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Understanding the Determinants of Academic Success in Apprenticeship Programs at Mohawk College

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Executive Summary

The primary objective of this study is to improve our understanding of which factors influence the likelihood of success in apprenticeship programs. Our data track most entrants to the apprenticeship programs offered at Mohawk College in Hamilton, Ontario, from 2000 through 2012. Mohawk offers three types of apprenticeship programs, each of which has a different pathway by which the students enter the program. One type of program includes the traditional skilled-trades apprenticeships which have two, three or four academic levels of courses and require employer sponsorship for entry. A second type is the Ontario Youth Apprenticeship Program (OYAP), which is initiated when the student is still in high school. We have only one OYAP program in our data, for child and youth workers. The third type of program begins through admission to a Co-op Diploma Apprenticeship Program (CODA), of which we have two in our data: electrical engineering and manufacturing engineering. These programs require two years of full-time study and yield both a college diploma and an apprenticeship certificate.[1]

When we average over all traditional apprenticeships, we find that 64% of entrants take (and complete) the final level of courses within five years of entering the program. This leaves room for improvement, but compares favourably with Desjardins (2010), who found a completion rate for both academic courses and on-the-job training of 50% within 11 years in six provinces.[2] We commonly observe that students in traditional apprenticeships take more than the minimum number of years to complete the program, but there is no evidence that this is due to academic challenges. Course failures rates at all levels are in most cases under 10%. Furthermore, only about 1% of students switch to other programs at Mohawk College, which suggests little dissatisfaction with the program offerings. Hence, it would appear by default that other factors are the key reasons for slow progress or failure to complete. Among these other factors may be changes in employment or residence.

In other results for the traditional apprenticeship programs, we find that gender and census neighbourhood characteristics, such as average household income and proportion of adults with a BA degree, have little relationship to the academic outcomes of apprentices. There is a common, though not universal, pattern of increased course failure and decreased program completion rates among the youngest (less than 20) and oldest (40 or older) students. Finally, we report some statistically significant differences in academic outcomes by year of entry to a program, but there is no clear pattern of trends over time.

The data that we have for one Ontario Youth Apprenticeship Program, child and youth worker, presents a very different and troubling picture. Course failure rates are high, the dropout rate after level 1 is 84%, and only 9% of students take level 4 courses within five years of program entry. The reasons for this poor performance are as yet unknown.

We analyzed data for two Co-op Diploma Apprenticeship Programs, electrical engineering and manufacturing engineering. These two programs, especially electrical engineering, have higher course failure rates and dropout rates than traditional apprenticeship programs. However, within five years of program entry, 55% of manufacturing engineering students and 43% of electrical engineering students have taken level 4 courses. The CODA programs have more demanding academic content than do traditional apprenticeship programs,

[1] A diploma is earned mainly through full-time classroom study. An apprenticeship has a classroom component, usually provided by a college, but the majority of training is on the job.
[2] New Brunswick, Quebec, Ontario, Manitoba, Alberta and British Columbia.

which likely accounts for the lower course pass and program completion rates. Mohawk College has high school grades for students in CODA programs but not for those in traditional apprenticeships, because only the former register using the standard college application process. Grade 12 grades prove to be a very strong predictor of performance in a CODA program. A CODA student with a Grade 12 GPA of 80 is 26 percentage points less likely to drop out after level 1 than is a student with a Grade 12 GPA of 60. The same difference in Grade 12 GPAs is also associated with a difference of 34 percentage points in the likelihood of completing the program.

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Introduction

This report presents an analysis of the classroom training provided by apprenticeship programs at Mohawk College in Hamilton, Ontario.[3] The key objective of this study is to improve our understanding of which factors influence the likelihood of success in apprenticeship programs. Of particular interest is the role of the pathways by which the students enter the apprenticeship program. We use student-level administrative data from Mohawk College, which houses the largest set of apprenticeship programs in Ontario. We analyze records for all entering cohorts of students in most apprenticeship programs from the fall of 2000 through the fall of 2012. These college data have also been linked with census data on the socioeconomic characteristics of the neighbourhood in which the student lives.

Students enter apprenticeship programs via one of three pathways at Mohawk and other colleges in Ontario. The most common pathway at Mohawk College is what we label the traditional apprenticeship pathway and includes most of the skilled trades such as plumbing, automotive repair and carpentry. Entrants following this pathway must have a job with an employer who has agreed to sponsor the apprentice and be registered with the Ministry of Training, Colleges and Universities. Most of these programs have three levels of training, but a few have two levels and one program in our data has four levels. For each level, an apprentice will typically spend two months out of a year in coursework at Mohawk and ten months in on-the-job training with the employer. A second pathway consists of Co-op Diploma Apprenticeship Programs (CODA) that require two years of full-time study and provide the graduate with both a college diploma and an apprenticeship certificate. Mohawk College has CODA programs in electrical engineering and in manufacturing engineering. The third pathway is an Ontario Youth Apprenticeship Program (OYAP). These apprenticeships may be initiated by a high school student by taking co-operative education in an apprenticed trade. There is only one OYAP program at Mohawk College with sufficient data for analysis, and that is for child and youth worker. Other colleges have both CODA and OYAP programs in other skilled trades areas.

We analyze academic outcomes using both descriptive statistics and regressions that include the program of enrolment, the age and gender of the student, the term and year of program entry, and census socioeconomic characteristics of the most recent neighbourhood in which the student lived (as recorded in the Mohawk data). We have also included in our analysis two other types of data provided by Mohawk for the CODA programs: high school course grades and measures of student fitness (or skill level) in reading, writing and mathematics. Unfortunately, these two types of data are not available for a sufficient number of students in other apprenticeship programs.

Previous Literature

There are few quantitative analyses of academic success in Canadian apprenticeship programs. Several recent studies (Laporte, Christine & Mueller, 2011; Dostie, 2010; Empey, 2010) use data from Statistics Canada's 2007 National Apprenticeship Survey (NAS). The population for the 2007 NAS study included apprentices registered with their province or territory between 2002 and 2004, in every province and territory except Nunavut. The telephone survey was administered between January and May 2007. The NAS data differ from the data used in this study in two key ways. First, the NAS uses a sample of all persons registered as apprentices between 2002 and 2004. Our Mohawk College data contain all persons starting an apprenticeship program between 2000 and 2012. Second, the NAS relies on self-reported, retrospective data. The key disadvantages of such data are that participation is voluntary and may be non-random, and responses to some questions may be erroneous either by design or by accident. For example, persons who

[3] It is important to note that an apprenticeship program involves both classroom training and on-the-job training. In most programs, classroom training accounts for less than 50% of the apprentice's time. For this report, we only have data on the classroom training provided by Mohawk College.

failed to complete the apprenticeship program may be less likely to participate in the survey to begin with and, if participating, less likely to respond that they have truly dropped out of the program. Our Mohawk administrative data include all persons who started each program and record their academic progress throughout the data period. We have the actual administrative record and not a self-report.

The study that used data closest in nature to that contained in this report was Desjardins (2010). This article summarizes the results of a Statistics Canada study that examined completion and discontinuation rates of registered apprentices over a period of 11 years, from 1995 to 2005, using a longitudinal cohort created from the Registered Apprenticeship Information System. This cohort comprised registered apprentices who first enrolled in an apprenticeship program in 1995 in one of six provinces: New Brunswick, Quebec, Ontario, Manitoba, Alberta and British Columbia. One-half of the 29,501 persons newly registered in an apprenticeship program in 1995 had completed both academic courses and on-the-job training by the end of the 11-year study period in 2005. The nominal program duration did not seem to influence the completion rate: apprentices in four-year programs were as likely to finish their program as were apprentices in two-year or three-year programs. Overall, completers took a median time of five years to complete their apprenticeship program, while discontinuers spent a median time of four years before leaving.

Data Availability by Apprenticeship Program at Mohawk College

Table 1 provides information about the various apprenticeship programs which we analyze in this report.[4] Column 1 indicates the type of apprenticeship program (CODA, OYAP or Traditional) and Column 2 provides the program title. Column 3 indicates the number of academic levels required by the program and Column 4 shows the academic years for which we observe courses in our data for this program. Column 5 indicates the number of students who we observe starting level 1 in this program and for whom we have the variables needed for our analysis. The greatest missing value problem in our data was for age. Approximately 15% of students for whom we have other relevant variables are missing a value for age (birth date). The observations with a missing age variable are heavily concentrated among those who entered a traditional apprenticeship program prior to 2008.

[4] We did not include some programs in our analysis, usually because of the absence of course data for all academic levels. These include cook, hairstylist, customer care agent, developmental service worker, drywall and acoustics mechanic, educational assistant, horticultural technician, instrumentation and control technician, and restoration mason programs.

Table 1: Characteristics of the Apprenticeship Programs Analyzed in Report

(1)	(2)	(3)	(4)	(5)
Type of Program	**Program Title**	**Required Course Levels**	**Course Years in Data**	**# Students in Level 1**
CODA/FT Post-Secondary Day	Electrical Engineering Technician	4	2000-2012	1322
CODA/FT Post-Secondary Day	Manufacturing Engineering Technician	4	2000-2012	458
OYAP	Child/Youth Worker	4	2005-2012	179
Traditional	Auto Body and Collision Damage Repairer	3	2000-2012	177
Traditional	Automotive Service Technician	3	2000-2012	1706
Traditional	General Carpenter	3	2000-2012	749
Traditional	Industrial Mechanic Millwright	3	2000-2012	616
Traditional	Plumber	3	2000-2012	779
Traditional	Refrigeration and Air Conditioning	3	2000-2012	838
Traditional	Sheet Metal Worker	3	2000-2012	508
Traditional	Steamfitter	3	2003-2012	359
Traditional	Truck and Coach Technician	3	2000-2012	739
Traditional	Fitter: Structural Steel/Plate plus Welder (same Level 1 & 2 courses)	3	2004-2011	144
Traditional	Electrician: Construction & Maintenance plus Industrial (same Level 1 & 2 courses)	3	2000-2012	1718
Traditional	General Machinist plus Tool & Die Maker (same Level 1 & 2 courses)	3	2000-2011	263
Traditional	Early Childhood Educator (now Child Development Practicioner diploma)	2	2004-2012	598
Traditional	Residential Air Condition (same Level 1 courses as Refrigeration and Air Conditioning)	2	2000 & 2003-2011	51
Traditional	Roofer	2	2000 & 2003-2011	54
Traditional	Truck Trailer Service Technician	2	2005-2010	50
Traditional	Automotive Service Education Program	4	2004-2012	92

Demographic Characteristics: Age and Gender

Table 2 provides a breakdown of our sample by age and gender. The top panel shows that the overall distribution by age has been quite stable over the sample period. Most apprentices are under age 30: one-fifth are less than age 20, two-fifths are age 20 to 24 and another one-fifth are age 25 to 29. The final 20% are mostly in their thirties, with only 5% being age 40 or over. The proportion of females in this population grew from a negligible number to about 10% over the sample period.

The lower panel shows that the distribution by age and gender varies noticeably by pathway. Forty to 50% of CODA students and 82% of OYAP students are under age 20. Students in the traditional apprenticeship programs are older, with the exception of the early childhood educator apprenticeship (which is now a diploma program). The major difference, though, is that students in the traditional programs are less likely to be in their teens and more likely to be in their twenties. Few students in most programs are age 30 or over.

The final column of the lower panel also shows the close to total segregation by gender of apprenticeship programs. Child and youth worker and early childhood educator programs are almost exclusively female and all other programs are almost exclusively male.

