
AC 2012-3937: COMPARING FIRST-YEAR ENGINEERING TECHNOLOGY PERSISTERS AND NON-PERSISTERS

Mr. Martin John Wagner, Indiana University-Purdue University, Indianapolis

Martin J. Wagner is a graduate student in the Purdue School of Engineering and Technology at IUPUI. He is working on his master's of science in technology. He is an IT Project Leader for Indiana University. He is also Adjunct Faculty for the IUPUI Kelley School of Business.

Prof. Barbara Christe, Indiana University-Purdue University, Indianapolis

Barbara Christe is an Associate Professor and Program Director for biomedical engineering technology at Indiana University-Purdue University, Indianapolis. Prior to teaching, Christe was a Clinical Engineer at the University of Connecticut Health Center in Farmington, Conn. She holds a biomedical engineering master's degree from Rensselaer at Hartford and a bachelor's degree in biomedical engineering from Marquette University. She is actively engaged in the recruitment and retention of students in the BMET field.

Eugenia Fernandez, Indiana University-Purdue University, Indianapolis

Eugenia Fernandez is an Associate Professor of computer and information technology and Chair of the Department of Computer, Information & Leadership Technology in the Purdue School of Engineering and Technology, Indiana University-Purdue University, Indianapolis. She is a Fellow of the Mack Center at Indiana University for Inquiry on Teaching and Learning and an Editor of the Journal of Scholarship of Teaching and Learning. Her research focuses on the scholarship of teaching and learning related to learning with technology.

Comparing First-Year Engineering Technology Persisters and Non-Persisters

Introduction

Science, technology, engineering, and math (STEM) education is a growing national priority. “Scientific and technological innovation continues to play an essential role in catalyzing the creation of new industries, spawning job growth, and improving the quality of life in the United States and throughout the world.”¹ “Reaffirming and strengthening America’s role as the world’s engine of scientific discovery and technological innovation is essential to meeting the challenges of this century,”² said President Obama. The Association of American Universities created a “five-year initiative to improve the quality of undergraduate teaching and learning in science, technology, engineering and mathematics (STEM) fields at its member institutions.”³

The School of Engineering and Technology at Indiana University-Purdue University Indianapolis is committed to the advancement of STEM education. Over one-third of graduates in the School of Engineering and Technology come from the Engineering Technology department. Improvement in engineering technology student retention plays a vital role in campus STEM graduate production. Between 2008 and 2010, less than 52% of students who started the program remained after their first year. (B. Christe, personal communication, October 5, 2011).⁴ There is not much known about the specific factors that contribute to this loss of engineering technology majors after their first year in the program. Little research has been reported focused on improving engineering technology student retention.

The purpose of the study is to examine the differences that exist between first year engineering technology majors who continue in the major and those who leave or are dismissed prior to the beginning of the second year. Analyzing data such as previous math courses taken, specific major, and method of admission may help develop a description of persisters and non-persisters. Persistence is defined as students who were enrolled or graduated in an Engineering Technology major as of fall 2011. Understanding the differences between the students who stay in the engineering technology major versus the ones who leave will guide faculty in creating possible interventions in the effort to increase retention.

Literature Review

Research examining persisters and non-persisters has largely focused generally on engineering majors and less specifically on technology majors. Two major themes emerge from the literature focusing on intellectual or academic predictors and non-intellectual factors.

Research by Eris et al.⁵ suggests that the engineering students’ decision to change from an engineering focus to something else “was rooted in the students’ concern about the future,” as well as “structural or cultural” sources within the institution, and not solely the academic rigors of the science and engineering majors” (p. 372). Eris observed twenty-one constructs of intellectual and non-intellectual factors. “Persisters and non-persisters do not differ significantly according to the majority of the constructs; analyses of 16 of the 21 constructs did not reveal significant differences.” (p. 390) The differences help identify possible non-persisters and create

an opportunity for intervention. Finding these differences in engineering technology learners, although subtle, will assist the school in planning similar interventions. The intermediation “can ensure that students engage in substantive conversations and relevant experiences to inform their decisions to stay or move away from engineering. These conversations and experiences might come from, for example, advising, courses, or extra-curricular involvement.” (p. 391)

Research by James-Byrnes⁶ suggested non-intellective factors influence the student’s academic success. Their purpose was to “identify variables that can predict the academic success of freshman engineering technology students at Ferris State University in Big Rapids, Michigan.” (p. v) “The study showed that there was no set of variables that was able to accurately predict academic success or retention.” (p. 94) This research could suggest the exploration of non-intellective data collection for future evaluation.

