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Ethno-Linguistic and Gender Differences in High School Selection Patterns

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Metropolis British Columbia

Centre of Excellence for Research on Immigration and Diversity

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INTRODUCTION

Access to post-secondary education (PSE) in Canada has been the subject of research and discussion for many years (Finnie, Mueller, Sweetman, and Usher 2008). Much of that work examined issues of equity and in doing so identified several groups in society that were under-represented in university and college classrooms. These included aboriginals, women, individuals from low-income families, and immigrants — the latter further differentiated by immigrant generation and ethnicity (Finnie and Mueller 2010). More recently, this situation has changed for at least two groups: women and immigrants are now enrolled at the post-secondary education level in large numbers, to the point where immigrant enrolments are proportionately greater than their representation in the general population and women now outnumber men at the undergraduate level (Abada and Tenkorang 2009; Statistics Canada 2010).

In addition to describing changes in PSE access, researchers have become interested in students' participation in so-called "STEM" (science, technology, engineering, and math) courses as these are seen as providing graduates with stable and well-remunerated employment. STEM skills are given additional importance by policy makers because of their perceived contribution to economic growth (Orpwood, Schmidt, and Hu 2012). Promoting STEM education may be of personal and national importance but developing a sufficient pool of scientific talent is an uneven process. This is seen in the marked preference for STEM programs among some ethnic groups and the equally strong tendency of many women to avoid these programs (Anisef, Sweet, and Frempong 2003; Andres and Adamuti-Trache 2007).

What factors are involved in the ethnic and gender differences observed in students' transitions from high school to PSE or more specifically, in their field of study choices? Basic elements of established PSE participation models include social structures and institutional contexts. Government policies such as financial aid and PSE admissions policies also act to facilitate or limit access. Nevertheless, much depends on the individual (Finnie, Childs, and Wismer 2011). Among the personal attributes of high school students that have been identified as important in PSE transitions is a record of high achievement. Good grades are an essential element in the admissions decisions of all PSE institutions. However, while marks or grades are important indicators of an individual's competence, doing well in the right courses is even more important. Recent evidence suggests that high school students who enrol in advanced placement courses are more likely to successfully transition to university or college. Those who have included math

and science courses have the additional benefit of being able to choose from a wider array of PSE programs, including STEM subjects (Wang 2012).

Course selection requires that students engage in a systematic process of educational planning (Sweet and Anisef 2005). Course choice typically reflects students' curricular interests and previous achievement but always benefits from knowledge of the curricular pathways from high school to PSE. This information can be supplied by teacher-counsellors or parents who have attended university or college. High school courses are quite varied in their content and relationships. Students' course selections form patterns or clusters that can (or not) facilitate a smooth PSE transition. To better organize this activity, Adamuti-Trache (2003) constructed a typology of high school course selection comprising life sciences, physical sciences, and mathematics categories and, by way of comparison, a non-science category that includes social studies, fine arts, languages, and the humanities.

PURPOSE

The gender and ethnic differences observed in PSE fields of study choice reflect individual circumstances that are present upon entry to university or college, but they will also be influenced by events experienced and decisions made much earlier in the schooling process. To the extent high school course selection patterns (CSP) anticipate those made at the PSE level, identifying significant ethnic and gender correlates of these earlier decisions would improve understanding of the high school to PSE transition.

In addition to the student's record of achievement, we would expect both gender and ethnic CSP differences among high school students to be shaped by related background factors such as family and school socio-economic status (SES) and by personal factors like age of entry and language competence.

Socio-economic status indicators include parents' education and income and represent the store of cultural and social capital that is available in the family. Students can draw on these resources in formulating their educational plans. Additional capital resources are available through interactions with peers whose personal and family backgrounds form a school SES context.

