Gain/develop skills	599 (68.8%)	*1. Continue doing research*	136 (73.5%)	8. Gain/develop skills	150 (70.4%)	8. Gain/develop skills	119 (68.0%)	8. Gain/develop skills	99 (66.0%)
1. Continue doing research	572 (65.7%)	*8. Gain/develop skills*	129 (69.7%)	1. Continue doing research	147 (69.0%)	1. Continue doing research	106 (60.6%)	1. Continue doing research	94 (62.7%)
10. I wanted an advanced degree	478 (54.9%)	*2. Contribute to society*	114 (61.6%)	10. I wanted an advanced degree	117 (54.9%)	10. I wanted an advanced degree	103 (58.9%)	10. I wanted an advanced degree	85 (56.7%)
2. Contribute to society	467 (53.6%)	*10. I wanted an advanced degree*	97 (52.4%)	2. Contribute to society	116 (54.5%)	**3. I liked engineering/thought it was fun**	92 (52.6%)	2. Contribute to society	77 (51.3%)

Total PhD participants (n=871)		5th year in grad school (n=105)		6th year in grad school (n=30)		7th+ year in grad school (n=13)	
Reasons to Enroll	n (%)		n (%)		n (%)		n (%)
4. Continue learning/gain knowledge	688 (79.0%)	4. Continue learning/gain knowledge	80 (76.2%)	*8. Gain/develop skills*	21 (70.0%)	*8. Gain/develop skills*	10 (76.9%)
8. Gain/develop skills	599 (68.8%)	8. Gain/develop skills	71 (67.6%)	*4. Continue learning/gain knowledge*	20 (66.7%)	**3. I liked engineering/thought it was fun**	8 (61.5%)
1. Continue doing research	572 (65.7%)	1. Continue doing research	65 (61.9%)	**12. Become a professor/teach at college level**	19 (63.3%)	*4. Continue learning/gain knowledge*	7 (53.8%)
10. I wanted an advanced degree	478 (54.9%)	*10. I wanted an advanced degree	57 (54.3%)	*1. Continue doing research*	18 (60.0%)	*10. I wanted an advanced degree	6 (46.2%)
2. Contribute to society	467 (53.6%)	**2. Contribute to society*	57 (54.3%)	**3. I liked engineering/thought it was fun**	17 (56.7%)	***9. Earn a higher salary**	6 (46.2%)
						***1. Continue doing research**	6 (46.2%)
						***14. Family/faculty encouraged me**	6 (46.2%)

Notes: *Italicized* text indicates a choice that is on both the total participant pool's and the individual subgroup's list of most frequent reasons to enroll but in different orders. An asterisk (*) indicates a choice that is tied with others in selected frequency. **Bolding** indicates an alternate choice not included in the total participants' five most frequent reasons.

Table 3b. The most frequently selected reasons to enroll for MS participants sorted by number of years in graduate school.

Total MS participants (n=213)		1st year in grad school (n=131)		2nd year in grad school (n=75)		3rd+ year in grad school (n=7)	
Reasons to Enroll	n (%)		n (%)		n (%)		n (%)
8. Gain/develop skills	174 (81.7%)	8. Gain/develop skills	105 (80.2%)	*8. Gain/develop skills	63 (84.0%)	*8. Gain/develop skills	6 (85.7%)
4. Continue learning/gain knowledge	172 (80.8%)	4. Continue learning/gain knowledge	103 (78.6%)	**4. Continue learning/gain knowledge*	63 (84.0%)	**4. Continue learning/gain knowledge*	6 (85.7%)
9. Earn a higher salary	131 (61.5%)	9. Earn a higher salary	81 (61.8%)	*10. I wanted an advanced degree*	50 (66.7%)	****2. Contribute to society**	4 (57.1%)
10. I wanted an advanced degree	130 (61.0%)	10. I wanted an advanced degree	78 (59.5%)	*9. Earn a higher salary*	47 (62.7%)	***3. I liked engineering/thought it was fun*	4 (57.1%)
3. I liked engineering/thought it was fun	105 (49.3%)	3. I liked engineering/thought it was fun	63 (48.1%)	3. I liked engineering/thought it was fun	38 (50.7%)	****9. Earn a higher salary*	3 (42.9%)
						****15. Got the opportunity & couldn't pass it up**	3 (42.9%)

Notes: *Italicized* text indicates a choice that is on both the total participant pool's and the individual subgroup's list of most frequent reasons to enroll but in different orders. An asterisk (*) indicates a choice that is tied with others in selected frequency. **Bolding** indicates an alternate choice not included in the total participants' five most frequent reasons.

Table 4a. The most frequently selected reasons to enroll for PhD participants sorted by citizenship.