The research from Kokkelenberg and Sinha⁷ also suggested the importance of non-intellective factors. “There are several issues that remain untested, issues that may be important. These include the early life experiences of a student, the effect of peers, and the career outlook.” (p. 944) Kokkelenberg and Sinha concentrated on students that are successful in STEM undergraduate studies. They “postulate that success in a STEM field, success here defined as declaring STEM as a major and graduating from a STEM field, accrues to those who have been interested and studying and working in STEM fields from high school or even possibly earlier.” (p. 944) Lichtenstein, McCormick, Sheppard, and Puma⁸ contend that more current non-intellective factors, such as “working for pay on campus, participating in co-curricular activities, and participation in learning communities” contribute to non-persistence. (p. 309) They suggested “that the engineering curriculum creates demands that force students to make choices between acquiring practical (and highly marketable) skills during college in exchange for missing out on various educationally enriching experiences.” (p. 305) They suggested a contributing factor to departure from engineering is the perception of gaining practical skills in another program that leaves room for other enriching experiences.

Ost⁸ examined peer effects persistence. “This peer effect exhibits important non-linearities such that weak students benefit from exposure to stronger peers while strong students are not dragged down by weaker peers.” (p. 1) Student peers have differences in their influence depending on their relationship. Ost found “evidence of positive peer effects in one’s core physical science classes suggesting that classmates may have a larger influence on academic decisions than roommates.” (p.3)

Some of the literature examined academic factors. Research from Ost⁹ found grades to be an intellective factor for persistence. “Examining the role of preparation, grades and peers, I find a large impact of grades on persistence in both fields.” (p. 18) The study by James-Byrnes⁶ “showed that there was no set of variables that was able to accurately predict academic success or retention; however, there were five variables that were common among the best three grade point average academic predictor models.” (p. 94) These variables may or may not be useful for predicting retention. “The common variables were the student's second semester high school Biology grade, second semester high school Chemistry grade, average high school Art grade and the Athletic Score and Service Organization score from the ACT score sheet.” (p. v)

All of the literature identified the importance of examining academics and non-intellective factors as linking to persistence. Although no non-intellective data was collected for this study, determining an academic description of the non-persisters will allow opportunities for any intervention to be focused around non-academic factors.

Method

Data was collected on 230 full-time first year engineering technology majors in a population of Engineering Technology students at Indiana University-Purdue University Indianapolis. Three groups of students were used: one group enrolled in the fall of 2008 (75 students, 32.6%), the second group enrolled in the fall of 2009 (86 students, 37.4%) and the third group enrolled in the fall of 2010 (69 students, 30%).

Data points consist of the following:

- Year in School [Freshman, Sophomore, Junior, Senior]
- Declared major at time of enrollment [Biomedical engineering tech (BMET), Electrical engineering tech (EET), Computer engineering tech (CPET), Construction engineering management tech (CEMT), Mechanical engineering tech (MET), other (OTHR)]
- Enrolled two semesters later [Yes, No]
- Entry math course
- Enrolled or graduated in Engineering Technology major in Fall 2011 [Yes, No]
- Admission pathway (direct admit vs. University College)
- Student dismissed after first year [Yes, No]

Direct admit and University College admissions are two pathways for students. Direct admits have stronger academic backgrounds and are accepted directly into the engineering technology major. Students who do not meet all of the entrance requirements, generally in math or English preparation are admitted to University College. Thus University College students are considered underprepared.

All students are age 18 and older. All identifying data was removed from the data set. An engineering technology faculty member collected all data from the Student Information System in September 2011. Analysis of the data was conducted using chi-square tests of independence.

Results

To obtain the minimum expected cell count of five or greater for chi-square tests of independence, two changes were made to the data for analysis. Because there were only two students in the other (OTHR) major, those students were removed from the data set. The entry math course was collapsed into three categories, pre-college, entry level, and advanced.

Demographic information on the resulting dataset is shown in Tables 1 -4.

Table 1 displays the students declared major at their time of enrollment. Table 2 is the student's admission path into the School of Engineering and Technology. Students are either directly admitted into the school or if the student is considered underprepared, they are admitted into University College. Table three is the student's year in school. Table four is the highest-level math course taken.