Language skills are essential to achievement in both English and math courses. Students whose first language (or language spoken most often at home) is not English are eligible for English as a Second Language (ESL) instructional support. Time spent in ESL classes may be an indicator of the student's proficiency in the academic uses of English and likely influences students' curricular choices and direction. Garnett (2010), for example, found students whose ESL instruction extended into the high school years were more inclined to enrol in advanced math courses. Many if not most of these non-English speakers will be recent immigrants who will be provided ESL support in the schools. The effectiveness of ESL will, however, depend on students' age at arrival in Canada and the school grade to which they are assigned. Acquiring competence in the academic uses of English takes several years and the opportunity to become proficient is curtailed for those individuals entering the system in the junior or senior high grades (Roessingh and Douglas 2011).

The study addresses the question: *Are there ethnic and gender differences in students' grade 12 course selection patterns?* This is first treated descriptively and then estimated using multinomial regression analysis where students' course selection patterns are examined in relation to ethnicity and gender, holding constant the effect of family and school socio-economic factors, English as a Second Language (ESL) support, and students' age-of-entry to the school system. Follow-up analyses deal with more specific differences in course choice across combined gender-ethnic groupings.

SIGNIFICANCE

The study contributes to existing research in three ways. First, by examining ethnic and gender divisions it draws attention to continuing concerns with issues of equity in PSE admissions. Secondly, in predicting course selection patterns (CSP's) at the high school level it underscores their importance in PSE admissions. Third, it acknowledges high school transitions as a developmental process and utilizes information on students' elementary as well as high school experiences. The study also includes students who enter at any time in the K-12 period introducing the effect of late entry to the analysis. Finally, it extends the analysis of student trajectories to include a particular focus on preparedness for university and college transitions in STEM fields of study.

LITERATURE REVIEW

Course Selection Patterns

Previous research indicates a steady rise in PSE aspirations among Canadian high school students (and their parents). This increase reflects the value assigned PSE in the workplace and a recognition of its role in facilitating social mobility (Davies 2005; Looker and Thiessen 2004). Aspirations have been widely used in analyses of (goal directed) student effort (Domina, Conley, and Farkas 2011); and in predicting actual PSE destinations – typically college or university but also alternative pathways including apprenticeships or employer-supported training (Finnie, et al. 2008). PSE aspirations are influenced by many factors but student characteristics such as ethnicity and gender are particularly salient. Immigrant and visible-minority youth favour university over college programs (Krahn and Taylor 2005). Additional differences emerge when gender is considered – more girls than boys aspire to a university degree while more boys than girls expect to enrol in a vocationally oriented college program (Christofides, Hoy, Li, and Stengos 2010). Socio-economic factors also play a role. In families with highly educated parents and/or those with high income levels, youth are more likely to hold university aspirations (and expectations).

A correlate of PSE destinations is the individual's assigned high school 'track'. Tracks consist of curricular programs broadly designed to develop either vocational or academic skills. Typically, tracks are assigned at entry to high school and, although they take into account students' interests and preferences, are largely determined by their record of achievement (Taylor and Krahn 2009). Like aspirations, tracks have been used as predictors of PSE destinations. The literature on tracking or 'streaming' necessarily raises concerns about equity. Many see track assignment as determining students' futures – providing avenues to further learning for some while curtailing the opportunities of others (Kao and Thompson 2003).

Both aspirations and tracks have additional limitations when used to predict and explain PSE pathways. Aspirations provide only one indicator of eventual PSE entry, and these often prove faulty guides to future behaviour. These arise because students often misjudge their academic abilities, fail to match their educational and occupational interests with the different opportunities available at universities and colleges, or lack essential information about prerequisite courses needed to gain entry to their preferred PSE program.