Table 2: Distribution of Students by Age at Entry							
Entry Year	**% 15-19**	**% 20-24**	**% 25-29**	**% 30-34**	**% 35-39**	**% 40-59**	**% Female**
2000	21%	48%	11%	11%	2%	7%	1%
2001	35%	41%	12%	6%	2%	5%	2%
2002	24%	40%	18%	9%	7%	3%	1%
2003	18%	43%	15%	10%	7%	7%	1%
2004	16%	37%	21%	14%	6%	6%	5%
2005	19%	42%	19%	10%	5%	6%	7%
2006	21%	42%	17%	11%	5%	4%	7%
2007	21%	43%	18%	9%	5%	5%	11%
2008	22%	40%	22%	8%	5%	5%	11%
2009	22%	41%	19%	7%	5%	6%	10%
2010	23%	39%	19%	9%	6%	4%	11%
2011	23%	41%	20%	6%	5%	5%	12%
2012	23%	33%	26%	10%	4%	4%	12%
Total	21%	41%	19%	9%	5%	5%	8%
Entry Program	**% 15-19**	**% 20-24**	**% 25-29**	**% 30-34**	**% 35-39**	**% 40-59**	**% Female**
CODA							

Electrical Engineering Technician	43%	37%	10%	3%	3%	3%	3%
Manufacturing Engineering Technician	49%	33%	10%	2%	2%	3%	1%
OYAP							
Child/Youth Worker	82%	9%	2%	2%	2%	3%	90%
Traditional 3 Level							
Auto Body and Collision Damage Repairer	21%	56%	18%	3%	1%	2%	1%
Automotive Service Technician	32%	49%	12%	4%	1%	2%	0%
General Carpenter	13%	48%	27%	7%	3%	2%	1%
Industrial Mechanic Millwright	11%	28%	20%	18%	11%	12%	1%
Plumber	5%	46%	25%	12%	8%	3%	0%
Refrigeration and Air Conditioning	4%	41%	28%	13%	8%	6%	1%
Sheet Metal Worker	3%	49%	29%	11%	4%	4%	1%
Steamfitter	1%	30%	28%	20%	9%	11%	0%
Truck and Coach Technician	16%	41%	20%	13%	6%	4%	1%
Fitter: Structural Steel/Plate plus Welder	22%	39%	20%	12%	6%	2%	1%
Electrician: Construction & Maintenance/Industrial	5%	45%	25%	12%	7%	6%	2%
General Machinist plus Tool & Die Maker	25%	40%	20%	9%	4%	2%	3%
Traditional 2 Level							
Early Childhood Educator	50%	20%	8%	7%	5%	10%	97%
Residential Air Conditioning	2%	29%	22%	25%	12%	10%	0%
Roofer	6%	38%	24%	12%	8%	12%	0%

Truck Trailer Service Technician	2%	23%	23%	15%	19%	19%	0%
Traditional 4 Level							
Automotive Service Education Program	15%	59%	18%	7%	1%	0%	2%

Descriptive Statistics for Three-Level Apprenticeship Programs

Table 3 provides summary statistics concerning academic outcomes. The number of relevant academic outcomes depends on the number of required academic levels. Hence, we separate programs by the number of academic levels required. We begin with Table 3A, which contains the descriptive statistics for the three-level apprenticeship programs, all of which follow a traditional pathway. For most outcome measures, we track students entering level 1 of the program over different periods of time or "data windows." For example, "2 Years" means two calendar years since the student started level 1 in the program. Our goal is to determine how many students have remained in the program through a given length of time. The data window is identified in the first column. The first panel of Table 3A shows the number of observations that we have for each data window by program. Shorter data windows provide larger samples but may also provide less accurate estimates of the proportion of students eventually completing the program.

The second panel shows the proportion of students failing to take level 2 courses within a given data window. As the final column shows, 36% of all students failed to take level 2 courses within two years, but this proportion falls to 22% as the data window widens to five years. There are two possible reasons for this. The first is that more students will take courses beyond level 1 given a longer span of time in which to do so. A second reason is that there are fewer observations in the larger data windows; we observe fewer students for five years than for two years. This change in sample composition will affect both numerator and denominator and, potentially, could cause the ratio to increase or decrease. As shown in the final column of the first panel in Table 3A, we observe 7,874 students for two years but only 5,324 for five years. Hence, the 36% "failure to take level 2" rate after two years is based on the 7,874 observations, and the 22% rate after five years is based on the 5,324 observations. We also know that, on average, the 5,324 students for whom we have five years of data also entered an apprenticeship program in an earlier year than the 7,874 students for whom we have only two years of data.

Table 3A: Academic Outcomes for Three Level Traditional Apprenticeships

Years Observed	Auto Service Tech	Auto Body Repairer	Carpenter	Industrial Mechanic Millwright	Plumber	Sheet Metal	Steamfitter	Truck Coach Tech	Electrician	Machinist - Tool & Die Maker	Refrigeration	Welder - Fitter	Total
Number of Observations													
1 year	1706	177	749	616	779	508	359	739	1718	263	838	144	8596
2 years	1553	135	669	595	727	459	339	689	1569	263	747	129	7874
3 years	1385	135	567	561	659	432	283	647	1406	263	652	121	7111
4 years	1206	107	444	515	566	381	245	561	1252	236	577	104	6194
5 years	1053	89	368	480	473	348	206	452	1084	194	501	76	5324
Proportion Failing to Take Level 2 Courses Among Students Taking Level 1 Courses													
2 years	38%	26%	41%	34%	28%	39%	27%	37%	33%	34%	49%	44%	36%
3 years	29%	21%	26%	24%	20%	28%	18%	31%	23%	30%	29%	42%	26%
4 years	28%	17%	25%	22%	16%	24%	15%	28%	18%	28%	23%	41%	23%
5 years	29%	16%	23%	21%	16%	23%	17%	28%	15%	24%	21%	33%	22%
Proportion Failing to Take Level 3 Courses Among Students Taking Level 2 Courses													
3 years	29%	41%	45%	26%	52%	60%	60%	22%	49%	19%	70%	19%	43%
4 years	20%	27%	21%	13%	27%	32%	28%	14%	28%	16%	40%	20%	24%
5 years	16%	23%	18%	10%	20%	26%	20%	11%	22%	16%	21%	18%	18%
Proportion Taking Level 3 Among Students Taking Level 1 Courses													
3 years	50%	47%	42%	57%	38%	29%	33%	54%	40%	57%	22%	47%	43%
4 years	58%	61%	61%	69%	61%	52%	61%	62%	60%	61%	47%	47%	59%
5 years	60%	65%	64%	71%	67%	57%	67%	64%	67%	64%	63%	55%	64%

% Failing 1+ Level 1 Courses	9%	1%	3%	5%	6%	7%	2%	3%	12%	6%	3%	6%	7%
% Failing 1+ Level 2 Courses	4%	1%	1%	3%	2%	3%	1%	3%	10%	4%	1%	8%	4%
% Failing 1+ Level 3 Courses	1%	0%	0%	2%	1%	1%	0%	1%	3%	2%	0%	2%	1%
% Switching to Apprenticeship Program	6%	1%	0%	1%	0%	1%	0%	0%	0%	1%	0%	0%	1%
% Switching to Non-Apprenticeship Program	1%	1%	0%	0%	0%	0%	1%	0%	0%	3%	0%	0%	0%

Table 3B: Academic Outcomes for Two Level and Four Level Apprenticeships

		Two Level Programs				Four Level Programs		
Years Observed	**Roofer**	**Early Childhood Educator**	**Residential AC**	**Truck Trailer Technician**	**Manufacturing Engineering - CODA**	**Electrical Engineering - CODA**	**Automotive Service Educator**	**Child & Youth Worker - OYAP**
Number of Observations								
1 year	54	598	51	50	458	1322	92	179
2 years	54	512	44	50	412	1140	92	143
3 years	54	418	33	42	359	941	83	118
4 years	34	350	26	42	303	760	83	84
5 years	34	250	18	27	265	605	67	56
Proportion Failing to Take Level 2 Courses Among All Entrants								
2 years	41%	55%	34%	32%	18%	25%	5%	82%
3 years	41%	49%	15%	19%	17%	26%	6%	83%
4 years	53%	46%	8%	19%	18%	26%	6%	82%
5 years	53%	43%	11%	19%	20%	27%	4%	84%
Proportion Failing to Take Level 3 Courses Among Students Taking Level 2 Courses								
3 years					21%	22%	4%	55%
4 years					22%	23%	4%	40%
5 years					23%	24%	3%	33%
Proportion Failing to Take Level 4 Courses Among Students Taking Level 3 Courses								
4 years					10%	20%	3%	11%
5 years					11%	23%	2%	17%
Proportion Taking Level 2 Courses Among All Entrants								
2 years	59%	45%	66%	68%				
3 years	59%	51%	85%	81%				
4 years	47%	54%	92%	81%				
5 years	47%	57%	89%	81%				

Proportion Taking Level 3 Among All Entrants								
3 years					66%	58%	90%	8%
4 years					64%	57%	90%	11%
5 years					62%	56%	93%	11%
Proportion Taking Level 4 Among All Entrants								
4 years					58%	46%	88%	10%
5 years					55%	43%	91%	9%
% Failing 1+ Level 1 Courses	6%	34%	0%	6%	29%	49%	1%	47%
% Failing 1+ Level 2 Courses	0%	20%	0%	3%	28%	41%	0%	19%
% Failing 1+ Level 3 Courses					18%	28%	2%	11%
% Failing 1+ Level 4 Courses					11%	17%	1%	25%
% Switching to Apprenticeship Program	0%	0%	0%	0%	5%	4%	1%	1%
% Switching to Non-Apprenticeship Program	0%	14%	0%	0%	12%	12%	0%	17%

More generally, there may be differences in various types of behaviour (completing levels and switching programs) among students from different entering cohorts. We have checked for the impact of sample composition on the differences in outcomes across data windows which we observe in Tables 3A and 3B. Specifically we have constructed Tables 3A and 3B using "samples with a constant composition", i.e., we have calculated the entries in these tables using only those students who we observe for five or more years. (We have also done the same using only those students who we observe for four or more and three or more years.) When we do so, the proportions with various outcomes are generally quite similar to those observed in Tables 3A and 3B. This implies that the differences across data windows (rows) which we observe in Table 3A and 3B are not primarily due to differences in the year of entry into a program but rather to differences in behaviour among students from all entering cohorts. Some students just take longer than others to progress in a program, regardless of the year in which they start.

The remaining panels in Table 3A and the associated figures (see discussion below) show the results for different outcomes. The third panel contains the proportion of students failing to take level 3 courses among those who have taken level 2. The fourth panel shows the proportion of students who take level 3 courses among all students who enter the program. Another term for this is the "completion rate." This term is not strictly accurate for two reasons. First, a very small percentage (1% on average) of students fail one or more courses at level 3. Second, we only have information on the completion of academic requirements. We have no data concerning the completion of work requirements for an apprenticeship certificate.

The next rows show the (very small) proportion of students failing one or more courses at each level. The final two rows show the proportion of students who switch to a different program. “Switching” means that the student made such a switch and did not return to the original apprenticeship program during the data window. The very few students who switched and then returned to the original apprenticeship program are in one of the “non-switcher” categories. The even smaller number of students who switched out, returned and then switched out again are placed in one of the “switcher” categories. Our findings for three-level programs were quite similar across programs. We summarize these below, pointing out exceptions where they exist.

First, the proportion of students failing one or more courses is very small, even at level 1 (igur). Electricians stand out as having a comparatively high rate of course failure (12%), but 67% of entering students in this program also take level 3 courses within five years, which is slightly higher than average. In data not shown here, we find that virtually no students in traditional apprenticeships appear to be part-time, i.e., all enrolled students take the regular course load.