Table 1.
Declared Major at
Time of Enrollment

BMET	34
CEMT	81
CPET	27
EET	36
MET	48

Table 2.
Students by Admission Pathway

University College	117
Direct admission	111

Table 3.
Year in School

Freshman	160
Sophomore	58
Junior	10

Table 4.
Math

Advanced math	25
Entry level math	56
Pre-college or no math	147

Chi-square tests of independence were calculated comparing the relationship between enrolled or graduated in engineering technology major and major at time of enrollment, year in school, entry math course, and the pathway to admission. The results can be found in Table 5. A significant interaction was found with the student's pathway to admission into the School of Engineering and Technology. Students who were directly admitted into the School of Engineering and Technology were more likely to be enrolled or graduated in the Engineering Technology major than University College students.

Table 5.
Chi Square Tests of Independence with enrolled or graduated in Engineering Technology major

Independent variable	X ²	df	p	Phi Effect Size
Major at Time of Enrollment	1.26	4	0.87	N/A
Year in School	0.49	2	0.79	N/A
Entry Math Course	3.85	2	0.15	N/A
Admission Pathway	6.02	1	0.01*	0.27 / small effect

* - Significant

In Table 2, the results are displayed for a similar chi-squared test of independence. This calculation compared the relationship between students who were enrolled two semesters later and their major at time of their enrollment, year in school, entry math course taken, and their admission pathway. There was a significant interaction found with the student's path to admission into the School of Engineering and Technology. Students who were directly admitted into the School of Engineering and Technology were more likely to be enrolled two semesters later (65.8%) than students who were admitted to University College (40%) as shown in Figure 1.

Table 6.
Enrolled two semesters later

Independent variable	X ²	df	p	Phi
Major at Time of Enrollment	4.95	4	0.30	N/A
Year in School	1.88	2	0.39	N/A
Entry Math Course	3.24	2	0.20	N/A
Admission Pathway	15.04	1	0.00*	0.26/medium effect

* - Significant

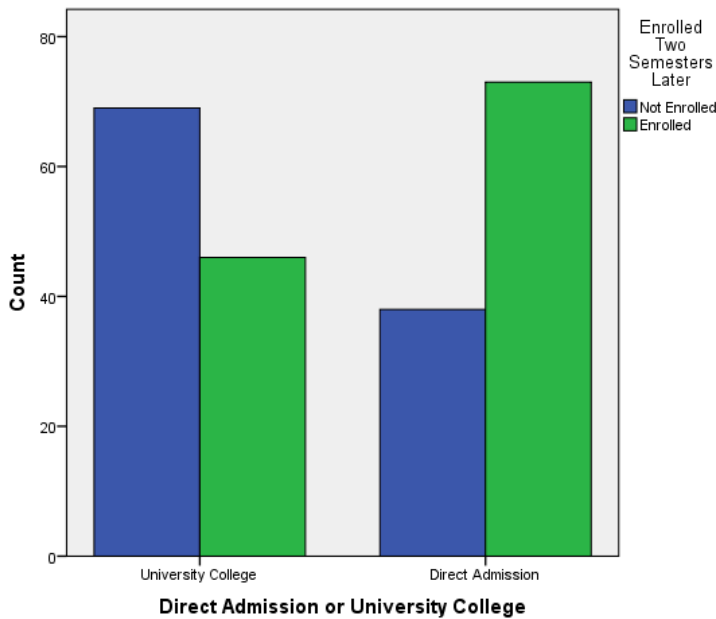


Figure 1. Students enrolled two semesters later by admission pathway.

Chi-square tests of independence were also calculated comparing the relationship between dismissed after first year and major at time of enrollment, student year in school, entry math course, and admission pathway. The results can be found in Table 7. There was a significant relationship found with the student's pathway to admission. Students who were directly admitted into the School of Engineering and Technology were less likely (4.5%) to be dismissed than the students who were in University College (21.74%) as shown in Figure 2.

Table 7.
Dismissed after first year

Independent variable	X ²	df	p	Phi
Major at Time of Enrollment	6.209	4	0.184	N/A
Year in School	0.633	2	0.718	N/A
Entry Math Course	0.538	2	0.764	N/A
Admission Pathway	14.573	1	0.00*	-0.254 / medium effect

