

AC 2007-1187: THE ROLE OF ‘DOGGEDNESS’ IN THE COMPLETION OF AN UNDERGRADUATE DEGREE IN ENGINEERING

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I. Introduction

Research in engineering education over the past 15 years has shown that the interest in pursuing undergraduate degrees in engineering has declined amongst graduating high school students. It also revealed that only half of the students entering U.S. universities as engineering majors actually complete all degree requirements. A large portion of the engineering education research focuses on factors used to predict the likelihood that a student will successfully complete an undergraduate degree in engineering. These factors include: a student's prior academic attainments, level of commitment, personal motivation, and level of enjoyment and satisfaction¹. However, there is a lack of research and discussion pertaining to the significance of personal motivation that can be described as 'doggedness' relative to successful completion of graduation requirements.

The term 'doggedness', although not a new term, has not been widely used in the vernacular of engineering education. Doggedness entails perseverance, tenacity, and the ability to stubbornly adhere to a course of action. It holds the potential promise of pointing to a valuable personality attribute or characteristic that supports greater levels of persistence in engineering students. For the purpose of this paper, the concept of '*doggedness*' is operationalized to include factors and characteristics that show a high level of commitment to completing a degree in engineering, an intention towards perseverance for its own sake, and varying degrees of enjoyment and satisfaction. Traditionally, students who enjoyed and were satisfied with the rigors of their engineering programs, and who completed their degrees, have typically been called persisters. However, this paper uses structured interview data to examine a targeted group of students that have experienced varying levels of enjoyment and satisfaction, but who remain highly committed to completing their engineering degrees. This population of students will be called dogged. The level of doggedness among engineering students may have some impact on students' ability to complete undergraduate engineering degrees, and may play a role in influencing students' decisions to work in the engineering industry or continue in graduate engineering degree programs in the future. Since the most dogged students persevere without a high level of satisfaction they are perhaps the most likely to make non-engineering post-baccalaureate career choices even if they are able to complete the undergraduate degree.

II. Background Literature

There is a paucity of literature that focuses specifically on doggedness. In as much as doggedness can be viewed in the context of personal motivation, it is largely an extension of persistence. The literature mentioned below provides the framework that is used to contextually describe the concept of doggedness.

Persistence

Research on persistence has focused on institutional factors and programs that promote

continuous student enrollment. However, it is the effort students put forth, particularly in the amount of study time, that is a key factor towards persistence². Swail reports that the combination of factors associated with persistence include academic preparedness, the campus climate towards diversity, social and academic integration, the availability of financial aid, and students' commitment to their educational goals and the institutions³. French, Immekus, and Oakes outline the salient features that distinguish engineering persisters and non-persisters. They predicted that persisters would have strong math and science preparation gained at the high school level, an interest in science, and a positive perception of engineering. Non persisters would have a lower impression of engineering, lower enjoyment of math and science courses, and lower rates of confidence in basic engineering knowledge and skills¹. Tinto's model of academic success and persistence was incorporated in this study to examine the relationship between the noted features and academic persistence. A major theme in his model was student commitment to completing the degree, conceptualized in terms of motivation, or the engagement in a task for its own sake. Characteristics of motivation include persistence, goal setting, and resilience. The persistence factors highlighted in this study include students' motivation and commitment to their educational goals⁴.

Motivation

Students are motivated to enter and complete engineering programs by a myriad of sources. Parents, teachers, mentors, and even other students provide the kind of guidance and support needed to complete an engineering degree program⁵. Some students require a great deal of support from teachers and mentors, while others persist on limited support or under their own volition. In this study, students that are motivated out of "a true sense of choice, a sense of feeling free in doing what [s/he] has chosen to do" are considered dogged⁶.

An important aspect of motivation is found in the placement of interest either internally or externally to the point of reference. Eccles and Wigfield suggest that people that are intrinsically motivated to do a task or activity are so designated because of their preference to take on hard or challenging tasks; because they are driven by curiosity or interest; or they strive for competence and mastery⁷. The inclusion of motivation in this study was for the purpose of looking at the impact of negative experiences on persistence among engineering students. Seymour and Hewitt established that negative experiences in science and math classes tended to have a negative impact on students "that damaged their interest in science and undermined their motivation to continue"⁸. Of interest to this study was the influence of students' "likes" and "dislikes" of various aspects of their engineering programs on the change in the level of commitment, persistence and, hence, doggedness.