Reynolds, Stewart, MacDonald, and Sischo (2006) examined the relationship between stated high school aspirations and actual PSE enrolments. He concluded that many students make unrealistic self-appraisals of their ability, or lack the information needed to make appropriate course choices. Côté and Allahar (2007) also question the academic preparedness of many students who aspire to university. Davies (2005) examined the aspirations of the parents of high school graduates and similarly concluded that, based on high school marks, many of their children were not prepared for PSE, whether university or college. Rosenbaum (2001) questioned whether university aspirations are appropriate goals for all students and suggests instead that more be encouraged to pursue a vocational education – available through community colleges or apprenticeships. Frenette (2011) recently studied the PSE aspirations of Canadian high school students and their awareness of the corresponding curricular prerequisites. He concluded they were often misinformed as to the nature of the curricular preparation needed for acceptance into a PSE program.

The binary perspective (vocational versus academic) of track systems may have prepared students for entry to a largely industrialized labour force with well-defined job categories and roles. It is less relevant in current labour markets that are characterized by highly differentiated and rapidly changing occupations and driven by intense technological innovation and globalized trade patterns. The concern with science and technology in this social-economic configuration is reflected in corresponding changes to the PSE curriculum that emphasize scientific thinking and problem solving. Recent research on the link between PSE and the intellectual infrastructure of modern economies has resulted in development at universities and colleges of STEM education programs comprising science, technology, engineering, and math curricula. In turn, this has led to calls for realignment of high school curricula to match the emerging PSE opportunities represented by STEM education (Brotman and Moore 2008).

In a recent review of the antecedents of high school transitions, Crosnoe and Johnson (2011) questioned the utility of using track information to predict PSE participation and instead recommended the use of course choice pattern (CSP) as the more appropriate indicator to use in understanding linkages to the broad array of university and college fields of study on offer at those institutions. Their review of the literature indicates that students' school trajectories are more complex than the traditional view of tracking would suggest. Course choice occurs throughout the HS experience although, because of the hierarchical nature of the curriculum, early choices establish patterns distinguishable by their content and level of difficulty.

 In general, student achievement is a strong predictor of PSE access (Finnie et al. 2008). However, academically capable students also choose more advanced (difficult) courses for study. Thiessen (2009), for example, examined the HS graduates who did or did not go on to PSE and found that the most salient difference was not achievement but course choice. Those most likely to proceed directly to university had enrolled in advanced math and English classes in HS.

Advanced course work in high school math and science also allows greater field of study choice at the PSE level. Adamuti-Trache (2003) developed a high school course choice typology that is responsive to STEM requirements and when applied to Grade 12 graduates has proven useful in predicting PSE participation and enrolment in particular fields of study. The typology consists of 4 options: math, physical science, life science, and non-science. Students with advanced coursework in math and physical sciences were more likely to attend university and access the widest array of fields of study options. The typology is also sensitive to differences in student background, including gender, socio-economic status, and ethnicity – all of which have been shown to shape CSP decisions (Adamuti-Trache and Andres 2008).

Ethno-cultural Background

Ethno-cultural background predicts educational performance in Canadian schools fairly consistently. For example, Chinese students, whether indicated by home language, or region of origin, demonstrate a pattern of success across multiple studies. In Garnett's (2010) examination of British Columbia's 1997 ESL Grade 8 cohort Chinese speakers graduated more frequently than all other groups including native English speakers. Their enrolment and performance in mathematics and science were also higher than any other home language group. McAndrew et al. (2009), in their study of non-English speakers in Montreal, Toronto, and Metro Vancou-

ver replicated these findings. Garnett et al. (2008) also discovered that, of Vancouver grade 12 students who had required ESL service, Chinese students had far greater odds of enrolling in the sciences than any other home language group, and that no other group could equal Chinese mean scores in mathematics and English or overall GPAs.

The results in these studies parallel Gunderson's (2007) analyses of immigrant students in Vancouver where he found speakers of Mandarin and Cantonese had "phenomenally high" mean scores in mathematics, easily outperforming Canadian-born students; they also outper-formed all other ethno-cultural groups, including Canadian-born, across almost all academic subjects at all grade levels. Similarly, in Anisef et al. (2010), students from East Asia were less likely to drop out than Canadian-born students; and in Samuel, Krugly-Smolska and Warren's (2001) survey of Toronto and Vancouver secondary students, Chinese region of origin students reported the highest last semester mean scores. Finally, in Toohey and Derwing's (2008) report, Chinese speakers had the second highest graduation rates among ESL students in grades 10-12 in Vancouver.