Second, over one-third of students (36%) fail to take level 2 courses within two years of entry, but this falls to almost one-quarter (26%) after three years. This rate declines further to 22% on average after five years (Figure 2). The welder-fitter program has the highest “failure to take level 2” value at 33% after five years, while electricians have the lowest at 15%.

Third, among students taking level 2 courses, 43% fail to take level 3 courses within three years, but this figure falls to 18% after five years. This rate has the highest value at 26% after five years for sheet metal apprentices, and the lowest rate is 10% for the industrial mechanic millwright program.

Fourth, only a minority (43%) of students take level 3 courses within three years of program entry, but this figure increases to 64% within five years of entry. As shown by the left hand side of Figure 3, the differences in the “completion rate” among three-level programs are not large. The “completion rate” is highest (71%) among industrial mechanic millwrights. The lowest completion rate at Mohawk is 55% for welder-fitters. As indicated above, Desjardins (2010) reported a 50% completion over a period of 11 years, but this was for both the classroom and on-the-job components of training, whereas our Mohawk data only account for the former.

Fifth, very few students switch either to a different apprenticeship program or to a non-apprenticeship program. The program with the highest switch rate (7%) is for auto service technicians, most of whom switch into a closely related four-level program for auto service education. The latter program requires employment at a General Motors dealership. Our interpretation is that these students are switching when they secure employment at such a firm.

In summary, over three-fifths of the students in three-level apprenticeships complete the program within five years, but it is common to take more than the minimum three years to do so. There is no evidence that course failure is a barrier to progress, and the very low switch rates do not reveal any serious dissatisfaction with the programs. Hence other factors, such as change in employment or residence, would appear to be the major reasons for slow progress or failure to complete.

Descriptive Statistics for Two-Level and Four-Level Apprenticeship Programs

We continue in Table 3B with the descriptive statistics for both two-level and four-level programs, which come from all three pathways. The left hand side of Table 3B presents a similar set of outcomes for the two-level programs, which are very diverse in terms of outcomes. One-third of students in the early childhood educator program (see Figure 1) failed one or more level 1 courses, as opposed to 0% in the residential air

conditioning program. Because these programs have only two levels of courses, the "dropout rate" after level 1 (Figure 2) is simply the inverse of the "completion rate" of level 2 courses (Figure 3). The early childhood educator program, which has recently been converted from an apprenticeship certificate to a diploma program, had a relatively low completion rate, for Mohawk at least, of 57% after five years.

Figure 1: Proportion Failing One or More Courses in Level 1

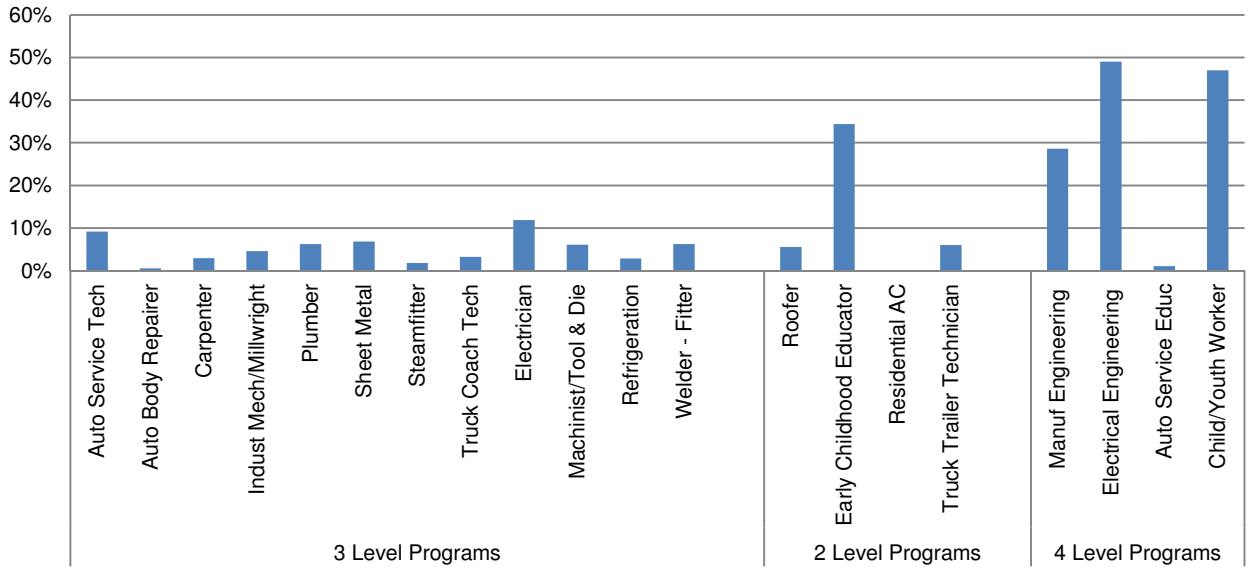
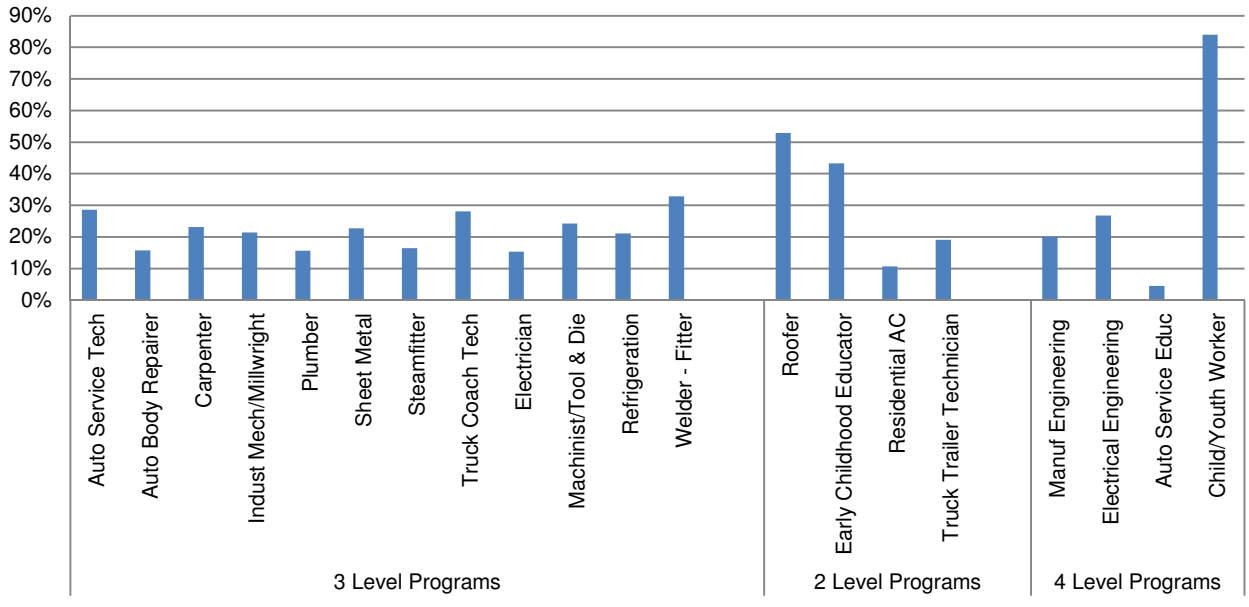
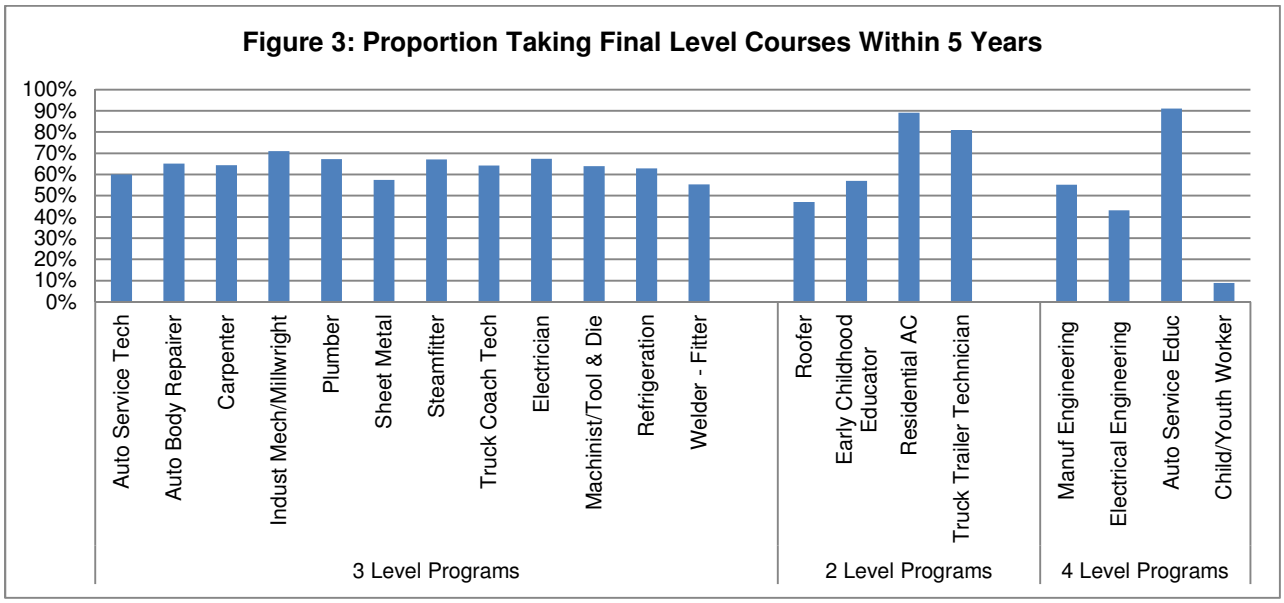


Figure 2: Proportion Failing to Take Level 2 Courses Within 5 Years





The residential air conditioning and truck trailer technician programs have high completion rates, with 89% and 81% of students taking level 2 courses within five years. Given some challenges we had in identifying students in this program, this is likely an overestimate of the completion rate for the residential AC program. The roofer program has a relatively low (for Mohawk) completion rate of 47%, despite a low course failure rate. Our understanding from discussions with Mohawk faculty is that this reflects the seasonal nature of the work. Most employers cannot keep their workers on over the winter. As a result, the proportion of students returning to the same employer and thus to the apprenticeship programs is low. The results for the roofer programs have an additional unusual pattern in that the completion rate falls as the data window widens. This presumably reflects differences in completion rates across entering cohorts. We have indeed combined the data for an older and a newer version of this program. The data imply that the earlier version had a lower completion rate.

The group of four-level programs on the right hand side of Table 3B consists of the following three types of programs: the two CODA programs for electrical engineering technicians and manufacturing engineering technicians; automotive service education, which is the only four-level program that follows a traditional pathway; and the child and youth worker program, which is the only OYAP program for which we had complete course data. These three types of programs differ considerably from each other in terms of their structure, types of entrants (age and gender) and outcomes. The CODA and OYAP programs attract younger entrants than do the traditional programs, and the child and youth worker program is one of only two in our analysis with a large proportion of female students. The following are some of the more important conclusions that one can draw concerning these programs.

First, in comparison with the traditional apprenticeships, the two CODA programs have high failure rates in level 1 courses (Figure 1), high “failure to complete level 2” rates (Figure 2) and low “completion rates” (Figure 3). Forty-nine per cent of students in the electrical engineering and 29% in the manufacturing engineering program fail one or more level 1 courses. Twenty-seven per cent of students in the electrical engineering and 20% in the manufacturing engineering program do not take level 2 courses within five years. Only 43% of students in the electrical engineering technician and 55% in the manufacturing engineering technician program take level 4 courses within five years. Note also that these two programs are structured so that a full-time student can complete all four levels in two academic years.