Total PhD participants (n=871)		Domestic (n=610)		International (n=254)	
Reasons to Enroll	n (%)		n (%)		n (%)
4. Continue learning/gain knowledge	688 (79.0%)	4. Continue learning/gain knowledge	482 (79.0%)	4. Continue learning/gain knowledge	200 (78.7%)
8. Gain/develop skills	599 (68.8%)	8. Gain/develop skills	427 (70.0%)	*1. Continue doing research*	172 (67.7%)
1. Continue doing research	572 (65.7%)	1. Continue doing research	396 (64.9%)	*8. Gain/develop skills*	166 (65.4%)
10. I wanted an advanced degree	478 (54.9%)	*2. Contribute to society*	356 (58.4%)	10. I wanted an advanced degree	130 (51.2%)
2. Contribute to society	467 (53.6%)	*10. I wanted an advanced degree*	345 (56.6%)	**9. Earn a higher salary**	117 (46.1%)

Notes: *Italicized* text indicates a choice that is on both the total participant pool's and the individual subgroup's list of most frequent reasons to enroll but in different orders. An asterisk (*) indicates a choice that is tied with others in selected frequency. **Bolding** indicates an alternate choice not included in the total participants' five most frequent reasons.

Table 4b. The most frequently selected reasons to enroll for MS participants sorted by citizenship.

Total MS participants (n=213)		Domestic (n=106)		International (n=101)	
Reasons to Enroll	n (%)		n (%)		n (%)
8. Gain/develop skills	174 (81.7%)	8. Gain/develop skills	89 (84.0%)	*4. Continue learning/gain knowledge*	82 (81.2%)
4. Continue learning/gain knowledge	172 (80.8%)	4. Continue learning/gain knowledge	85 (80.2%)	*8. Gain/develop skills*	82 (78.2%)
9. Earn a higher salary	131 (61.5%)	9. Earn a higher salary	69 (65.1%)	*10. I wanted an advanced degree*	64 (63.4%)
10. I wanted an advanced degree	130 (61.0%)	10. I wanted an advanced degree	64 (60.4%)	*9. Earn a higher salary*	60 (59.4%)
3. I liked engineering/thought it was fun	105 (49.3%)	3. I liked engineering/thought it was fun	56 (52.8%)	**1. Continue doing research**	47 (46.5%)

Notes: *Italicized* text indicates a choice that is on both the total participant pool's and the individual subgroup's list of most frequent reasons to enroll but in different orders. An asterisk (*) indicates a choice that is tied with others in selected frequency. **Bolding** indicates an alternate choice not included in the total participants' five most frequent reasons.

Table 5a. The most frequently selected reasons to enroll for PhD participants sorted by gender.

Total PhD participants (n=871)		Women (n=435)		Men (n=411)		Non-binary/third gender (n=21)		Another gender (n=3)	
Reasons to Enroll	n (%)		n (%)		n (%)		n (%)		n (%)
4. Continue learning/gain knowledge	688 (79.0%)	4. Continue learning/gain knowledge	351 (80.7%)	4. Continue learning/gain knowledge	320 (77.9%)	*1. Continue doing research*	17 (81.0%)	*8. Gain/develop skills*	3 (100%)
8. Gain/develop skills	599 (68.8%)	8. Gain/develop skills	295 (67.8%)	8. Gain/develop skills	287 (69.8%)	*4. Continue learning/gain knowledge*	14 (66.7%)	***3. I liked engineering/thought it was fun**	2 (66.7%)
1. Continue doing research	572 (65.7%)	1. Continue doing research	293 (67.4%)	1. Continue doing research	260 (63.3%)	*8. Gain/develop skills*	13 (61.9%)	**4. Continue learning/gain knowledge*	2 (66.7%)
10. I wanted an advanced degree	478 (54.9%)	10. I wanted an advanced degree	240 (55.2%)	**3. I liked engineering/thought it was fun**	227 (55.2%)	*10. I wanted an advanced degree	12 (57.1%)	***7. Be a role model for others with similar identities**	2 (66.7%)
2. Contribute to society	467 (53.6%)	2. Contribute to society	232 (53.3%)	*10. I wanted an advanced degree*	224 (54.5%)	***12. Become a professor/teach at college level**	12 (57.1%)	***9. Earn a higher salary**	2 (66.7%)
						***13. Degree necessary for career/job I want**	12 (57.1%)	**10. I wanted an advanced degree*	2 (66.7%)

Notes: *Italicized* text indicates a choice that is on both the total participant pool's and the individual subgroup's list of most frequent reasons to enroll but in different orders. An asterisk (*) indicates a choice that is tied with others in selected frequency. **Bolding** indicates an alternate choice not included in the total participants' five most frequent reasons.