Eastern Europeans also appear to be academically very successful. Romanians in Mon-treal graduated in larger numbers, and performed better in academic courses, than any other group. Similarly, Russians were top mathematics performers in Toronto (McAndrew et al. 2009). Anisef et al. (2010) in a study of dropouts from the Toronto District School Board discovered 'Europeans' dropped out less frequently than any group except East Asians. In another study of ethnicity and achievement, Eastern Europeans self-reported higher mean scores than Canadian born students (Samuel et al. 2001).

Other ethno-cultural groups are also successful. Korean speakers fared well in academic enrolment and performance (Garnett et al. 2008). Koreans and Persians have high graduation rates and mathematics and science scores in Vancouver (Garnett, 2010). However, Persians ex-hibit only average outcomes in Toronto (McAndrew et al. 2008).

South Asian groups generally have inconsistent outcomes. Punjabi-speakers gradu-ated more frequently than non-English speakers (NES) in Metro Vancouver (Garnett, 2010). South Asians' average achievement scores were higher than the Canadian-born in Samuel et al. (2001); and they dropped out less frequently than Canadians (Anisef et al. 2010). These re-sults contrast with math scores and math course enrolment rates for Tamil and Urdu speakers. Although these were generally positive in Toronto and in Montreal, Tamil outcomes were rela-tively poor in Vancouver, (McAndrew et al. 2009). Similarly, Indo-Punjabi speakers' graduation rates were problematic in Toohey and Derwing's (2008) study.

A number of other groups appear vulnerable with respect to academic outcomes. The different populations labeled 'Spanish' had the lowest graduation rates, academic course en-rolments, and mean scores in many studies (Garnett 2010; Gunderson 2007; McAndrew et al. 2009; Toohey and Derwing 2008). In Samuel et al., Latin American students self-reported low marks. Portuguese students' results are generally poor (e.g., Cummins 1997). Toronto and Mon-treal's Portuguese students had among the lowest graduation rates of ten groups in McAndrew et al. (2009).

Other groups that demonstrate an ongoing pattern of vulnerability include those from the Caribbean. They were part of the largest identifiable dropout group in Radwanski (1987).

They self-reported the lowest scores of all groups in Samuel et al (2001) and exhibited the highest dropout rates in Anisef et al. (2010). Similarly, Montreal's Creole speakers had the lowest graduation rates in McAndrew et al. (2009), and in McAndrew et al.'s (2005) study of Black youth in Montreal where Creole and English-speaking youth's graduation rates within seven years of starting secondary school were only 40%.

Vietnamese students had lower graduation rates than non-English speakers (NES) and most other ethno-cultural groups (Garnett 2010; McAndrew et al. 2009; Toohey and Derwing, 2008). Large numbers of these students 'disappeared' from the enrolment data in Gunderson (2007). Despite average to strong enrolment in academic subjects in Garnett et al. (2008), Vietnamese students' mean scores were well below other ethnic groups and the NES baseline. However, Vietnamese outcomes approached the NESs in Toronto and exceeded them in Montreal (McAndrew et al. 2009).

Finally, many Filipino students appear to be academically at-risk. Tagalog speakers' enrolment and mean scores in grade 12 academics were among the lowest of all groups in Vancouver (Garnett et al. 2008). Filipino beginner ESL graduation rates were lower than the NES baseline and lower than other home language groups; and Filipino language speakers had lower graduation rates and mean scores than NESs in Metro Vancouver (Garnett 2010; Toohey and Derwing 2008). Gunderson (2007) found Filipinos were among the two groups most likely to drop in academic mean scores once ESL support had been removed in grade 10.