III. Methodology

This study takes a longitudinal, multi-method approach to investigate the engineering experiences of undergraduate engineering students at four U.S. universities. Participating institutions varied in their designations as public or private; research or technical orientations; the size of their undergraduate student populations; and the ratio of female to male students. Data for the larger study, of which this project represents a subset, was initiated in 2004. A total of 60 engineering students participated in structured interviews in the first three years of the

study. Data from a subset of this sample were used to assess levels of commitment, persistence, satisfaction, and ultimately doggedness, among respondents. A ‘within case’ analysis was used to provide a snapshot of characteristics that demonstrate doggedness in the sample. A student that displays doggedness does so over a period of time and the data collected over several years will provide sufficient data to measure this concept. Data derived from structured interviews will be analyzed qualitatively. The validity of the study’s findings will rest in the analysis of multiple structured interview questions, both open-ended and closed-ended, over the course of three years that assess levels of commitment, persistence, and enjoyment.

IV. Findings

As we examined our structured interview data, evidence for doggedness was revealed by student responses in two primary areas: level of commitment and persistence. This data was supplemented by responses to interview questions used to measure level of enjoyment and satisfaction. Enjoyment and satisfaction were used as secondary measures for doggedness to assess whether or not they are important factors, and to determine the range of responses for persisters. Specifically we asked, “Are there any aspects of engineering that you particularly like?” and “Are there any aspects of engineering that you particularly dislike?”

Commitment

Overall, student commitment to studying engineering grew stronger over time. Examination for level of commitment was guided by the review of the question, “How committed are you to pursuing an engineering degree? And why”? A total of 60 engineering students longitudinally participated in Year 1, Year 2 and Year 3 of the study. In Year 1, 27 first year students (45%) stated that they were very committed to completing the major in engineering. The number of second year students that were very committed increased to 49 students (81.6%), representing a 37% increase from the previous year. Third year students showed only a 5% increase, to 52, that indicated that they were very committed (Table 1). Correspondingly, the number of students that indicated that they were “somewhat committed” decreased with time.

Table 1: How committed are you to pursuing an engineering major?

	YEAR 1 2004		YEAR 2 2005		YEAR 3 2006	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Very Committed	27	45.0	49	81.6	52	86.7
Somewhat Committed	27	45.0	8	13.3	6	10.0
Not Very Committed	2	3.3	0	0.0	2	3.3
Not Committed	1	1.7	1	1.7	0	0.0
Invalid Response	2	3.3	1	1.7	0	0.0
No Response	0	0.0	1	1.7	0	0.0
Don't Know	1	1.7	0	0.0	0	0.0
	n = 60	100%	n = 60	100%	n = 60	100%

When asked “why” they selected a particular level of commitment, student responses varied. Students repeatedly mentioned and elaborated on their strong sense of persistence. However, it was the intensity of their persistence that stood out in their comments. Examples of student responses that highlight what is meant by persistence include: *‘I’ve gone too far to turn back now’*, *‘I’ve put in a lot of work and there’s no reason to back out whatsoever right now’*, and *‘I’m in too deep to leave and, even though it’s very hard right now, I think it will pay off in the end’*. Students that were both “very committed” and “persistent” were considered to be strong candidates that exhibited the characteristics of what researchers described as doggedness and included in a subset for further study. Students identified in this group represent a range of engineering disciplines. Below are excerpts from interviews with second and third year engineering students that illustrate this intense level of student persistence.

Unyielding Persister. Many students that persist in engineering programs believe that pursuing an engineering degree is what they are supposed to do. At the same time, they do so while maintaining good academic standing. Other students will proceed with their programs with diligence even when things do not go as planned. One example of a student that persisted despite not being at the top of his class was found in Brian*, a male petroleum engineering major. During his second year, he indicated that he was very committed to getting a degree in engineering. He pointed to the number of times that he had to retake some of his courses, and his insistence that *“I will stay here as many years as I have to, to get my petroleum degree”*, as testimony to his persistence. In the end, he declared, *“if I wasn’t committed then I wouldn’t be here”*.