Table 5b. The most frequently selected reasons to enroll for MS participants sorted by gender.

Total MS participants (n=213)		Women (n=78)		Men (n=128)		Non-binary/third gender (n=2)		Another gender (n=1)	
Reasons to Enroll	n (%)		n (%)		n (%)		n (%)		n (%)
8. Gain/develop skills	174 (81.7%)	*4. Continue learning/gain knowledge*	65 (83.3%)	8. Gain/develop skills	106 (82.8%)	***1. Continue doing research**	2 (100%)	*8. Gain/develop skills	1 (100%)
4. Continue learning/gain knowledge	172 (80.8%)	*8. Gain/develop skills*	62 (79.5%)	4. Continue learning/gain knowledge	101 (78.9%)	**3. I liked engineering/thought it was fun*	2 (100%)	**3. I liked engineering/thought it was fun*	1 (100%)
9. Earn a higher salary	131 (61.5%)	*10. I wanted an advanced degree*	48 (61.5%)	9. Earn a higher salary	82 (64.1%)	**4. Continue learning/gain knowledge*	2 (100%)	**4. Continue learning/gain knowledge*	1 (100%)
10. I wanted an advanced degree	130 (61.0%)	*9. Earn a higher salary*	45 (57.7%)	10. I wanted an advanced degree	80 (62.5%)	****2. Contribute to society**	1 (50%)	***7. Be a role model for others with similar identities**	1 (100%)
3. I liked engineering/thought it was fun	105 (49.3%)	**1. Continue doing research**	37 (47.4%)	3. I liked engineering/thought it was fun	69 (53.9%)	****5. Challenge myself**	1 (50%)	***2. Contribute to society**	1 (100%)
						****7. Be a role model for others with similar identities**	1 (50%)	**9. Earn a higher salary*	1 (100%)
						**8. Gain/develop skills	1 (50%)	***11. Switch fields**	1 (100%)
						**9. Earn a higher salary	1 (50%)		
						**10. I wanted an advanced degree	1 (50%)		
						****15. Got the opportunity & couldn't pass it up**	1 (50%)		
						****20. Didn't know what else to do**	1 (50%)		

Notes: *Italicized* text indicates a choice that is on both the total participant pool's and the individual subgroup's list of most frequent reasons to enroll but in different orders. An asterisk (*) indicates a choice that is tied with others in selected frequency. **Bolding** indicates an alternate choice not included in the total participants' five most frequent reasons.

Table 6a. The most frequently selected reasons to enroll for PhD participants sorted by race/ethnicity.

Total PhD participants (n=871)		Latinx (n=37)		Black (n=30)		Asian (n=262)		White (n=430)		Multiple selected (n=81)	
Reasons to Enroll	n (%)		n (%)		n (%)		n (%)		n (%)		n (%)
4. Continue learning/gain knowledge	688 (79.0%)	4. Continue learning/gain knowledge	31 (83.8%)	*8. Gain/develop skills	20 (66.7%)	4. Continue learning/gain knowledge	207 (79.0%)	4. Continue learning/gain knowledge	345 (80.2%)	4. Continue learning/gain knowledge	64 (79.0%)
8. Gain/develop skills	599 (68.8%)	*8. Gain/develop skills	24 (64.9%)	**9. Earn a higher salary**	20 (66.7%)	*1. Continue doing research*	190 (72.5%)	8. Gain/develop skills	294 (68.4%)	8. Gain/develop skills	62 (76.5%)
1. Continue doing research	572 (65.7%)	**2. Contribute to society*	24 (64.9%)	*4. Continue learning/gain knowledge*	19 (63.3%)	*8. Gain/develop skills*	181 (69.1%)	1. Continue doing research	267 (62.1%)	*10. I wanted an advanced degree*	54 (66.7%)
10. I wanted an advanced degree	478 (54.9%)	***1. Continue doing research*	22 (59.5%)	*1. Continue doing research*	18 (60%)	10. I wanted an advanced degree	143 (54.6%)	10. I wanted an advanced degree	236 (54.9%)	*1. Continue doing research*	53 (65.4%)
2. Contribute to society	467 (53.6%)	****9. Earn a higher salary**	22 (59.5%)	*10. I wanted an advanced degree*	17 (56.7%)	**3. I liked engineering/thought it was fun**	131 (50.0%)	2. Contribute to society	231 (53.7%)	2. Contribute to society	51 (63.0%)

Notes: *Italicized* text indicates a choice that is on both the total participant pool's and the individual subgroup's list of most frequent reasons to enroll but in different orders. An asterisk (*) indicates a choice that is tied with others in selected frequency. **Bolding** indicates an alternate choice not included in the total participants' five most frequent reasons.

