A COMPARISON OF ACCESS AND DIRECT ENTRY STUDENT SUCCESS IN ELECTRICAL ENGINEERING TECHNOLOGY

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Abstract - This paper provides an overview of the Introduction to Electrical Engineering Technology program, analyzes its success, and provides observations for administrators considering a similar initiative.

A barrier to access for Science Technology Engineering and Math-based careers is the requirement for high school math and physics courses. To address this shortcoming, an Electrical Engineering Technology (EET) program at a major Manitoba college implemented a one term Introduction to Electrical Engineering Technology (Introduction to EET) program to upgrade student mathematical abilities, reduce the first-year workload, and help them identify a career that interest and motivate them.

Student success is evaluated by comparing the retention and relative performance of the Introduction to EET students who entered the regular EET program with the performance of direct entry students in the same classes. The grades were analyzed using an ANOVA approach to determine if the two groups were statistically different. In the first cohort, statistical differences were observed in three courses with the direct entry students performing lower. In the second cohort, the Introduction to EET students performed poorer in mathematics than their direct entry peers. As students continued through the program, performance differences became harder to detect.

Keywords: Electrical Engineering Technology Program, math and physics requirements, Student retention, EET access program, College students.

1. INTRODUCTION

In the fall of 2015, an Electrical Engineering Technology (EET) department at a major Manitoba college implemented one term (4 months) "Introduction to Electrical Engineering Technology" (Introduction to EET) program to prepare students missing the math and physics entrance requirements for the program for entry into the EET program. Students who successfully complete all the

Introduction to EET courses with a C average are guaranteed a spot in the regular program.

A comparison of the average grades of Intro to EET and direct entry students on a course by course basis was done to assess whether the Intro to EET program was achieving its goal of equivalency and preparedness of students entering the regular program.

Overall, the results are very similar between the two groups, with only a few statistical differences between the two groups.

The current rate of students successfully completing all courses in the Introduction to EET program is 59%. Of these students, 100% of them have gone on to enroll in the regular program.

Since this program was created in the fall of there are no current graduates yet from the main program, however, only 4 of the 38 Introduction to EET who subsequently enrolled in the regular program withdrawn from the EET program (11% attrition rate).

This suggests that the Introduction to EET model is adequately preparing students for entry into the program. To the extent that there is attrition, it is primarily occurring during the Introduction to EET program as opposed to during the regular program.

Table 1: Transition rates for the intro to EET students.

	Intro to EET Cohort		
	Sept 2015	Jan 2016	Sept 2016
Enrolled students	22	20	22
Completed all courses	17	9	12
Transitioned to the regular EET program	17	9	12

2. ACCESS PROGRAM

The Introduction to EET program replaced a previous "Integrated" access program in which students took two years to complete the first year of the regular program. During its lifespan, the Integrated program was plagued with high dropout rates, 17% of the students graduated with one cohort only having one student graduate. Anecdotally, those who did succeed performed well when integrated into the regular program.

2.1 Program Overview

The overarching goal of the Introduction to EET program is to help students decide, is Engineering Technology the right choice for them. Do they have the mathematical skills required, can they manage the workload, and are they interested in the careers that follow. To this end, the courses are structured to meet the following outcomes.

- Upgrade student's math and physics competency to a level equivalent to a grade 12 pre-calculus program.
- Reduce student workload in the first term by completing non-math based courses in the first term.
- Enhance student success through a study skills course.
- Enhance student motivation and awareness of the program by going on industry tours and completing electronic based design projects.

Table 2: Introduction to EET - contact hours.

Course	Contact Hours per Week
Math	6
Physics	6
Introduction To Technology	6
Self-Management	3
Workshop Practices	2
PC Application Software	3

2.2 Introduction to EET Program structure

Students in the Introduction to EET program spend approximately 26 hours a week in class [Table 2], with 45% of their time spent on math and physics instruction. The math course covers basic algebra, functions, and trigonometry. The physics course covers vectors, mechanics, and electromagnetics.