Gender

Gender and schooling have been well documented in the general educational literature. The last two decades have seen a turn from concern with equality of opportunity for females to concern for males' underachievement and oppositional behaviour (Martino 2008). These issues are not unique to Canada. Females in England outperform males in General Certificate of Secondary Education exams across the full range of subjects, with particular advantage in English, the humanities and foreign languages (Warrington and Younger 2000). Boys also appear to drop out more frequently and enrol in university less frequently than girls (King et al. 2009). Indeed, boys' school difficulties have given rise to a 'moral panic' in the UK, Australia and to some degree in the USA (Francis 2008) although more recent research suggests achievement differences are greater across SES and ethnicity/race than between genders. (Corbett, Hill, and St. Rose 2008).

Discussion of gender differences in the literature generally concerns two topics – achievement 'gaps' and trajectories that typically involve analyses of graduation rates and course-program selection criteria.

In most analyses, significant gender differences are found in overall levels of achievement, favouring girls. These differences tend to be subject-specific. Language and literacy appear to be the areas where females outperform males. Ma's (2008) analysis of PISA data shows reading scores of females were higher than males in 40 of 41 countries. By contrast, boys significantly outperformed girls in mathematics in 29 of the 41 countries. These results are consistent with the typically high achievement reported for boys in math-sciences (Adamuti-Trache and

Andres 2008). Within the science area there are anomalies in the relationship between gender and achievement depending on the type of scores reported. Girls received higher teacher-assigned grades while boys obtained higher scores on standardized tests (Sweet and Adamuti-Trache 2009). However measured, gender differences in school achievement have implications for PSE participation. Drewes (2010) finds female achievement differences in high school grades accounts for much of the growing gender gap in university enrolments.

Gender effects on immigrant students' transitions to PSE suggest significant differences in graduation and in post-high school destinations. In B.C., analyses of provincial data indicate females have a substantial advantage over males in graduation rates. They also have a modest performance advantage in Math 12 and a larger one in English 12. However males appear to enrol more frequently in Math 12 (Garnett 2010). In Garnett et al. (2008), male ESL students had better odds of enrolling in Math 12, Physics 12 and Chemistry 12 than female students. However, female students had a very small mean score advantage in Math 12, a larger one in English 12, and a modest one in overall GPA.

These findings are reinforced in McAndrew et al. (2009) where female immigrant students had much better odds of graduation than male immigrant students in Montreal, Toronto and Vancouver, and better odds of participating in university entrance academic courses in Toronto. Similarly, Gunderson's (2007) study of immigrant students in Vancouver reported small advantages to females in their mean scores across academic subjects throughout grades 8-12. It is not, however, clear from any of these studies how gender intersects with ethnicity.

Socio-economic Status

A number of Canadian studies have attempted to qualify ethno-cultural differences with various indicators of socio-economic status (SES). These indicators are located at the family, school, and neighbourhood levels and include measures of financial wealth and immigration status. The general sociological literature contains many references to the relationship between family SES and school performance of children. This research suggests indicators of income and parental education have separate effects (Willms 2002). Parents' education in particular provides important transfers of cultural and social capital to children. This suggests that relatively high levels of education among immigrants can buffer the effects of low income (Sweet, Anisef, and Walters 2010). School SES and ethnic composition also play an important role in shaping children's school performance as well as their PSE aspirations (Friesen and Krauth 2008; Wells 2010). Recent literature on the relationship between SES and the school performance of immigrant and ethnically diverse youth based on Canadian data is summarized below. More general reviews and analyses are found in Finnie and Mueller (2010) and Thiessen (2009).

Anisef et al. (2010) used multilevel modeling to capture the effects on student dropout of neighbourhood level poverty, indicated by the percentage of the population in the neighbourhood living under the low income cut-off (LICO). They found the LICO variable explained two-thirds of neighbourhood level variance, which itself accounted for 13 % of the variance in dropout.