There are two important qualifications, however, to the above conclusions. The first is that these course failure, dropout and completion rates may compare favourably with other full-time day programs at Mohawk. Unfortunately, we have not collected the data on these other programs and hence cannot make any such comparisons. A second qualification is that a large proportion of CODA students switch to another program. Four to five per cent switch to a different apprenticeship program and 12% switch to non-apprenticeship program. Hence, their ultimate completion rate in some Mohawk program is likely higher than that demonstrated in Table 3B.

Second, the automotive service education program has the best outcomes of any apprenticeship program. As demonstrated by Figures 1, 2 and 3, very few students fail a level 1 course or drop out of the program, and 91% have taken level 4 courses within five years of beginning the program. Our understanding from discussions with Mohawk faculty is that the high level of success is due to the fact that this program is tied to employment with one, stable employer (General Motors) that takes a very strong interest in the content and success of the program.

Third, Figures 1, 2 and 3 show that the child and youth worker program has a very high level 1 course failure rate and by far the highest "failure to take level 2 courses rate" (80% or more) and lowest "completion rates" (9% after five years) of any apprenticeship program. We have checked with Mohawk staff to make sure this is not a data problem. Our inquiries with the teaching staff have not uncovered any clear explanation for why this program has such poor outcomes. The students in this program are young, but similarly young students in other programs do not have such weak performance. This OYAP program is not tied to a specific job, but the same is true of the two CODA programs. Seventeen per cent of child and youth worker students do switch to a daytime program, but this fact alone would not appear to account for the low level of success in this program.

Regression Estimates for Three-Level Apprenticeship Programs

We have estimated regressions in order to assess the impact on academic outcomes of factors such as program when other variables, such as age or year of entry, are held constant. We use the following sets of independent variables: binary variables that identify apprenticeship program, gender, age category and year of entry; and continuous variables for the socioeconomic characteristics of the student's neighbourhood as measured in the 2001 and 2006 censuses. Census data for 2011 are not yet available. These census variables (and their sample means in parentheses) are the following: average household equivalent income ($45,000 – see below for a definition); the proportion of families headed by a lone parent (11%); the proportion of adults with a BA degree (21%); the proportion of adults who are unemployed (7%); the proportion of the population with an English mother tongue (85%); and the proportion of the population that has immigrated to Canada since 1981 (13%).

Household equivalent income is a standard method of adjusting household income for family size. For the equivalent income concept, household income is divided, not by the number of persons in the household, but rather by the square root of the number of persons in the household. The square root function adjusts for economies of scale, i.e., two people do not need twice as many stoves or washing machines as one person. Census data provide neighbourhood averages of household income and the number of persons per household. Hence average household equivalent income is defined as the average household income in a neighbourhood divided by the square root of the average number of persons per household. This variable is measured in thousands of 2006 dollars.

The dependent variables are all binary measures corresponding to whether or not a student had failed one or more courses in a given level, had failed to take courses in a given level or had taken courses in a given level. We estimate linear regressions and hence the coefficients estimate the effect of a one-unit change in the independent variable on the likelihood that the dependent variable will take on a value of one rather than zero, controlling for all the other independent variables.

Immediately below each regression coefficient is the standard error of the estimate. This provides an indication of how precise the coefficient estimate is, that is, the extent to which this estimate would differ in repeated sampling. For each coefficient estimate we have conducted a test of the hypothesis that the true value of the effect of the variable (on the average student) is zero (the "null hypothesis"). Loosely speaking, the asterisks which accompany the estimates indicate the likelihood that we would get the estimates that we did if the true effect was zero. Three (two, one) asterisks indicate that there is less than a 1% (5%, 10%) likelihood that we would get the estimate that we did if the true value of the effect is zero. The absence of an asterisk implies that the data do not permit us to reject the null hypothesis with much confidence. In the literature, an estimate is commonly referred to as "significant" when one can reject the null hypothesis with a certain level of confidence. Opinions differ as to whether the appropriate threshold is 1%, 5% or 10%. Note that the failure to reject the hypothesis that the effect is zero by no means confirms that the true value IS zero. In general, failure to reject often simply confirms that the data are inconclusive, i.e., not rich enough to tell us whether the true value is zero or some value other than (and possibly quite different from) zero. Small sample size is a common reason for inconclusive results. Further discussion will be more helpful in the context of a particular set of estimates.

Table 4A contains the regression estimates for the three-level apprenticeship programs. The dependent variable for the first set of estimates in column 2 is whether or not the student failed one or more courses in level 1. The estimate for the constant at the bottom of the column (see second page) estimates the likelihood of failure for the "reference group" (also called the "omitted category"). As indicated in the last row of the table, the reference group for this set of regressions is a male student in the auto service technician program, age 20-24, entering in 2006 with mean values of census neighbourhood characteristics. This estimate is 6% (0.06) and the asterisks indicate that the data permit us to reject the hypothesis that the true failure rate for this group is zero with a high degree of confidence.

Table 4A: Regressions for Three Level Apprenticeship Programs

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Outcome	**Failed Level 1 Course**	**Failed Level 2 Course**	**Failed Level 3 Course**	**Did Not Take Level 2 Courses Within 5 Years (All Entrants)**	**Did Not Take Level 3 Courses Within 5 Years (Those Taking Level 2 Courses)**	**Did Take Level 3 Courses Within 5 Years (All Entrants)**
Auto Body	-0.059***	-0.020*	-0.005	-0.054	0.124**	-0.066
	(0.010)	(0.012)	(0.004)	(0.042)	(0.059)	(0.063)
Carpentry	-0.029***	-0.019**	-0.008*	0.047	-0.009	-0.031
	(0.011)	(0.008)	(0.004)	(0.030)	(0.029)	(0.035)
Millwright	-0.013	0.002	0.002	0.016	-0.031	0.013
	(0.012)	(0.011)	(0.009)	(0.027)	(0.026)	(0.031)
Plumber	-0.002	-0.006	-0.003	-0.032	0.010	0.017
	(0.012)	(0.009)	(0.006)	(0.024)	(0.027)	(0.031)
Sheetmetal	0.003	-0.001	-0.005	-0.007	0.075**	-0.056

	(0.014)	(0.012)	(0.007)	(0.028)	(0.034)	(0.037)
Steamfitter	-0.030***	-0.009	-0.011**	-0.056**	0.053	-0.002
	(0.012)	(0.010)	(0.005)	(0.028)	(0.035)	(0.039)
Truck_Coach	-0.031***	0.001	-0.008*	0.054**	-0.029	-0.026
	(0.010)	(0.011)	(0.005)	(0.027)	(0.025)	(0.031)
Electrician	0.061***	0.077***	0.017**	-0.028	0.054**	-0.018
	(0.012)	(0.011)	(0.007)	(0.020)	(0.023)	(0.025)
Machinist_Tool_Die	-0.015	0.018	-0.003	0.056	0.018	-0.067
	(0.016)	(0.018)	(0.008)	(0.038)	(0.038)	(0.044)
Refrigeration_AC	-0.027***	-0.017**	-0.014***	0.021	0.080***	-0.081**
	(0.010)	(0.008)	(0.004)	(0.026)	(0.029)	(0.032)
Welder_Fitter	0.004	0.052	0.008	0.135**	0.054	-0.153**
	(0.022)	(0.032)	(0.016)	(0.056)	(0.058)	(0.061)
Female	-0.049***	-0.005	-0.017***	0.059	0.046	-0.067
	(0.019)	(0.028)	(0.004)	(0.062)	(0.076)	(0.072)
Age Less Than 20	0.044***	0.014	-0.001	0.086***	0.056**	-0.116***
	(0.011)	(0.011)	(0.005)	(0.023)	(0.024)	(0.026)
Age 25-29	-0.022***	-0.019***	0.001	-0.005	0.009	-0.002
	(0.007)	(0.007)	(0.004)	(0.015)	(0.018)	(0.020)
Age 30-34	-0.022***	-0.015*	0.012*	-0.013	0.016	-0.002
	(0.008)	(0.009)	(0.007)	(0.018)	(0.022)	(0.023)
Age 35-39	0.013	-0.017	0.009	0.006	-0.029	0.022
	(0.014)	(0.011)	(0.009)	(0.025)	(0.026)	(0.030)
Age 40 or More	0.011	-0.019	-0.000	0.048*	0.072**	-0.099***
	(0.015)	(0.013)	(0.009)	(0.029)	(0.035)	(0.036)
Entry 2000	0.149**	0.080	0.014	0.121*	0.295***	-0.285***
	(0.059)	(0.054)	(0.024)	(0.066)	(0.088)	(0.072)
Entry 2001	-0.003	0.073**	0.058*	-0.017	0.105*	-0.061
	(0.027)	(0.037)	(0.031)	(0.044)	(0.059)	(0.058)
Entry 2002	-0.003	0.028	0.022	-0.037	-0.033	0.069**
	(0.019)	(0.020)	(0.013)	(0.026)	(0.028)	(0.032)
Entry 2003	-0.010	0.014	0.005	-0.105***	0.043*	0.063**
	(0.014)	(0.013)	(0.007)	(0.018)	(0.025)	(0.026)
Entry 2004	-0.007	0.015	0.001	-0.049**	-0.005	0.047*
	(0.013)	(0.012)	(0.006)	(0.020)	(0.021)	(0.025)
Entry 2005	0.000	0.005	0.006	0.005	0.022	-0.024
	(0.011)	(0.010)	(0.006)	(0.019)	(0.020)	(0.023)
Entry 2007	0.001	0.011	0.003	-0.002	0.009	-0.007
	(0.011)	(0.010)	(0.005)	(0.018)	(0.019)	(0.022)
Entry 2008	-0.003	0.018*	-0.002			
	(0.011)	(0.010)	(0.005)			
Entry 2009	0.002	0.020*	-0.004			
	(0.011)	(0.010)	(0.004)			

Entry 2010	0.008	0.008	-0.002			
	(0.012)	(0.011)	(0.008)			
Entry 2011	0.017	-0.015*	-0.005			
	(0.012)	(0.009)	(0.005)			
Entry 2012	0.024	-0.007				
	(0.017)	(0.008)				
Average Equivalent Income (000)	0.000	0.000	0.000	-0.001	0.001	0.000
	(0.001)	(0.001)	(0.000)	(0.001)	(0.002)	(0.002)
% Lone Parent Families	0.002**	0.001	-0.000	0.003	0.006***	-0.008***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.003)
% with BA Degree	0.000	-0.000	-0.001*	-0.000	0.002	-0.001
	(0.001)	(0.001)	(0.000)	(0.001)	(0.002)	(0.002)
% Unemployed	-0.005	-0.004	-0.001	-0.013	-0.003	0.014
	(0.004)	(0.004)	(0.002)	(0.008)	(0.009)	(0.010)
% English Mother Tongue	-0.001	0.000	-0.001	-0.001	-0.006**	0.006**
	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)	(0.003)
% Immigrated Since 1981	-0.001	0.001	0.000	0.001	-0.006**	0.005*
	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)	(0.003)
Constant*	0.060***	0.024***	0.007	0.164***	0.117***	0.738***
	(0.011)	(0.009)	(0.006)	(0.021)	(0.021)	(0.025)
Observations	7,371	5,236	3,956	3,813	3,128	3,813
R-squared	0.033	0.038	0.019	0.034	0.034	0.032
Sample mean or proportion	6%	4%	1%	0%	16%	71%
Clustered standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1						
Constant (reference group) is a male student in the Auto Service Technician program, age 20-24, entering in2006 with mean values of census neighbourhood characteristics. Income is in thousands of $2002. Proportionate variables are in percentage points, e.g., 10.3%.						