The Introduction to Technology and Self-Management courses are unique to the Introduction to EET program. In the Introduction to Technology course, students spend 50% of their time visiting industry sites and talking to program alumni. From this, they gain an appreciation of the career choices available and a real sense that the intense school work required has real benefit. The other 50% of the time is spent doing team-based projects. The key outcome of which is building community and strengthening the students critical thinking skills. The Self-Management course focuses on study skills, active reading, and time management.

The final two courses Workshop Practices and PC Application Software are part of the regular program

and do not require strong math skills. Thus they allow the students to gain credit for courses in the regular program and subsequently reduce their course load.

2.3 Program Demographics

In this paper, two cohorts of students will be focused upon, those starting in September 2015 and those starting in January 2016. Grade information is not yet available for the September 2016 and January 2017 students.

Table 3: Cohort dates.

	Cohort 1	Cohort 2
Introduction to Technology	Sept. 2015	Jan. 2016
Transition to EET	Jan. 2016	Sept. 2016
Expected completion	Apr. 2018	Dec. 2018

Based on in-class discussions with the students in each of the cohorts it was apparent that the first cohort (Sept 2015) of Introduction to EET students was comprised almost completely of mature students with five or more years of work experience. This group had high expectations of their performance, good team working skills, and above average commitment to the program.

In the second cohort (Jan. 2016) virtually all the students came directly from high school students with minimal work experience. They were interested in becoming engineers and technologists but were missing either the math or physics entrance requirements.

Subsequent cohorts (Sept 2016 and Jan 2017) more have been more balanced with a noticeable number of students having prior work experience. As a department, 40% of the students indicate they have prior post-secondary experience.

3. EVALUATION

For analysis, term one and term two retention (Table 4, Table 5 and Table 6) and relative performance were considered (Table 7, Table 8 and Table 9). Term one courses were evaluated for both cohorts, while term two is limited to the first cohort. To create comparable groups, only first-time direct entry students were considered. Repeating students were not included. Additionally, the grades obtained in PC Applications and Workshop practices during the Introduction to EET program have been transferred to the first term to facilitate comparison. Thus the number of Introduction to EET students in these two

courses is substantially higher than the other first year courses.

The standard practice when calculating course averages is to exclude students who withdrawal from the course as per the institution's withdrawal policy. The number of students who completed the course and the number of students who enrolled is shown for each both the direct entry and Introduction to EET students (completed/enrolled).

While many students withdraw from a course due to poor academic performance, students may withdraw for other non-academic reasons.

3.1 Course Completion Rates

Table 4: Completion rates for term 1 – cohort 1.

Term 1 – Cohort 1 Course	Completion Rate	
	Direct Entry	Intro. to EET
DC Circuits	30/31	16/17
PC Application Software	30/31	20/20
Digital Logic	29/31	16/18
Drafting	30/31	15/16
Mathematics	30/31	16/17
Physics 1	29/31	16/18
Workshop Practices	30/31	19/19

Table 5: Completion rates for term 1 – cohort 2.

Term 1 – Cohort 2 Course	Completion Rate	
	Direct Entry	Intro. to EET
DC Circuits	49/59	9/9
PC Application Software	51/60	12/20
Digital Logic	51/60	9/9
Drafting	52/61	9/9
Mathematics	49/60	11/11
Physics 1	45/60	10/10
Workshop Practices	51/60	12/19

Table 6: Completion rates for term 2 – cohort 1.

Term 2 – Cohort 1 Course	Completion Rate	
	Direct Entry	Intro. to EET
AC Circuits	18/18	12/12
Technical Comm.	20/21	13/13
Computer Systems	19/20	14/14
Semiconductor Devices	18/18	12/12
Calculus	13/18	10/12
Physics 2	19/20	12/12
Intro to Microcontrollers	16/19	13/14

Based on the tables above, both the direct entry and Introduction to EET students have comparable completion rates within the regular program. For example, in Table 4, 6.5% (2/31) of the direct entry

students and 6% (1/17) of the Introduction to EET did not complete all the courses. In Table 5, 25% (15/60) of the direct entry students and 0% (0/9) of the Introduction to EET did not complete all the courses.