Table 6b. The most frequently selected reasons to enroll for MS participants sorted by race/ethnicity.

Total MS participants (n=213)		Latinx (n=7)		Black (n=3)		Asian (n=109)		White (n=72)		Multiple selected (n=12)	
Reasons to Enroll	n (%)		n (%)		n (%)		n (%)		n (%)		n (%)
8. Gain/develop skills	174 (81.7%)	*8. Gain/develop skills	4 (57.1%)	**16. Assumed was the right thing to do for someone like me**	3 (100%)	*8. Gain/develop skills	89 (81.7%)	8. Gain/develop skills	61 (84.7%)	*4. Continue learning/gain knowledge*	11 (91.7%)
4. Continue learning/gain knowledge	172 (80.8%)	***15. Got the opportunity & couldn't pass it up**	4 (57.1%)	*4. Continue learning/gain knowledge	2 (66.7%)	*4. Continue learning/gain knowledge*	89 (81.7%)	4. Continue learning/gain knowledge	57 (79.2%)	*8. Gain/develop skills*	10 (83.3%)
9. Earn a higher salary	131 (61.5%)	*3. I liked engineering/thought it was fun*	4 (57.1%)	*8. Gain/develop skills*	2 (66.7%)	*10. I wanted an advanced degree*	71 (65.1%)	9. Earn a higher salary	44 (61.1%)	**5. Challenge myself**	9 (75.0%)
10. I wanted an advanced degree	130 (61.0%)	*9. Earn a higher salary*	4 (57.1%)	***1. Continue doing research**	2 (66.7%)	*9. Earn a higher salary*	67 (61.5%)	10. I wanted an advanced degree	41 (56.9%)	**1. Continue doing research**	8 (66.7%)
3. I liked engineering/thought it was fun	105 (49.3%)	*10. I wanted an advanced degree*	4 (57.1%)	***2. Contribute to society**	2 (66.7%)	3. I liked engineering/thought it was fun	52 (47.7%)	3. I liked engineering/thought it was fun	36 (50.0%)	***2. Contribute to society**	8 (66.7%)
		4. Continue learning/gain knowledge	4 (57.1%)	***13. Degree necessary for career/job I want**	2 (66.7%)					*9. Earn a higher salary*	8 (66.7%)

Notes: *Italicized* text indicates a choice that is on both the total participant pool's and the individual subgroup's list of most frequent reasons to enroll but in different orders. An asterisk (*) indicates a choice that is tied with others in selected frequency. **Bolding** indicates an alternate choice not included in the total participants' five most frequent reasons.

Table 7a. PhD participants' reasons to persist from most to least frequent.

PhD participants (n=871)

Reasons to Persist	n (%)
4. Continue learning/gain knowledge	509 (58.4%)
1. Continue doing research	478 (54.9%)
24. Already put in significant amount of time	477 (54.8%)
8. Gain/develop skills	432 (49.6%)
25. Worked so hard for this	377 (43.3%)
3. I like engineering/think it's fun	363 (41.7%)
13. Degree necessary for career/job I want	345 (39.6%)
10. I want an advanced degree	344 (39.5%)
2. Contribute to society	343 39.4%)
9. Earn a higher salary	315 (36.2%)
5. Challenge myself	232 (26.6%)
12. Become a professor/teach at college level	231 (26.5%)
15. Have the opportunity & feel I can't pass it up	220 (25.3%)
26. So close to graduating	182 (20.9%)
7. Be a role model for others with similar identities	150 (17.2%)
14. Family/faculty encourage me to persist	126 14.5%)
16. Assume it's the right thing to do for someone like me	80 (9.2%)
20. Don't know what else to do	69 (7.9%)
18. Close friends, peers, partner also enrolled	66 (7.6%)
6. Follow in the footsteps of someone I admire	54 (6.2%)
17. Feel pressured	53 (6.1%)
11. Switch fields	46 (5.3%)
22. Something else (Fill in blank)	32 (3.7%)
19. Have a student visa and stay in country	28 (3.2%)
23. Don't know why I'm still enrolled	6 (0.7%)
21. No other reason	3 (0.3%)

Table 7b. MS participants' reasons to persist from most to least frequent.