The coefficients for all other variables represent *differences* from the estimated failure rate for the reference group of 6%. Returning to the top of column 2, the coefficients for the auto body repair indicate that the likelihood of failing a level 1 course is 5.9 percentage points *lower* than that of the reference group. Hence, our estimate of the likelihood of level 1 course failure for students in the auto body repair program who have the other characteristics of the reference group is equal to 0.06 minus 0.059 or 0.1%. Because we are using linear regression, it is possible for predicted probabilities to be less than zero or greater than one. There are estimation methods that restrict the predicted probabilities to be greater than zero and less than one, but they are more difficult for a general audience to interpret and provide very similar predictions to those shown in Table 4A.

Six of the eleven coefficients for programs are statistically significant, meaning that the data support the hypothesis that the likelihood of failure differs between these programs and the reference group (Auto Service). Carpentry, Steamfitter, Truck_Coach and Refrigeration_AC all have a likelihood of failure that is about 3 percentage points lower than that of the reference group. Electricians have a likelihood of failure that is 6.1 percentage points higher than that of the reference group. The remaining program coefficients are all

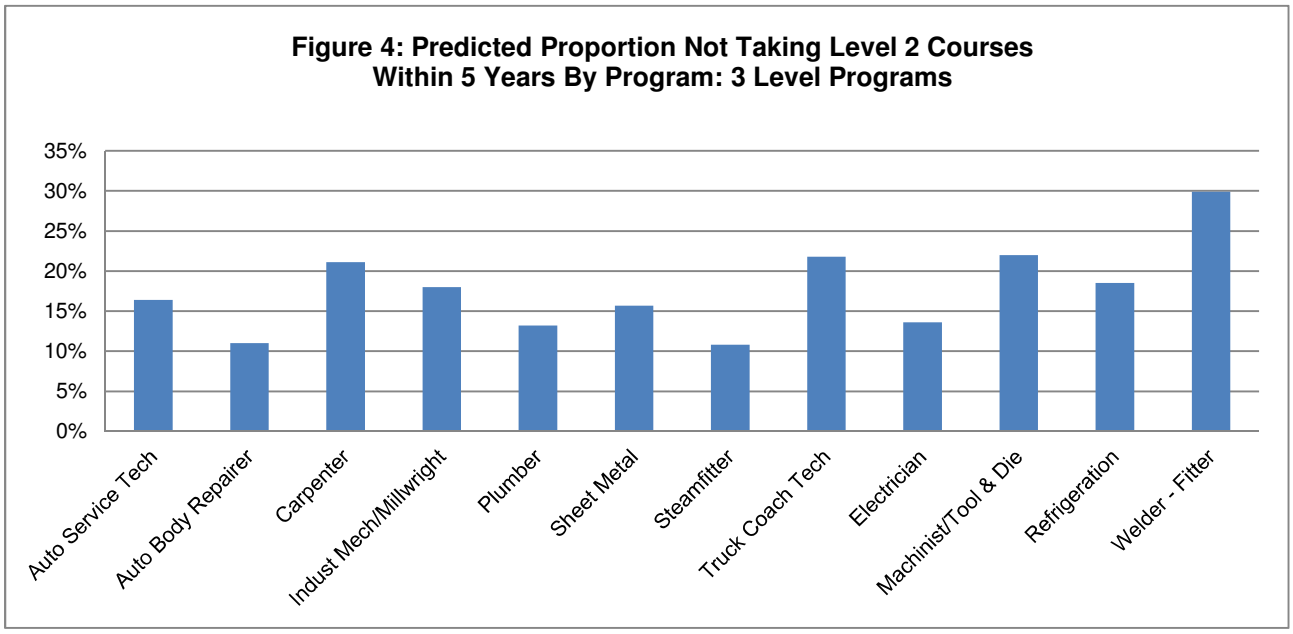
small in size and the data do not support the hypothesis that the likelihood of failure differs between these programs and the reference group (Auto Service). Table 3A showed that all of the three-level programs have similarly low rates of course failure, and Table 4A shows that this is true even when one controls for other variables.

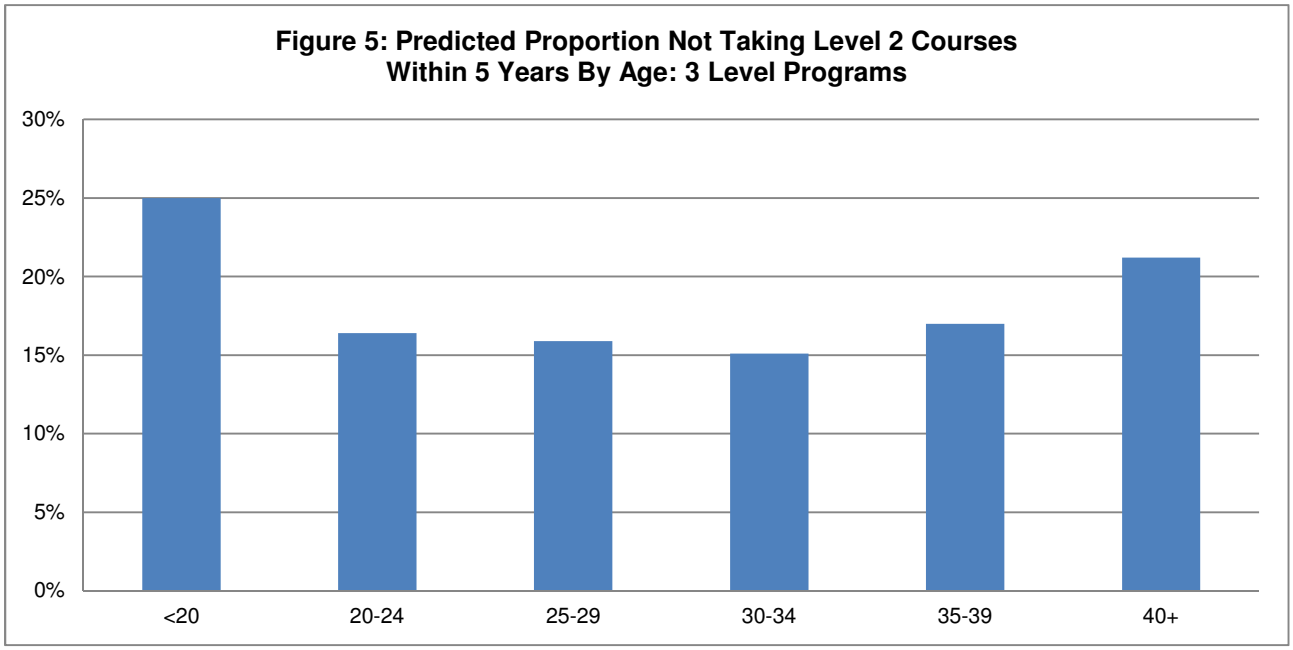
The coefficient for Female indicates that women have a rate of course failure that is 4.9 percentage points lower than that for men, but this coefficient is generally not significant for the other regressions in this Table 4A. The coefficient for Age Less Than 20 indicates that the youngest students have a higher (4.4 percentage points) likelihood of failure than the reference group (Age 20-24). The rate for students age 25-29 and age 30-34 is 2.2 points lower than that for the reference group. The next set of coefficients is for entry year. The year 2000 is the only one with a failure rate significantly different from that for the reference group, which is 2006. Hence, there is no time trend in the outcome revealed by the data.

The final set of coefficients is for the census neighbourhood characteristics. As is typical throughout Table 4, these estimates are usually not significantly different from zero. The one exception in column 2 indicates that a one percentage point increase in the proportion of families headed by a lone parent is associated with a 0.2 percentage point increase in the likelihood of level 1 course failure.

Columns 3 and 4 of Table 4A contain the coefficient estimates for the likelihood of failing one or more courses in levels 2 and 3. The basic conclusions are similar to those for column 2. The failure rates for the reference group (constant coefficients) are only 2.4% and 0.7%, respectively. Most of the other coefficients in this column are not statistically significant and the significant coefficients are all small in size. For virtually all cases considered, the failure rates in each level of the program are quite low. (There is no coefficient for the entry year 2012 due to colinearity between this variable and one or more other variables in the regression.)

The values in column 5 provide estimates of the impact of the independent variables on the likelihood of not taking courses in level 2 within five years. Figure 4 contains the probability of “not taking courses in level 2” predicted for each program by the coefficients in Table 4A assuming the other characteristics (age, gender, etc.) of the reference group. The estimate for the auto service technician program is 16.4%. Only one program (steamfitter) has a likelihood that is (significantly) lower than the reference group, and only two programs (welder fitter and truck coach) have a likelihood that is (significantly) higher than the reference group. Hence we continue to find little variability among three-level programs in the likelihood of “dropping out”, even after controlling for other characteristics.





The estimates in column 5 and Figure 5 demonstrate that the youngest and oldest age groups (<20 and 40+) have likelihoods of not proceeding to level 2 that are 8.6 and 4.8 percentage points higher, respectively, than that of the reference group. The remaining coefficients in column 5 show no clear trend over time and no significant effects of the neighbourhood characteristics.

The values in column 6 provide estimates of the impact of the independent variables on the likelihood of not taking courses in level 3 (“dropping out after the second level”) within five years among those students who

took level 2 courses. The estimate for the reference group is 11.7%. No program has a likelihood that is (significantly) lower than this. Four programs have a higher likelihood, especially auto body repair. Once again, the youngest and oldest age groups (<20 and 40+) have significantly higher likelihoods of not proceeding to level 3. A one percentage point increase in the proportion of families headed by a lone parent is associated with a 0.6 percentage point increase in the likelihood of not taking level 3 courses. The opposite is true of a one percentage point increase in the proportion of the population that has English as mother tongue and the proportion that immigrated to Canada since 1981.

The values in column 7 provide estimates of the impact of the independent variables on the likelihood of taking courses in level 3 or "completing" among all students. Figure 6 contains the likelihood predicted for each program by the coefficients in Table 4A assuming the other (age, gender, etc.) characteristics of the reference group. The estimate for the reference group of this "completion rate" is 73.8%. This reflects the combined impact of the dropout rates after levels 1 and 2. No program has a likelihood that is (significantly) higher than this. Two programs (refrigeration AC and welder fitter) have likelihoods that are significantly lower, by 8.1 and 15.3 percentage points respectively. Figure 3 showed that all of the three-level programs have high rates of program completion and Figure 6 shows that this is true even when one controls for other variables.