* - Significant

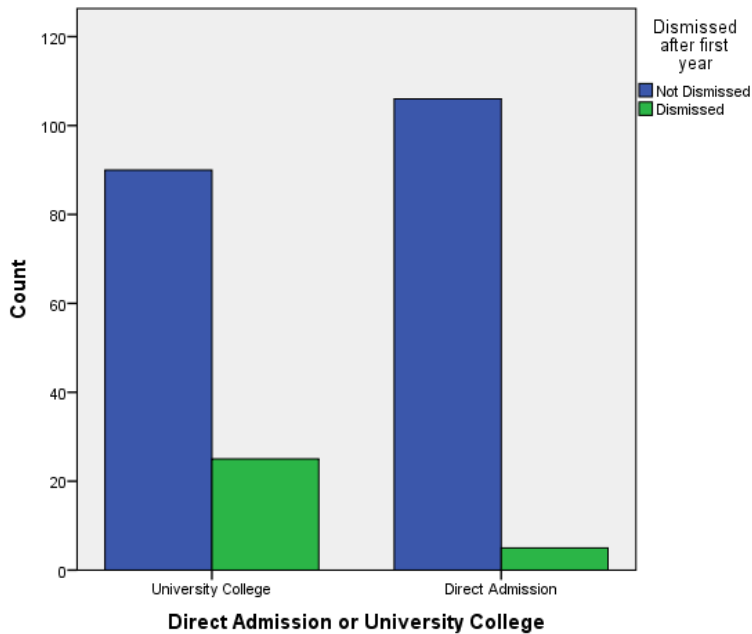


Figure 2. Students dismissed after first year by admission.

Discussion

Statistical analysis of the data revealed only one predictor for persistence of first year engineering technology students. No correlation was revealed for persistence and academic major, entry level math class enrollment, or year in school (freshman, sophomore, or junior). The data analysis showed admission pathway (University College or direct admission to the school) as a significant predictor of one year retention. Students who were admitted to University College were less likely to persist than students directly admitted to the School of Engineering and Technology.

An analysis of the connection between persistence and admission pathway requires an understanding of the conditions that segregate students during the application process. The School of Engineering and Technology has specific admission criteria (generally high school preparation, high school grades, and standardized test scores) that are more rigorous than the admission criteria for students who are not directly admitted into their major. University College students typically lack of preparation or have previous academic performance challenges. Thus, University College admits may be academically underprepared and have more trouble with their first year courses.

The fact that University College students are dismissed at a higher rate than directly admitted students is associated with a University College dismissal policy that is more stringent than the policy for students in the School of Engineering and Technology. University College requires students "obtain at least a 1.0 GPA at the end of their first semester or they will be dismissed."¹⁰ However, School of Engineering and Technology students are not dismissed until "they fail to attain a 2.0 semester grade point average in any two consecutive semesters or when their cumulative semester index has remained below 2.0 (C) for any two consecutive semesters."¹¹

Students who were directly admitted to the School of Engineering and Technology can have two or three poor semesters and still remain at the University.

One item of note is the continued persistence of students beyond the first year. Of the 2008 engineering technology cohort, 38 students persisted beyond the first year. Two years later 84.2% were still enrolled in an engineering technology major. In the 2009 cohort, of those 45 students who were retained one year, 93.3% were still enrolled one year later in the fall semester of 2011.

All of the data collected was limited due to the duration in time and lack of non-intellective factors. Much of the existing literature mentions non-academic factors that could possibly contribute to non-persistence in STEM majors. In a further exploration, having data such as number of hours worked per week during the school year, if the student is paying for his or her own education, and hours spent participating in non-academic groups could give a more illustrative picture of the persisters and non-persisters and provide more information regarding the causes of low retention.

Conclusion

The lack of scholarly literature illuminating the academic experience of engineering technology students promotes the importance of the findings of this study. In the three entry-level cohorts under study, entry level mathematics coursework did not predict retention. Students who enrolled in a high-school level algebra class were just as likely to be retained as students who began their college mathematics coursework in calculus. This may be counter-intuitive to educators who believe that the first year in a college major is a time for the academically weak and underprepared to be “weeded-out.”

Of the engineering technology majors offered at the university under study: electrical, computer, biomedical, construction, and mechanical, students in one discipline were no more likely to be retained than students in a different major. This result was observed regardless of variations in the discipline-specific career information, student organizations, academic advising, or employment prospects.

Students who were placed in University College were far less likely to be retained than directly admitted students. This connection may be due to different academic dismissal policies or admission standards. However, the situation could also be associated with a lack of student association with the engineering technology department, generic advising by University College advisors, or a lack of awareness of career possibilities related to the chosen discipline.

Most significantly, the study results indicate that if a student can complete the first year of an engineering technology major, there is a very high probability that the student will remain enrolled or earn a degree in engineering technology in the following years. As a result, educators should understand that a substantial improvement in retention in the first year directly impacts the graduation rates for the discipline. The results of this study bolster evidence to support the importance of the first year experience for engineering technology students. Both academically strong and weak students drop out of the major equally. Educators hoping to improve the

number of STEM graduates should explore first year interventions designed to support the success of students.

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