Intense Goal Setter. Then there are students who are doing well in their classes, but continue for the sake of completing what they have already started. Two examples were found in Melissa and Thomas. Melissa, a third year female chemical engineering major said, *“I set this goal for myself and not much is going to get in my way”*. She established that it was just her “nature” to finish. She said, *“I can’t quit anything ...I’m just driven, I guess”*. Thomas, a second year male aeronautical engineering major said that *“when I say that I’m gonna do something I always do it. I can’t stand when I fail at something that I say I’m going to complete”*. In a subsequent year, he explained that he was the kind of guy that *“usually goes all out”* and that he is *“not going to drop out just because it’s hard”*.

Economic Rationalizer. There are also pragmatic reasons for student persistence. With the costs affiliated with obtaining a technical degree rising annually, many students fear the financial ramifications of switching majors to their parents, benefactors, or themselves. A time element is also in play. Philip, a male management science and engineering major, said that there was *“a practical reason for being very committed to completing the major in engineering”*. If he were to change majors, he predicted that he *“would be in school for another four years”*. In addition, he said that he really enjoyed his classes related to engineering, and predicts that he will enjoy the companies that he plans to work for in the future.

Another student who rationalized his commitment on practical terms was Steven, a male mechanical engineering major. Steven allowed time to explore courses in political science, philosophy, and history in the midst of a very demanding engineering program. Engaging in other subjects allowed him to determine that he *“would never want to do those majors”* and

stated that “*at this point in my school career, I’m not changing majors [because] my parents are not going to pay for a fifth year in college and I wouldn’t finish anything at that point anyhow*”. He concluded by adding, “*when I looked at all the different majors I could possibly pursue at school, engineering was the only one that really appealed to me*”.

Engineering Program Satisfaction

Students displaying intense levels of persistence prompted further examination of their level of satisfaction with their academic programs. During the structured interview, students were asked, “Are there any aspects of engineering that you particularly like?” and “Are there any aspects of engineering that you particularly dislike?” The question probed for specific features of engineering programs, whether positive or negative, that students experienced in the course of their programs. In describing what students liked, the greatest frequency of responses was their engagement in the problem solving and design aspects of their coursework. On the other hand, students indicated that the aspect of their programs that they disliked most consisted of the great amount of work involved, associated stress, and the considerable amount of time required to carry out assignments. For the most part, students did not provide any definitive area of their academic programs that would cause them to switch from their programs. In fact, several students that indicated that they disliked the level of difficulty of their courses recanted their statements by adding that they “liked engineering”. In a sense, the level of stated difficulty can be equated with the value students place on obtaining their degrees.

Again, doggedness is defined as being very committed to pursuing a major in engineering, displaying a strong sense of determination, and showing varying levels of enjoyment and satisfaction with the academic program. When reviewing the levels of program enjoyment, the subset of very committed and persistent students was fairly unchanged from the group of respondents that will be called dogged. In Year 1, 5 students (8.3%) were identified as dogged, 14 (23.3%) dogged students were identified in Year 2, and 22 (36.7%) in Year 3 (Figure 1). While the number of dogged students was small, their total numbers grew in each sequential year of the study. This follows the pattern of growing persistence that increases with time. The longer students are in school, the more they show characteristics of doggedness. However, the number of students that started out as dogged in their first year and who remained dogged through their third year of study decreased.