Figure 6: Predicted Proportion Taking Level 3 Courses Within 5 Years By Program: 3 Level Programs

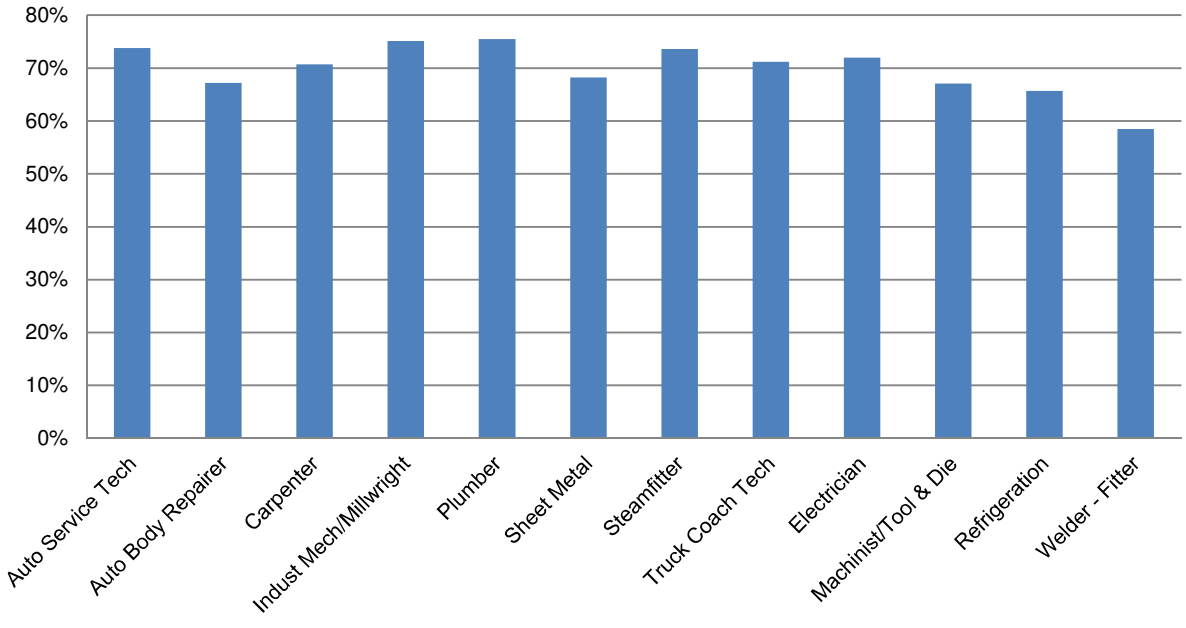
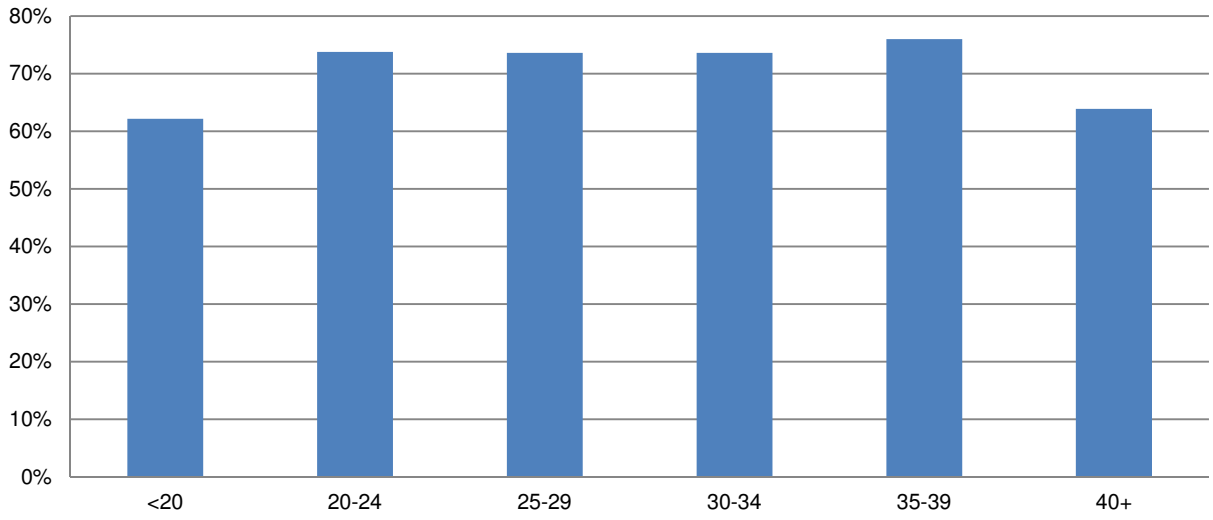


Figure 7: Predicted Proportion Taking Level 3 Courses Within 5 Years By Age: 3-Level Programs



As shown in Figure 7, the youngest and oldest age groups (<20 and 40+) have significantly lower (by about 10 percentage points) likelihoods of proceeding to level 3. Desjardins (2010) reported that apprentices age 25 and older were less likely to complete than were younger ones. She did not test for a more complex set of age categories as we did. Our results reveal that the youngest apprentices (less than 20) are generally the highest-risk group for failing a course and failing to take level 2 and level 3 courses.

There are no differences by gender or apparent time trends in column 7. A one percentage point increase in the proportion of families headed by a lone parent is associated with a 0.8 percentage point decrease in the likelihood of taking level 3 courses. A one percentage point increase in the proportion of the population that has English as mother tongue or the proportion that immigrated to Canada since 1981 are associated with an increase of 0.5 or 0.6 percentage point increase in the likelihood of taking level 3 courses. These neighbourhood effects are all quite small quantitatively.

Regression Estimates for Two-Level Apprenticeship Programs

The regression estimates in Table 4B are for the two-level programs and contain the same independent variables as Table 4A, save for the program indicators. There are fewer regressions given that there are only two levels in these programs. Column 1 shows that the estimated failure rate in level 1 courses for the reference group (Roofers) is 10.6 percentage points. The students in the early childhood educator program have a level 1 failure rate that is much (34.8 percentage points) higher than that of the reference group. The coefficient in column 2 for Residential_AC indicates that this group has a level 1 failure rate of virtually zero, but this may be an underestimate as indicated above. As in Table 4A, the likelihood of failure in level 1 is somewhat higher (11 percentage points) for the youngest students. Unlike in Table 4A, the oldest students (and those aged 30-34) are about 9 percentage points less likely to fail level 1 courses than is the reference group.

Table 4B: Regressions for Two Level Apprenticeship Programs			
(1)	(2)	(3)	(4)
Outcome	**Failed Level 1 Course**	**Failed Level 2 Course**	**Did Take Level 2 Courses Within 5 Years (All Entrants)**
Early Childhood Educator	0.348**	0.016	0.097
	(0.139)	(0.055)	(0.216)
Residential AC	-0.116**	0.040	0.401***
	(0.050)	(0.041)	(0.103)
Truck Trailer Technician	-0.008	0.092	0.269**
	(0.062)	(0.067)	(0.128)
Female	-0.194	0.200***	0.093
	(0.131)	(0.050)	(0.193)
Age Less Than 20	0.110**	0.059	-0.374***
	(0.046)	(0.067)	(0.073)
Age 25-29	-0.004	0.004	-0.110
	(0.053)	(0.059)	(0.088)
Age 30-34	-0.091**	-0.085*	-0.013
	(0.046)	(0.046)	(0.085)
Age 35-39	-0.006	-0.108**	0.091
	(0.061)	(0.047)	(0.058)
Age 40 or More	-0.090*	-0.063	-0.007
	(0.049)	(0.052)	(0.075)
Entry 2002	0.028	0.068	-1.072***
	(0.069)	(0.066)	(0.095)
Entry 2004	-0.170**	-0.041	0.229***
	(0.072)	(0.082)	(0.070)
Entry 2005	-0.099	-0.017	-0.053
	(0.071)	(0.074)	(0.091)
Entry 2007	-0.072	0.014	0.015
	(0.063)	(0.067)	(0.068)
Entry 2008	-0.032	0.050	
	(0.063)	(0.067)	
Entry 2009	0.097	0.102	
	(0.072)	(0.077)	
Entry 2010	0.148**	0.031	
	(0.069)	(0.076)	
Entry 2011	0.093	-0.051	
	(0.073)	(0.077)	
Entry 2012	-0.253***		
	(0.079)		

Average Equivalent Income (000)	0.001	-0.001	0.002
	(0.003)	(0.003)	(0.005)
% Lone Parent Families	-0.002	-0.011*	-0.002
	(0.006)	(0.006)	(0.010)
% with BA Degree	-0.005	-0.002	0.002
	(0.003)	(0.003)	(0.005)
% Unemployed	0.007	0.034	0.000
	(0.023)	(0.024)	(0.039)
% English Mother Tongue	0.003	0.004	0.012
	(0.008)	(0.005)	(0.012)
% Immigrated Since 1981	0.000	0.004	0.014
	(0.008)	(0.005)	(0.013)
Constant*	0.106	-0.037	0.608***
	(0.074)	(0.075)	(0.119)
Observations	692	368	275
R-squared	0.167	0.120	0.259
Sample mean or proportion	28%	14%	60%

Constant (reference group) isa male student in the Roofer program, age 20-24, entering in 2006 with mean values of census neighbourhood characteristics. Income is in thousands of $2002. Proportionate variables are in percentage points, e.g., 10.3%.

The proportion of students failing one or more level 2 courses is so low that the estimate for the reference group (the constant) is actually a negative number. Most of the coefficients in column 3 are not significant, which implies that very few students of any type fail level 2 courses in these programs.

The final column shows that the reference group has a likelihood of taking level 2 courses ("completing") of 60.8%. Figure 8 contains the likelihood of taking level 2 courses, predicted for each program by the coefficients in Table 4B, assuming the other (age, gender, etc.) characteristics of the reference group. The likelihood of completion for the residential AC program is 40.1 percentage points higher than that of the reference group and the completion rate for the truck trailer technician program is 26.9 percentage points higher. There is no statistically significant difference between the completion rates for the early childhood educator program and the reference group. As shown in Figure 9, the youngest age group (less than 20) has an estimated likelihood of taking level 2 courses that is only 23.4% (0.608 minus 0.374). No other age group stands out nearly as much. For all of the outcomes in Table 4B, gender and census neighbourhood variables have no significant coefficients save for gender in column 3. There are a few significant coefficients for term and year of entry, but there is no clear pattern of differences.

Figure 8: Predicted Proportion Taking Level 2 Courses Within 5 Years By Program: 2 Level Programs

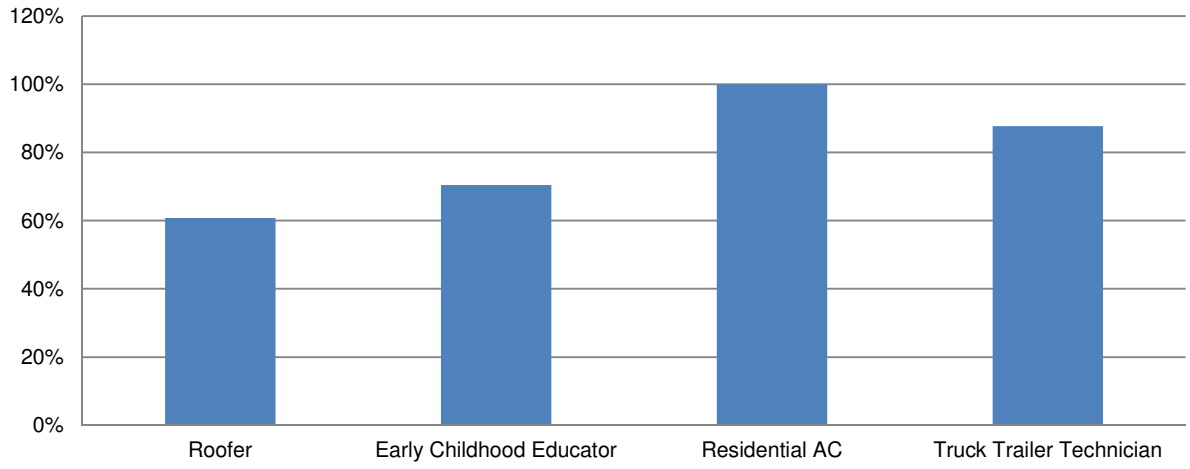
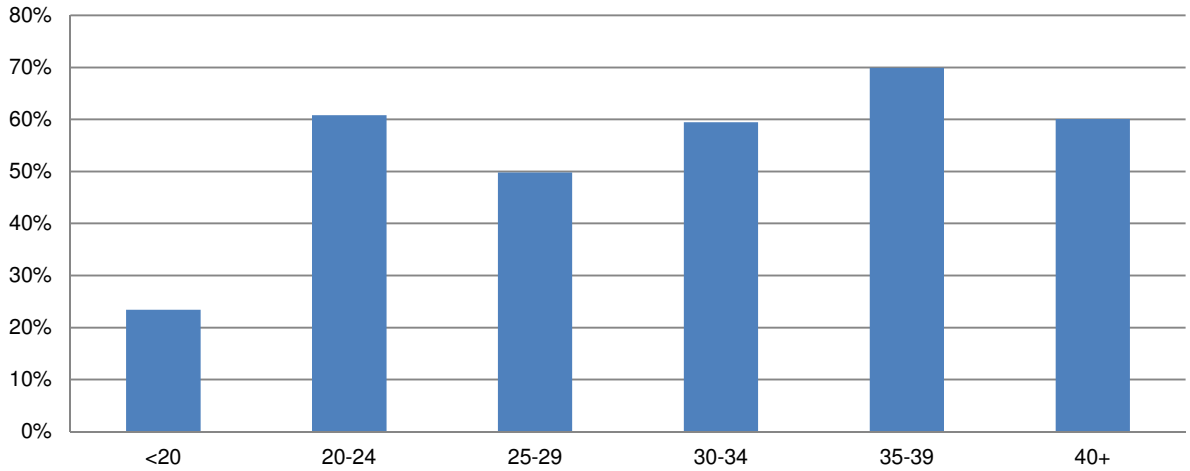