Gunderson (2007) argued that the high family SES of Chinese students in his study contributed substantially to their academic success. As evidence, he reported the better GPAs and higher propensities to remain in the school system of children whose parents entered Canada

under different entry-class categories. While limitations to the analyses of the available data constrain the findings in this study, additional qualitative evidence supports Gunderson's interpretation.

Toohey and Derwing (2008) similarly questioned the results of analyses that related SES indicators (income or wealth) to achievement when such indicators were averages across ethnic groups. They noted that the results obscured real within-group variation in wealth and so ignored the differential effects of SES on school achievement. Toohey and Derwing specifically examined whether the large influx of wealthy Asians to the Metro Vancouver region in British Columbia masked the difficulties of culturally similar and socio-economically disadvantaged ESL students. Like Gunderson, their data permitted only an estimation of family SES by immigration status and was not tied to individual students but rather 'grouped generally' (p.185). Students with home language groups most often characterized as high SES had higher graduation rates. Toohey and Derwing also reported graduation rates from high and low SES schools. Here, school SES was indicated by the characteristics of surrounding housing and, more broadly, by the subjectively described geographic boundaries — East (not wealthy) and West (wealthy). The results were mixed: while one of the high SES schools had a much higher ESL graduation rate than one of the low SES schools, the other two schools' rates were nearly identical.

Garnett (2010) used postal codes to estimate family-level income based on census data. He found almost no difference in graduation rates when he divided home language groups into high and low income categories. However, mathematics performance and enrolment was moderately better in higher income groups. Interestingly, estimated family income was a good predictor of NES students' graduation rates. Related analyses confirmed these findings across Montreal, Toronto, and Vancouver cohorts (McAndrew et al. 2009). Although a high-income advantage existed in a few groups, overall, family income was a weak predictor of participation in academic courses. In these studies, neighbourhood income was used as aproxy for family income. Despite a generally positive relationship with academic performance, income measures in any given year may not capture the availability of other financial and cultural resources immigrant families have available.

Garnett et al. (2008) found school-level SES, based on census data, was a good predictor of participation in mathematics and science courses. Students at high SES schools had much higher odds of participating in these courses (odds ratios of 1.4 to 1.7) as compared to their low SES school counterparts.

The relationship between SES (family, neighbourhood, or school) and the school performance of children and youth provides a context for more specific effects. At the school level, for example, the availability (and duration) of English as a Second Language (ESL) courses are often critical to the successful adjustment of newcomers to BC classrooms (Gunderson 2007). Since the first language spoken by most immigrant youth is not English, ESL instruction forms a foundation for academic growth in other subjects, notably English, math, and science (Garnett 2010).

Age of Entry to the School System

Language proficiency is correlated with age (and grade) of entry to the school system. The widely accepted five to seven years posited for academic language development (Cummins

1997) suggests that later arrival offers inadequate time for second language acquisition and therefore diminished academic opportunity. Certainly the literature shows that students who arrived in Canada later in their high school careers struggle more than those who arrived early in elementary school (Derwing et al. 1999; Toohey and Derwing 2008; Watt and Roessingh 1994 and 2001; Worswick 2001).

Cognitive and literacy skills established in the first language will transfer across languages to the second language, although a certain level of proficiency must be developed in the first language in order to add the second successfully (Cummins 1997; 2000). While the surface features of two languages, such as vocabulary and grammar, may be different, basic concepts in many school subjects are not language specific. Students with well-developed first language academic literacy (older learners with more schooling in their first languages) may acquire second language academic literacy quickly and more easily than younger learners. Gunderson (2007) showed that first language written composition scores were better predictors than English composition scores of high school English and Social Studies grades.