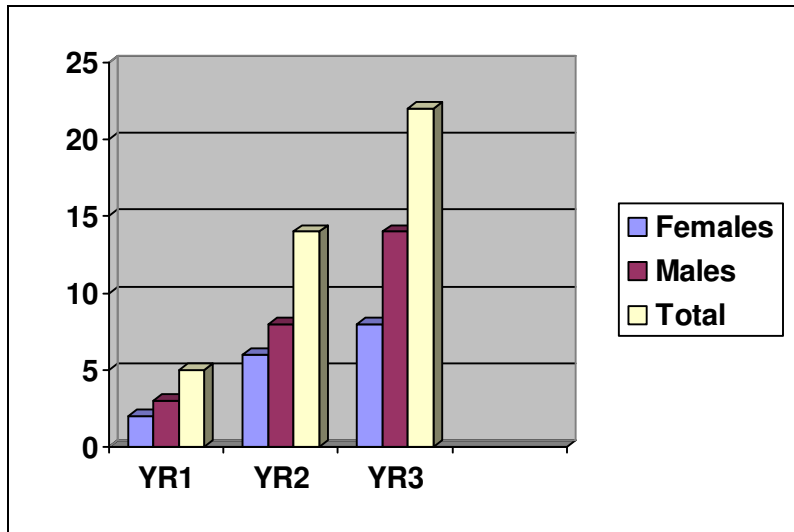


Figure 1. Number of Students Exhibiting Doggedness in YR1, YR2, and YR3

Initially, it was posited that a dogged student would be one that was very committed to completing the major in engineering. However, the function that enjoyment, interest, and satisfaction play in determining the level of doggedness among engineering students is mixed. The survey found that enjoyment and satisfaction rated high amongst both students who were determined to be dogged and otherwise in the structured interview. A female engineering student, for example, indicated that there were aspects of her program that she liked as well as disliked. She particularly liked problem solving and doing logic problems. On the other hand, the aspects of engineering that she disliked was the likelihood that, as a chemical engineer, she would likely work in an environment that was “not exactly ideal”, such as a plant or oil refinery. After graduation, the student plans to pursue a graduate degree in Bioengineering or Biochemical Engineering. She also noted that many of her courses were “really tough”, but that she planned to continue working hard and studying a lot to get through her program. She realized early on that she might not achieve “the best grade point average” or “understand all of the material”, but that she would finish her degree.

There was only a limited variation found in the number of female and male students that exhibited doggedness. Of the 5 dogged students identified in Year 1, 2 were female and 3 were male. In Year 2, 6 of the 14 dogged students were female and 8 were male. And in Year 3, the total number of dogged students were 22, 8 females and 14 males.

Future Plans of Dogged Engineering Students

Most students choose to either work or pursue advanced degrees after completing their undergraduate degrees. Where high achieving engineering majors decide to use their skills is of vital importance to the engineering community. Dogged students that enjoyed their educational experience and that planned to go to graduate school totaled 35.7 percent. Conversely, students that placed greater emphasis on areas of dissatisfaction and are more likely to join the workforce totaled 60.7 percent. The remaining students were either undecided or planned to take time away from engineering altogether.

Table 2: Post-Baccalaureate Plans of Third Year Students

Plans	Short Term Plan	Long Term Plan
	<i>%</i>	<i>%</i>
Work in Engineering	45.2	17.1
Graduate School in Engineering	22.6	8.1
Uncertain	12.9	0.0
Travel/ Take Time Off	11.3	0.0
Engineering Management	6.5	3.2
Work in Non-Engineering	4.8	1.6

The entire population of third year students in the study was compared to the dogged subset. The greatest number of third year students, 45.2 percent, said they planned to work in the engineering industry immediately after graduation. The second largest response came from students that planned to pursue a graduate degree in engineering, representing 22.6 percent of respondents. Some respondents mentioned both immediate and long term plans. An additional 17.1 percent of third year students said that they planned to work in engineering following some time off (Table 2). Reasons cited for needing time away from the discipline range from the stress of obtaining the degree to a need to satisfy interests in other subject areas.

V. Conclusion

Several findings of interest to the engineering community are provided. First, a small but identifiable group of dogged engineering students was found in the structured interview segment of the study. High levels of commitment, persistence, and satisfaction are conveyed across the spectrum of engineering majors. In this study, students identified as dogged were pursuing undergraduate degrees in chemical engineering, mechanical engineering, computer science, management science and engineering, aeronautical engineering, electrical engineering, and product design.

Second, doggedness is a characteristic that develops and increases with time. The need to complete a task that has been started becomes more urgent the longer a student sticks with the program. The goal of engineering programs is to produce high quality engineers that are capable of being productive in the field. A greater level of productivity is achieved through the acquisition of graduate engineering degrees. There remains a problem when students that graduate from engineering programs decide to leave the field altogether, or when they decide to work in the engineering industry because they are exhausted from the rigors of their programs.

Third, with regard to satisfaction, students that were identified as dogged exhibited varying levels of enjoyment and satisfaction. Students that primarily enjoyed experiences associated with pursuing their engineering degrees were more intent on working in the engineering industry. Moreover, doggedness is not limited to application in engineering and related technical fields only. It is a characteristic that may prove useful across other fields, especially as it relates to promoting academic and professional persistence. A dogged student may or may not enjoy his/her studies, but innately feels it is their responsibility to proceed with the academic program

they started.

Continued effort needs to be made to promote graduate education among engineering degree recipients. To increase the number of engineering students entering graduate school undergraduate program coordinators need to address some of the aspects of the program that students dislike.

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