Figure 9: Predicted Proportion Taking Level 2 Courses Within 5 Years By Age: 2 Level Programs



Regression Estimates for Four-Level CODA Apprenticeship Programs

The regression estimates in Tables 4C and 4D are for the two CODA programs, both of which have four academic levels. We have not included regression estimates for the two other programs that have four levels, child and youth worker and automotive service educator, for the reasons presented below. As shown in Table 3B, close to 100% of apprentices in the automotive service educator program pass all courses and complete the program. Success is almost universal, so there is very little variation in outcomes to analyze. Students in the child and youth worker program have an 84% dropout rate after level 1 and only 10% take level 4 courses within a five-year window. Hence there is little variation in outcomes to analyze for this apprenticeship because failure to progress and complete is almost universal. We have tried a few regressions for these two programs and there is little insight to be gained from them.

There are two sets of regression estimates for the CODA programs in Tables 4C and 4D. In Table 4C, we include the same independent variables as in Tables 4A and 4B. In Table 4D, we add a measure of high school academic success to the regression in 4C, specifically, the student's grade point average (GPA) in Grade 12. As indicated above, not all CODA students in our data have high school grade variables. Hence the samples sizes in Table 4D are only 30% to 50% of the sample size in Table 4C. In both 4C and 4D we have omitted the binary variables for entry year. Our purpose in doing so is to limit the number of coefficients being estimated, in light of the small samples sizes in Table 4D. In results not shown here, we have estimated these models with year of entry variables and, as in Table 4A and 4B, there is no indication of any time trend for the outcomes. We also have fitness scores in reading, writing and math for some CODA students, but the number of observations is usually too small for regression analysis. We do comment in the text on the few exceptions.

We first consider the estimates in Table 4C. The reference group is Manufacturing Engineering Technician. The estimated constant terms in columns 2 through 5 show that the estimated likelihood of failing one or more courses ranges from 31% in level 1 to 16% in level 4 for the reference group. These values are much higher than was the case for the reference group in Table 4A for the three-level programs. Furthermore, the likelihood of failing one or more courses for students in the electrical engineering program is even higher than for the manufacturing engineering program. Just over one-half (31.1% plus 20.9%) of male electrical engineering students aged 25-29 are predicted to fail one or more courses in level 1. Female students are 12.7 percentage points less likely to fail a level 1 course, but the coefficient estimates for this factor are mostly not significant in this table.

Table 4C: Regressions for Four Level CODA Apprenticeship Programs								
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Outcome	**Failed Level 1 Course**	**Failed Level 2 Course**	**Failed Level 3 Course**	**Failed Level 4 Course**	**Did Not Take Level 2 Courses Within 5 Years (All Entrants)**	**Did Not Take Level 3 Courses Within 5 Years (Those Taking Level 2 Courses)**	**Did Not Take Level 4 Courses Within 5 Years (Those Taking Level 3 Courses)**	**Did Take Level 4 Courses Within 5 Years (All Entrants)**
Electrical Engineer	0.209***	0.132***	0.108***	0.052*	0.068*	-0.026	0.082**	-0.083**
	(0.026)	(0.030)	(0.030)	(0.029)	(0.035)	(0.040)	(0.037)	(0.040)
Female	-0.127*	-0.064	0.163*	0.052	-0.097	-0.063	0.167	-0.020
	(0.068)	(0.076)	(0.093)	(0.090)	(0.085)	(0.097)	(0.129)	(0.102)
Age Less Than 20	0.040	0.028	0.063*	-0.032	-0.046	0.015	0.012	0.011
	(0.026)	(0.031)	(0.034)	(0.033)	(0.033)	(0.038)	(0.040)	(0.037)
Age 25-29	-0.158***	-0.128***	-0.114***	-0.129***	-0.074	-0.085	-0.071	0.147**
	(0.039)	(0.044)	(0.041)	(0.035)	(0.055)	(0.058)	(0.054)	(0.063)
Age 30-34	-0.311***	-0.311***	-0.204***	-0.177***	-0.223***	-0.065	-0.008	0.161
	(0.055)	(0.049)	(0.051)	(0.040)	(0.068)	(0.108)	(0.132)	(0.136)
Age 35-39	-0.279***	-0.155**	-0.021	-0.025	-0.238***	-0.189**	0.000	0.270**
	(0.062)	(0.073)	(0.080)	(0.078)	(0.068)	(0.077)	(0.124)	(0.128)
Age 40 or More	-0.332***	-0.225***	-0.217***	-0.159***	-0.179*	0.012	-0.020	0.188
	(0.049)	(0.060)	(0.042)	(0.044)	(0.096)	(0.155)	(0.145)	(0.164)
Average Equivalent Income (000)	-0.001	-0.003	0.000	-0.003	0.004	0.002	0.008*	-0.009**
	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)
% Lone Parent Families	0.005	0.007	0.009**	0.003	0.001	0.005	0.013**	-0.010*
	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)
% with BA Degree	-0.000	0.002	-0.000	0.004	-0.004	-0.002	-0.003	0.006
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)
% Unemployed	-0.020	0.003	-0.013	-0.004	0.010	0.029	0.003	-0.023
	(0.016)	(0.018)	(0.019)	(0.020)	(0.021)	(0.023)	(0.024)	(0.025)
% English Mother Tongue	0.005**	0.005**	0.002	-0.001	0.005	0.004	-0.013	0.002
	(0.002)	(0.003)	(0.002)	(0.004)	(0.007)	(0.008)	(0.008)	(0.007)

% Immigrated Since 1981	0.005**	0.003	0.001	-0.002	0.008	0.010	-0.013	-0.005
	(0.003)	(0.003)	(0.003)	(0.004)	(0.007)	(0.009)	(0.009)	(0.008)
Constant*	0.311***	0.298***	0.176***	0.160***	0.226***	0.251***	0.145***	0.512***
	(0.028)	(0.031)	(0.032)	(0.034)	(0.037)	(0.042)	(0.041)	(0.042)
Observations	1,809	1,357	971	814	856	642	491	856
R-squared	0.081	0.051	0.055	0.032	0.022	0.038	0.053	0.047
Sample mean or proportion	42%	35%	23%	14%	25%	22%	17%	49%
Clustered standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1								
Constant (reference group) is a male student in the Manufacturing Technician program, age 20-24, with mean values of census neighbourhood characteristics. Income is in thousands of $2002. Proportionate variables are in percentage points, e.g., 10.3%.								

Table 4D: Regressions for Four Level CODA Apprenticeship Programs With Grade 12 Grade Point Average								
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Outcome	**Failed Level 1 Course**	**Failed Level 2 Course**	**Failed Level 3 Course**	**Failed Level 4 Course**	**Did Not Take Level 2 Courses Within 5 Years (All Entrants)**	**Did Not Take Level 3 Courses Within 5 Years (Those Taking Level 2 Courses)**	**Did Not Take Level 4 Courses Within 5 Years (Those Taking Level 3 Courses)**	**Did Take Level 4 Courses Within 5 Years (All Entrants)**
Grade 12 GPA	-0.022***	-0.016***	-0.010***	-0.008***	-0.013***	-0.012***	-0.005	0.017***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.005)	(0.004)	(0.003)
Electrical Engineer	0.230***	0.178***	0.067	0.015	0.059	0.048	-0.082	-0.037
	(0.036)	(0.041)	(0.042)	(0.044)	(0.063)	(0.074)	(0.069)	(0.065)
Female	-0.092	0.073	0.253**	0.043	0.044	-0.318***	0.210	-0.045
	(0.085)	(0.108)	(0.116)	(0.116)	(0.204)	(0.088)	(0.165)	(0.174)
Age Less Than 20	0.140***	0.133***	0.114***	0.023	-0.005	0.143*	0.034	-0.088
	(0.033)	(0.042)	(0.044)	(0.046)	(0.072)	(0.083)	(0.084)	(0.072)
Age 25-29	-0.265***	-0.140*	-0.077	-0.108*	-0.115	0.011	-0.071	0.130
	(0.063)	(0.076)	(0.069)	(0.061)	(0.125)	(0.150)	(0.072)	(0.131)
Age 30-34	-0.430***	-0.432***	-0.063	-0.119	-0.270***	-0.179**	0.814***	-0.519***
	(0.099)	(0.044)	(0.101)	(0.086)	(0.086)	(0.088)	(0.088)	(0.101)
Age 35-39	-0.390***	-0.257*	-0.180***	-0.198***				
	(0.120)	(0.136)	(0.054)	(0.055)				
Age 40 or More	-0.362***	-0.320***	-0.067	-0.020				
	(0.119)	(0.100)	(0.125)	(0.169)				
Average Equivalent Income (000)	0.003	-0.003	-0.005	-0.003	0.012*	0.001	0.019*	-0.011**
	(0.004)	(0.006)	(0.005)	(0.005)	(0.006)	(0.012)	(0.010)	(0.005)
% Lone Parent Families	-0.000	-0.002	-0.001	0.012**	0.003	-0.000	0.014	-0.005
	(0.005)	(0.006)	(0.006)	(0.006)	(0.010)	(0.013)	(0.012)	(0.011)
% with BA Degree	0.001	0.009*	0.005	0.005	0.005	0.006	-0.009	-0.005
	(0.004)	(0.005)	(0.005)	(0.005)	(0.007)	(0.009)	(0.008)	(0.007)
% Unemployed	0.011	0.048*	0.003	-0.035	0.063	0.068	0.128**	-0.136***
	(0.022)	(0.028)	(0.028)	(0.024)	(0.041)	(0.059)	(0.052)	(0.045)

% English Mother Tongue	-0.004	-0.003	-0.008	-0.012	-0.015	-0.008	0.010	0.014
	(0.007)	(0.008)	(0.008)	(0.008)	(0.011)	(0.015)	(0.010)	(0.013)
% Immigrated Since 1981	-0.008	-0.008	-0.010	-0.011	-0.025**	-0.007	0.006	0.019
	(0.007)	(0.008)	(0.008)	(0.008)	(0.011)	(0.016)	(0.010)	(0.014)
Constant*	0.281***	0.225***	0.119**	0.184***	0.257***	0.192**	0.151**	0.527***
	(0.041)	(0.048)	(0.049)	(0.054)	(0.071)	(0.078)	(0.065)	(0.072)
Observations	932	677	458	383	248	176	125	248
R-squared	0.220	0.128	0.072	0.079	0.129	0.113	0.251	0.177
Sample mean or proportion	42%	35%	23%	14%	25%	22%		49%
Clustered standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1								
Constant (reference group) is a male student in the Manufacturing Technician program, age 20-24, with mean values of census neighbourhood characteristics. Income is in thousands of $2002. Proportionate variables are in percentage points, e.g., 10.3%.								