MS participants (n=213)

Reasons to Persist	n (%)
4. Continue learning/gain knowledge	129 (60.6%)
8. Gain/develop skills	115 (54.0%)
9. Earn a higher salary	106 (49.8%)
1. Continue doing research	95 (44.6%)
3. I like engineering/think it's fun	87 (40.8%)
10. I want an advanced degree	84 (39.4%)
24. Already put in significant amount of time	82 (38.5%)
25. Worked so hard for this	70 (32.9%)
2. Contribute to society	61 (28.6%)
5. Challenge myself	51 (23.9%)
13. Degree necessary for career/job I want	49 (23.0%)
26. So close to graduating	42 (19.7%)
15. Have the opportunity & feel I can't pass it up	36 (16.9%)
16. Assume it's the right thing to do for someone like me	24 (11.3%)
11. Switch fields	18 (8.5%)
14. Family/faculty encourage me to persist	18 (8.5%)
7. Be a role model for others with similar identities	13 (6.1%)
12. Become a professor/teach at college level	12 (5.6%)
18. Close friends, peers, partner also enrolled	10 (4.7%)
20. Don't know what else to do	9 (4.2%)
22. Something else (Fill in blank)	9 (4.2%)
17. Feel pressured	8 (3.8%)
6. Follow in the footsteps of someone I admire	7 3.3%))
19. Have a student visa and stay in country	6 (2.8%)
23. Don't know why I'm still enrolled	-
21. No other reason	-

Table 8a. The most frequently selected reasons to persist for PhD participants sorted by number of years in graduate school.

Total PhD participants (n=871)		1st year in grad school (n=185)		2nd year in grad school (n=213)		3rd year in grad school (n=175)		4th year in grad school (n=150)	
Reasons to Persist	n (%)		n (%)		n (%)		n (%)		n (%)
4. Continue learning/gain knowledge	509 (58.4%)	4. Continue learning/gain knowledge	123 (66.5%)	*1. Continue doing research*	135 (63.4%)	*24. Already put in significant amount of time*	117 (66.9%)	*24. Already put in significant amount of time*	117 (78.0%)
1. Continue doing research	478 (54.9%)	1. Continue doing research	116 (62.7%)	*4. Continue learning/gain knowledge*	133 (62.4%)	*4. Continue learning/gain knowledge*	108 (61.7%)	*25. Worked so hard for this*	99 (66.0%)
24. Already put in significant amount of time	477 (54.8%)	*8. Gain/develop skills*	102 (55.1%)	*8. Gain/develop skills*	124 (58.2%)	*1. Continue doing research*	100 (57.1%)	*4. Continue learning/gain knowledge*	85 (56.7%)
8. Gain/develop skills	432 (49.6%)	**3. I like engineering/think it's fun**	94 (50.8%)	**2. Contribute to society**	96 (45.1%)	*25. Worked so hard for this*	91 (52.0%)	*1. Continue doing research*	72 (48.0%)
25. Worked so hard for this	377 (43.3%)	**13. Degree necessary for career/job I want**	81 (43.8%)	**3. I like engineering/think it's fun**	91 (42.7%)	*8. Gain/develop skills*	88 (50.3%)	**10. I want an advanced degree**	68 (45.3%)

Total PhD participants (n=871)		5th year in grad school (n=105)		6th year in grad school (n=30)		7th+ year in grad school (n=13)	
Reasons to Persist	n (%)		n (%)		n (%)		n (%)
4. Continue learning/gain knowledge	509 (58.4%)	*24. Already put in significant amount of time*	93 (88.6%)	*24. Already put in significant amount of time*	25 (83.3%)	**26. So close to graduating**	13 (100%)
1. Continue doing research	478 (54.9%)	*25. Worked so hard for this*	76 (72.4%)	*25. Worked so hard for this*	21 (70.0%)	*24. Already put in significant amount of time*	12 (92.3%)
24. Already put in significant amount of time	477 (54.8%)	**26. So close to graduating**	73 (69.5%)	**26. So close to graduating**	19 (63.3%)	*25. Worked so hard for this*	10 (76.9%)
8. Gain/develop skills	432 (49.6%)	*4. Continue learning/gain knowledge*	49 (46.7%)	**1. Continue doing research*	12 (40.0%)	**9. Earn a higher salary**	6 (46.2%)
25. Worked so hard for this	377 (43.3%)	**1. Continue doing research*	44 (41.9%)	***13. Degree necessary for career/job I want**	12 (40.0%)	**13. Degree necessary for career/job I want**	4 (30.8%)
		**8. Gain/develop skills*	44 (41.9%)				

Notes: *Italicized* text indicates a choice that is on both the total participant pool's and the individual subgroup's list of most frequent reasons to enroll but in different orders. An asterisk (*) indicates a choice that is tied with others in selected frequency. **Bolding** indicates an alternate choice not included in the total participants' five most frequent reasons.

Table 8b. The most frequently selected reasons to persist for MS participants sorted by number of years in graduate school.