3.2 Relative Performance

The tables below compare the average grade points of Direct Entry and Introduction to EET students. For each course, an ANOVA test was done to determine if the differences in grade point averages and standard deviation represented a statistically significant difference between the two groups. In most cases, no significant difference at $p = 0.05$ was found.

In Table 7, the Introduction to EET students performed significantly better in both the Digital Logic $p = 0.05$ and Drafting $p = 0.10$ courses.

In Table 8, the direct entry students performed better in mathematics with a statistically significant difference existing at the $p = 0.10$ level.

In Table 9, the second term performance of the two groups revealed no statistical difference exists at either the $p = 0.10$ or $p = 0.05$ levels.

Table 7: Term 1 performance – cohort 1.

Term 1 – Cohort 1 Course	Grade Point Averages			
	Direct Entry		Intro. to EET	
	μ	σ	μ	σ
DC Circuits	2.7	1.7	3.0	1.1
PC Application Software	3.0	1.6	3.0	1.5
Digital Logic	2.5	1.7	3.6	0.7
Drafting	2.8	1.8	3.7	0.7
Mathematics	2.4	1.8	2.3	1.5
Physics 1	2.4	1.6	2.4	1.3
Workshop Practices	3.6	1.5	3.7	1.1

Table 8: Term 1 performance – cohort 2.

Term 1 – Cohort 2 Course	Grade Point Averages			
	Direct Entry		Intro. to EET	
	μ	σ	μ	σ
DC Circuits	3.3	1.4	3.4	0.6
PC Application Software	3.9	1.0	3.8	1.3
Digital Logic	3.4	1.2	3.9	0.4
Drafting	4.0	0.9	4.3	0.3
Mathematics	2.9	1.6	2.0	1.3
Physics 1	2.6	1.6	2.2	1.2
Workshop Practices	4.1	0.9	4.5	0.1

It should be recognized that although the two-term 1 groups have slight differences in grade point averages, this does not indicate that one is performing better than the other. Specifically, the differences are not consistent between the two groups. Furthermore,

Table 9 indicates that direct entry and Introduction to EET groups less distinguishable as the program develops.

Table 9: Term 2 performance – cohort 1.

Term 2 – Cohort 1 Course	Grade Point Averages			
	Direct Entry		Intro. to EET	
	μ	σ	μ	σ
AC Circuits	3.6	0.7	3.5	0.8
Technical Comm.	4.0	1.0	4.2	0.4
Computer Systems	3.5	0.5	3.8	0.5
Semiconductor Devices	3.2	0.9	3.0	1.0
Calculus	3.3	1.0	2.9	1.2
Physics 2	3.8	1.0	3.8	0.7
Intro to Microcontrollers	4.0	0.5	3.7	1.0

The averages represented in the tables above do not follow a normal distribution as they are biased to students who have passed. Thus for students who have completed the course, grade points range from a 2.0 (C) to 4.5 (A+).

4. DISCUSSION

Referring to Table 1, it is important to notice that the first iteration of the Introduction to EET program had a 77% completion rate as compared to 45% and 50% completion rates in the subsequent term. As well, their marks in DC circuits, mathematics, and physics were comparable the direct entry students (Table 7). In areas of new mathematics: calculus, AC circuits,

and semi – conductors (Table 6), the two groups of students behaved similarly.

In the second cohort (Table 8) both groups also performed in a relatively similar manner with a statistically significant difference existing in mathematics.

5. CONCLUSION

The Electrical Engineering Technology department had an Integrated program that helped students to get into the regular program over the period of two years. However, due to poor graduation rates, it was replaced by the Introduction to EET program.

The main objective of the Introduction to EET Program is to provide access to students who lack math and physics entrance requirements by providing fundamental math instruction and building an awareness of the EET program as a whole. The motivation behind the Introduction to EET program was not only to enable students to join the regular program in four months (one semester), but also to enable them to make an educated decision whether or not the EET program fits into their careers plans. To date, 38 students have transitioned from the Introduction to EET program into the regular program and 89% of them have stayed in the program and had performed at a level equivalent to their peers.

Moving forward, the Introduction to EET program has proved its success and it will be interesting to follow these students as they move forward in completing the program.