There are also significant differences by age in the likelihood of level 1 course failure, but the pattern is somewhat different than that for other apprenticeship programs. In Tables 4A and 4B the youngest (less than age 20) apprentices were more likely than the reference group to fail a level 1 course. In Table 4C, in contrast, there are no significant differences between students aged less than 20 and those aged 20 to 24. However, almost all students over age 24, including the oldest ones, have likelihoods of course failure that are significantly lower than those of the reference group. The size of the age coefficients are often large, e.g., apprentices over age 30 are about 30 percentage points less likely to fail a level 1 course than are students under age 25. As is common, almost no coefficients for the neighbourhood characteristics are statistically significant and the few that are significant often have an unexpected sign, e.g., the positive coefficient for English Mother Tongue in column 2.

Columns 6, 7 and 8 contain the coefficients for the likelihood of not taking courses in levels 2, 3 and 4 respectively within five years of entering the program. In each case, we restrict the sample to students who had taken courses at the previous level. These estimates can also be thought of as indicating the likelihood of "dropping out" after levels 1, 2 and 3 respectively. For the reference group (the constant coefficient), these likelihoods are 22.6%, 25.1% and 14.5%, respectively. These proportions are also greater than for the reference group in three-level programs in Table 4A. Some of the higher "dropout rates" for CODA students, however, reflect their greater likelihood of transferring to another college program, as shown in Table 3.

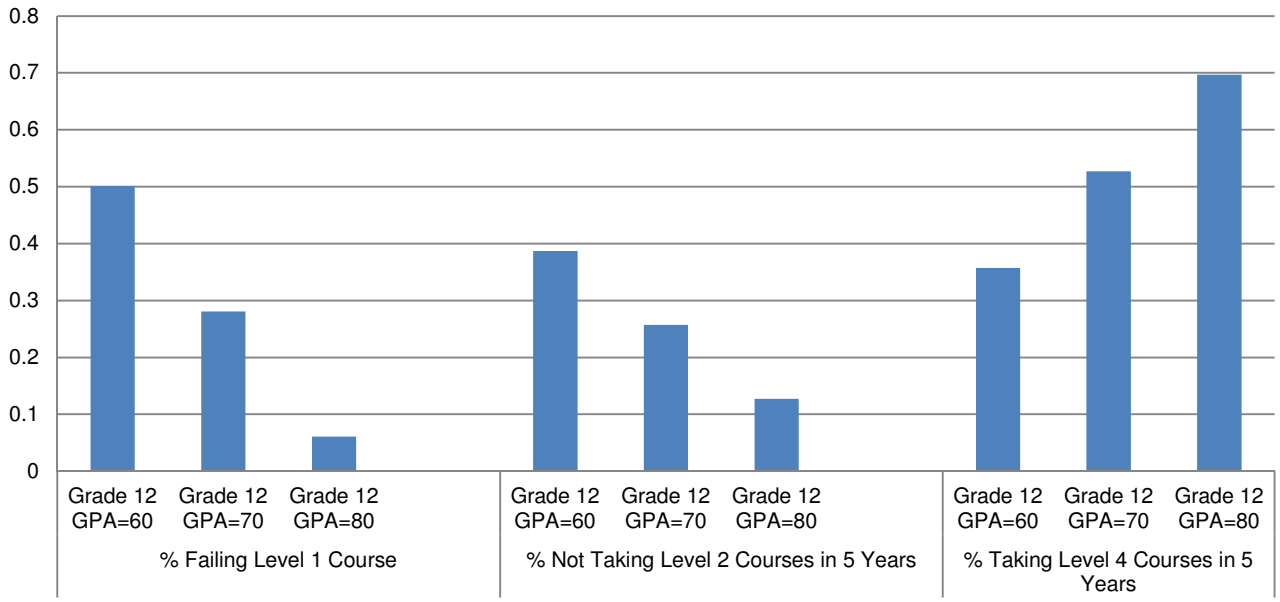
Students in the electrical engineering program are more likely to "drop out" after levels 1 and 3 than are students in manufacturing engineering, but these differences are smaller (6.8 and 8.2 percentage points respectively) than was the case for the likelihood of course failure. Students aged 30 and over are significantly less likely to drop out after level 1 compared to students aged 20-24, but most of the age coefficients for dropping out after levels 2 and 3 are not significant.

Column 9 contains the coefficients for the likelihood of taking courses in level 4 within five years of entry. The constant coefficient indicates that this "completion rate" is just over one-half (51.2%) for students in the reference group. Students in the electrical engineering program are 8.3 percentage points less likely to complete. Students over age 24 are more likely to complete than are students in the reference group, but these coefficients are significant only for the 25-29 and 35-39 age groups.

In Table 4D, we include the same independent variables as in Table 4C and we add a measure of high school academic success to the regression, specifically, the student's grade point average (GPA) in Grade 12. In our sample, the median Grade 12 GPA among CODA students is 70 and the distribution is as follows: 14% of students have a GPA of less than 60; 39% have a GPA of 60 to 70; 35% have a GPA or 70 to 80; and 12% have a GPA of more than 80.

All of the coefficients for this variable, save that in column 8, are significant and imply sizable differences by Grade 12 GPA. For example, the coefficient of 0.022 in column 2 implies that there is a difference of 44 percentage points (0.022 times 20) in the likelihood of failing a level 1 course between a student with a Grade 12 GPA of 60 and one with a Grade 12 GPA of 80. These differences are illustrated on the left hand side of Figure 10, which shows the predicted proportion of students in the reference group failing one or more level 1 courses corresponding to values of 60, 70 and 80 in the Grade 12 GPA.

Figure 10: Predicted Proportion With Various Outcomes: CODA Programs



A difference in Grade 12 GPA of 20 percentage points is associated with differences of 26 percentage points (0.013 times 20) in the likelihood of failing to take level 2 courses ("dropping out") and with a difference of 34 percentage points (0.017 times 20) in the likelihood of taking level 4 courses ("completing the program"). These differences are illustrated in the middle and right hand side respectively of Figure 10.

We have run these same regressions using not the Grade 12 GPA but the grade obtained in Grade 12 Math in one instance and the grade obtained in Grade 12 English in the other instance. The purpose of this experiment was to see if performance in a specific type of course, especially mathematics, was a better predictor of performance in CODA program than is the GPA. The coefficient for the grade in either Grade 12 Math or Grade 12 English was almost always statistically significant but, interestingly, always had a coefficient which is about one-half the size of the coefficient for the Grade 12 GPA or less. In other words, average academic performance in Grade 12 is a stronger predictor of performance in a CODA program than is the grade in any one Grade 12 course, even a math course. In other research (Dooley, Payne & Robb 2012), we have also found the same to be true of university academic performance, i.e., the average high school grade is a better predictor of success in university than is the grade in any one course.

The other coefficients in Table 4D are generally similar to those in Table 4C, although the significance levels are generally weaker. The sample sizes in columns 6 through 9 are quite small and one should be hesitant about placing too much confidence in these. As indicated above, we also have fitness scores in reading, writing and math for about one-fifth of the CODA students. What we received from Mohawk is a binary variable indicating if there is a "deficiency" in this subject or not. "Deficiency" is defined in terms of the skills needed for the CODA program. Among students with these variables, two-thirds of the students had a deficiency in mathematics and one-third had a deficiency in reading or writing. In our regressions, a student with a math deficiency was about 30 percentage points more likely to fail a level 1 or level 2 course. A student with a reading or writing deficiency was about 14 percentage points more likely to fail a level 1 course. For other outcomes, the sample sizes were too small to have any statistical usefulness.

Summary and Comments

The primary objective of this study is to improve our understanding of which factors influence the likelihood of success in apprenticeship programs. Our data track most entrants to the apprenticeship programs offered at Mohawk College in Hamilton, Ontario, from 2000 through 2012. Mohawk offers three types of apprenticeship programs, each of which has a different pathway by which the students enter the program. One type of program includes the traditional skilled-trades apprenticeships which have two, three or four academic levels of courses and require employer sponsorship for entry. A second type is the Ontario Youth Apprenticeship Program (OYAP), which is initiated when the student is still in high school. We have only one OYAP program in our data, for child and youth workers. The third type of program begins through admission to a Co-op Diploma Apprenticeship Program (CODA), of which we have two in our data: electrical engineering and manufacturing engineering. These programs require two years of full-time study and yield both a college diploma and an apprenticeship certificate.

When we average over all (2, 3 and 4 level) traditional apprenticeships, we find that 64% of entrants take (and complete) the final level of courses within five years of entering the program. The Mohawk traditional program with the lowest completion rate, at 47%, is the roofing program. The seasonal nature of the work in this trade provides a straightforward explanation for this low completion rate.

Another benchmark for comparison is our finding that approximately 80% of students at four Ontario universities who enter a full-time program directly from high school complete a degree within six years (Dooley, Payne & Robb, 2012). These students are mostly single persons, aged 20 or less, still living at home at the time of registration. We do not have data on degree completion rates for university entrants who more closely resemble our Mohawk apprenticeship students, i.e., older, with more family obligations and less family financial support. Our suspicion, however, is that such university entrants would likely exhibit lower completion rates, possibly down near the 64% rate exhibited by Mohawk students in traditional apprenticeships.

We commonly observe that students in traditional apprenticeships take more than the minimum number of years to complete the program, but there is no evidence that this is due to academic challenges. Course failures rates at all levels are very low. Furthermore, the very low program switch rates do not reveal any serious dissatisfaction with the academic offerings. Hence, it would appear that other factors, such as changes in employment or residence, are the key reasons for slow progress or even failure to complete.

In other results for the traditional apprenticeship programs, we find that gender and census neighbourhood characteristics have little relationship with our academic outcomes. There is a common, though not universal, pattern of more course failure and less program completion among the youngest (less than 20) and oldest (40 or older) students. Finally, we report some significant coefficients for year of entry to a program, but there is no clear pattern of trends over time.

The data that we have for one Ontario Youth Apprenticeship Program, child and youth worker, present a very different and troubling picture. Course failure rates are high, the dropout rate after level 1 is 84% and only 9% of students take level 4 courses within five years of programs entry.

We analyzed data for two Co-op Diploma Apprenticeship Programs: electrical engineering and manufacturing engineering. These two programs, especially electrical engineering, have higher course failure rates and dropout rates than traditional apprenticeship programs. However, within five years of program entry, 55% of manufacturing engineering students and 43% of electrical engineering students have taken level 4 courses.

These completion rates may also compare favourably with other full-time day programs at Mohawk.[5]
The CODA programs are the only two for which we have high school grades at present. We find that average academic performance in Grade 12 is a very strong predictor of performance in a CODA program. A CODA student with a Grade 12 GPA of 80 is 26 percentage points less likely to drop out after level 1 than is a student with a Grade 12 GPA of 60. The same difference in Grade 12 GPAs is also associated with a difference of 34 percentage points in the likelihood of completing the program. These results indicate the importance of our plans to obtain high school grades for all apprenticeship students in our sample who attend Hamilton school boards.

[5] Data are currently unavailable.

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