Total MS participants (n=213)		1st year in grad school (n=131)		2nd year in grad school (n=75)		3rd+ year in grad school (n=7)	
Reasons to Persist	n (%)		n (%)		n (%)		n (%)
4. Continue learning/gain knowledge	129 (60.6%)	4. Continue learning/gain knowledge	83 (63.4%)	*1. Continue doing research*	45 (60.0%)	4. Continue learning/gain knowledge	4 (57.1%)
8. Gain/develop skills	115 (54.0%)	8. Gain/develop skills	71 (54.2%)	*8. Gain/develop skills	42 (56.0%)	***24. Already put in significant amount of time**	3 (42.9%)
9. Earn a higher salary	106 (49.8%)	9. Earn a higher salary	65 (49.6%)	**4. Continue learning/gain knowledge*	42 (56.0%)	***2. Contribute to society**	3 (42.9%)
1. Continue doing research	95 (44.6%)	**3. I like engineering/think it's fun*	53 (40.5%)	**24. Already put in significant amount of time**	41 (54.7%)	**3. I like engineering/think it's fun*	3 (42.9%)
3. I like engineering/think it's fun	87 (40.8%)	***10. I want an advanced degree**	53 (40.5%)	*9. Earn a higher salary*	39 (52.0%)	****26. So close to graduating**	2 (28.6%)
						****7. Be a role model for others with similar identities**	2 (28.6%)
						***8. Gain/develop skills*	2 (28.6%)
						***9. Earn a higher salary*	2 (28.6%)
						****10. I want an advanced degree**	2 (28.6%)
						****13. Degree necessary for career/job I want**	2 (28.6%)
						****14. Family/faculty encourage me to persist**	2 (28.6%)
						****15. Have the opportunity & feel I can't pass it up**	2 (28.6%)

Notes: *Italicized* text indicates a choice that is on both the total participant pool's and the individual subgroup's list of most frequent reasons to enroll but in different orders. An asterisk (*) indicates a choice that is tied with others in selected frequency. **Bolding** indicates an alternate choice not included in the total participants' five most frequent reasons.

Table 9a. The most frequently selected reasons to persist for PhD participants sorted by citizenship.

Total PhD participants (n=871)		Domestic (n=610)		International (n=254)	
Reasons to Persist	n (%)		n (%)		n (%)
4. Continue learning/gain knowledge	509 (58.4%)	4. Continue learning/gain knowledge	361 (59.2%)	4. Continue learning/gain knowledge	145 (57.1%)
1. Continue doing research	478 (54.9%)	*24. Already put in significant amount of time*	337 (55.2%)	1. Continue doing research	143 (56.3%)
24. Already put in significant amount of time	477 (54.8%)	*1. Continue doing research*	331 (54.3%)	24. Already put in significant amount of time	137 (53.9%)
8. Gain/develop skills	432 (49.6%)	8. Gain/develop skills	313 (51.3%)	8. Gain/develop skills	117 (46.1%)
25. Worked so hard for this	377 (43.3%)	**13. Degree necessary for career/job I want**	266 (43.6%)	25. Worked so hard for this	113 (44.5%)

Notes: *Italicized* text indicates a choice that is on both the total participant pool's and the individual subgroup's list of most frequent reasons to enroll but in different orders. An asterisk (*) indicates a choice that is tied with others in selected frequency. **Bolding** indicates an alternate choice not included in the total participants' five most frequent reasons.

Table 9b. The most frequently selected reasons to persist for MS participants sorted by citizenship.

Total MS participants (n=213)		Domestic (n=106)		International (n=101)	
Reasons to Persist	n (%)		n (%)		n (%)
4. Continue learning/gain knowledge	129 (60.6%)	4. Continue learning/gain knowledge	62 (58.5%)	4. Continue learning/gain knowledge	61 (60.4%)
8. Gain/develop skills	115 (54.0%)	*9. Earn a higher salary*	52 (49.1%)	8. Gain/develop skills	59 (58.4%)
9. Earn a higher salary	106 (49.8%)	*8. Gain/develop skills*	51 (48.1%)	9. Earn a higher salary	52 (51.5%)
1. Continue doing research	95 (44.6%)	*3. I like engineering/think it's fun*	49 (46.2%)	1. Continue doing research	46 (45.5%)
3. I like engineering/think it's fun	87 (40.8%)	**10. I want an advanced degree**	46 (43.4%)	**10. I want an advanced degree**	37 (36.6%)

Notes: *Italicized* text indicates a choice that is on both the total participant pool's and the individual subgroup's list of most frequent reasons to enroll but in different orders. An asterisk (*) indicates a choice that is tied with others in selected frequency. **Bolding** indicates an alternate choice not included in the total participants' five most frequent reasons.

Table 10a. The most frequently selected reasons to persist for PhD participants sorted by gender.

Total PhD participants (n=871)		Women (n=435)		Men (n=411)		Non-binary/third gender (n=21)		Another gender (n=3)	
Reasons to Persist	n (%)		n (%)		n (%)		n (%)		n (%)
4. Continue learning/gain knowledge	509 (58.4%)	4. Continue learning/gain knowledge	253 (58.2%)	4. Continue learning/gain knowledge	241 (58.6%)	*1. Continue doing research*	15 (71.4%)	4. Continue learning/gain knowledge	3 (100%)
1. Continue doing research	478 (54.9%)	*24. Already put in significant amount of time*	243 (55.9%)	1. Continue doing research	230 (56.0%)	**12. Become a professor/teach at college level**	12 (57.1%)	***3. I like engineering/think it's fun**	2 (66.7%)
24. Already put in significant amount of time	477 (54.8%)	*1. Continue doing research*	235 (54.0%)	24. Already put in significant amount of time	223 (54.3%)	**4. Continue learning/gain knowledge*	11 (52.4%)	***7. Be a role model for others with similar identities**	2 (66.7%)
8. Gain/develop skills	432 (49.6%)	8. Gain/develop skills	216 (49.7%)	8. Gain/develop skills	207 (50.4%)	***13. Degree necessary for career/job I want**	11 (52.4%)	***12. Become a professor/teach at college level**	2 (66.7%)
25. Worked so hard for this	377 (43.3%)	25. Worked so hard for this	198 (45.5%)	**3. I like engineering/think it's fun**	177 (43.1%)	****2. Contribute to society**	10 (47.6%)	***15. Have the opportunity & feel I can't pass it up**	2 (66.7%)
						****5. Challenge myself**	10 (47.6%)		

Notes: *Italicized* text indicates a choice that is on both the total participant pool's and the individual subgroup's list of most frequent reasons to enroll but in different orders. An asterisk (*) indicates a choice that is tied with others in selected frequency. **Bolding** indicates an alternate choice not included in the total participants' five most frequent reasons.

Table 10b. The most frequently selected reasons to persist for MS participants sorted by gender.

Total MS participants (n=213)		Women (n=78)		Men (n=128)		Non-binary/third gender (n=2)		Another gender (n=1)	
Reasons to Persist	n (%)		n (%)		n (%)		n (%)		n (%)
4. Continue learning/gain knowledge	129 (60.6%)	*8. Gain/develop skills*	47 (60.3%)	4. Continue learning/gain knowledge	77 (60.2%)	*4. Continue learning/gain knowledge	2 (100%)	*4. Continue learning/gain knowledge	1 (100%)
8. Gain/develop skills	115 (54.0%)	*4. Continue learning/gain knowledge*	46 (59.0%)	8. Gain/develop skills	63 (49.2%)	***24. Already put in significant amount of time**	2 (100%)	**3. I like engineering/think it's fun*	1 (100%)
9. Earn a higher salary	106 (49.8%)	9. Earn a higher salary	41 (52.6%)	9. Earn a higher salary	61 (47.7%)	**1. Continue doing research*	2 (100%)	***2. Contribute to society**	1 (100%)
1. Continue doing research	95 (44.6%)	*1. Continue doing research	36 (46.2%)	*3. I like engineering/think it's fun*	56 (43.8%)	**3. I like engineering/think it's fun*	2 (100%)	***7. Be a role model for others with similar identities**	1 (100%)
3. I like engineering/think it's fun	87 (40.8%)	***10. I want an advanced degree**	36 (46.2%)	*1. Continue doing research*	54 (42.2%)	***10. I want an advanced degree**	2 (100%)	**8. Gain/develop skills*	1 (100%)
								**9. Earn a higher salary*	1 (100%)
								***13. Degree necessary for career/job I want**	1 (100%)

Notes: *Italicized* text indicates a choice that is on both the total participant pool's and the individual subgroup's list of most frequent reasons to enroll but in different orders. An asterisk (*) indicates a choice that is tied with others in selected frequency. **Bolding** indicates an alternate choice not included in the total participants' five most frequent reasons.

Table 11a. The most frequently selected reasons to persist for PhD participants sorted by race/ethnicity.

Total PhD participants (n=871)		Latinx (n=37)		Black (n=30)		Asian (n=262)		White (n=430)		Multiple selected (n=81)	
Reasons to Persist	n (%)		n (%)		n (%)		n (%)		n (%)		n (%)
4. Continue learning/gain knowledge	509 (58.4%)	4. Continue learning/gain knowledge	23 (62.2%)	*24. Already put in significant amount of time*	21 (70.0%)	4. Continue learning/gain knowledge	159 (60.7%)	4. Continue learning/gain knowledge	250 (58.1%)	*1. Continue doing research*	51 (63.0%)
1. Continue doing research	478 (54.9%)	*8. Gain/develop skills*	21 (56.8%)	***25. Worked so hard for this**	16 (53.3%)	1. Continue doing research	152 (58.0%)	1. Continue doing research	238 (55.3%)	*4. Continue learning/gain knowledge*	49 (60.5%)
24. Already put in significant amount of time	477 (54.8%)	**2. Contribute to society**	19 (51.4%)	***9. Earn a higher salary**	16 (53.3%)	24. Already put in significant amount of time	140 (53.4%)	24. Already put in significant amount of time	237 (55.1%)	*8. Gain/develop skills*	43 (53.1%)
8. Gain/develop skills	432 (49.6%)	*24. Already put in significant amount of time*	18 (48.6%)	***13. Degree necessary for career/job I want**	16 (53.3%)	8. Gain/develop skills	136 (51.9%)	8. Gain/develop skills	212 (49.3%)	*24. Already put in significant amount of time*	42 (51.9%)
25. Worked so hard for this	377 (43.3%)	***3. I like engineering/think it's fun**	16 (43.2%)	**10. I want an advanced degree**	14 (46.7%)	25. Worked so hard for this	115 (43.9%)	**13. Degree necessary for career/job I want**	185 (43.0%)	***3. I like engineering/think it's fun**	41 (50.6%)
		***9. Earn a higher salary**	16 (43.2%)							***10. I want an advanced degree**	41 (50.6%)

Notes: *Italicized* text indicates a choice that is on both the total participant pool's and the individual subgroup's list of most frequent reasons to enroll but in different orders. An asterisk (*) indicates a choice that is tied with others in selected frequency. **Bolding** indicates an alternate choice not included in the total participants' five most frequent reasons.

Table 11b. The most frequently selected reasons to persist for MS participants sorted by race/ethnicity.

Total MS participants (n=213)		Latinx (n=7)		Black (n=3)		Asian (n=109)		White (n=72)		Multiple selected (n=12)	
Reasons to Persist	n (%)		n (%)		n (%)		n (%)		n (%)		n (%)
4. Continue learning/gain knowledge	129 (60.6%)	**10. I want an advanced degree**	5 (71.4%)	***24. Already put in significant amount of time**	2 (66.7%)	4. Continue learning/gain knowledge	70 (64.2%)	4. Continue learning/gain knowledge	41 (56.9%)	*8. Gain/develop skills	10 (83.3%)
8. Gain/develop skills	115 (54.0%)	***24. Already put in significant amount of time**	4 (57.1%)	***2. Contribute to society**	2 (66.7%)	8. Gain/develop skills	61 (56.0%)	*3. I like engineering/think it's fun*	33 (45.8%)	*9. Earn a higher salary	10 (83.3%)
9. Earn a higher salary	106 (49.8%)	***25. Worked so hard for this**	4 (57.1%)	*8. Gain/develop skills*	2 (66.7%)	9. Earn a higher salary	58 (53.2%)	***24. Already put in significant amount of time**	32 (44.4%)	*4. Continue learning/gain knowledge*	9 (75.0%)
1. Continue doing research	95 (44.6%)	**2. Contribute to society**	3 (42.9%)	***25. Worked so hard for this**	1 (33.3%)	1. Continue doing research	52 (47.7%)	*8. Gain/develop skills*	32 (44.4%)	1. Continue doing research	8 (66.7%)
3. I like engineering/think it's fun	87 (40.8%)	*8. Gain/develop skills*	3 (42.9%)	***26. So close to graduating**	1 (33.3%)	3. I like engineering/think it's fun	41 (37.6%)	*9. Earn a higher salary*	32 (44.4%)	**10. I want an advanced degree**	7 (58.3%)
		***14. Family/faculty encourage me to persist**	3 (42.9%)	*1. Continue doing research	1 (33.3%)						
				*3. I like engineering/think it's fun	1 (33.3%)						
				*4. Continue learning/gain knowledge	1 (33.3%)						
				***5. Challenge myself**	1 (33.3%)						
				***7. Be a role model for others with similar identities**	1 (33.3%)						
				*9. Earn a higher salary	1 (33.3%)						
				***10. I want an advanced degree**	1 (33.3%)						
				***12. Become a professor/teach at college level**	1 (33.3%)						
				***13. Degree necessary for career/job I want**	1 (33.3%)						
				***14. Family/faculty encourage me to persist**	1 (33.3%)						
				***20. Don't know what else to do**	1 (33.3%)						

Notes: *Italicized* text indicates a choice that is on both the total participant pool's and the individual subgroup's list of most frequent reasons to enroll but in different orders. An asterisk (*) indicates a choice that is tied with others in selected frequency. **Bolding** indicates an alternate choice not included in the total participants' five most frequent reasons.