Students who arrive at an older age, then, may or may not be positioned to succeed. Indeed, Garnett (2010), for example, showed that a later age of entry was advantageous in math and English achievement when English proficiency was controlled. In other words, assuming the student was English proficient, it was better to have entered the British Columbian school system at an older age. In Garnett et al. (2008), later ages of entry also increased the odds of participation in mathematics and sciences courses. However, in this study, late entry was associated with lower mean scores in English and lower GPAs while having no significant effect in mathematics. Overall, the effects of age of entry remain unclear, especially among ethnic groups who bring with them different amounts of previous schooling and varying degrees of knowledge in different content areas.

Proficiency in Language of Instruction

Canadian research generally supports the link between academic success and proficiency in the language of instruction, although the relationship is less straightforward than might be expected. Watt and Roessingh's (1994; 2001) studies strongly indicated that students with less proficiency in English were more likely to drop out. Over 90% of those classified as 'beginner' ESL students in grade 10, the first high school year at the research site, dropped out, compared to 50% of 'advanced' ESL students.

Similarly, 60% of students enrolled in ESL in Alberta high schools failed to graduate from high school (Derwing et al. 1999). Forty percent of B.C. students who required ESL services between grades 8 and 12 did not graduate (Toohey and Derwing, 2008). By contrast the students in studies by Samuel et al (2001) and Worswick (2001), whose outcomes typically equalled or exceeded native English speakers, appeared to have achieved an English proficiency at least approaching grade level.

Garnett's (2010) study suggests that effects of English proficiency interact with ethnocultural background. He categorized all students in his Grade 8 cohort who required two or

more years of ESL service in high school as 'beginners.' Beginners among Spanish, Vietnamese, and Filipino language speakers were substantially disadvantaged in comparison with their ethnic peers in graduation rates and other outcomes. By contrast, Chinese-speaking beginners were very resilient to the challenges of low English proficiency, experiencing only a minimal decline in their graduation rates compared to the entire Chinese group.

In Garnett (2010) and Garnett et al. (2008) English proficiency is shown to have different effects across the curriculum. Students who had spent more years in ESL classes – i.e., those with lower English proficiency upon entry to grade 8 – performed better in math than English 12. Furthermore, students who needed more years of ESL were often *more* likely to enrol in senior academic mathematics than their counterparts with fewer years of ESL.

Across the three cities of Vancouver, Montreal, and Toronto, McAndrew et al. (2009) set the criterion of language-of-instruction proficiency as requiring one year or more of ESL or FSL service in high school. This measure had no significant effects across most outcomes. However, this criterion was likely not sensitive enough to assess language proficiency. Indeed the indicators of language proficiency, such as 'year(s) requiring ESL service', are only approximate in all the above studies. There are no standard criteria for exit from ESL services across jurisdictions, or across schools, and often not even among teachers in the same school.

Summary

This body of research clearly indicates significant variability in the high school to post-secondary transitions of youth when differentiated by ethno-linguistic group and by gender. It also reinforces the importance assigned socio-demographic and situational factors in predicting PSE participation by diverse student populations. However, more recent analyses demonstrate that, net of these structural factors, an individual's high school achievement and course choice are of fundamental importance to eventual PSE participation and, equally important, to their field of study choices. With respect to course choice patterns at the high school level, there is a need for a closer examination of the bases for choosing science and math courses that offer opportunities for further study in STEM areas — science, technology, engineering, and math.

METHOD

Data

Various British Columbia administrative databases are merged to form a longitudinal file that allows analyses of factors associated with students' K-12 academic achievement and high school course choice. The data sets can be linked through a unique student identifier assigned by the data provider.[1] We employ four data sets to construct a longitudinal file that allows us to

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[1]   Access to BC K-12 student data and school census data is part of a Research Agreement between the researcher and the BC Ministry of Education. The datasets were prepared by Edudata Canada based on the data specifications indicated in the Research Agreement. Edudata Canada replaced the Personal Education Number

examine individual students' progress through the BC K-12 system:

1. Student-level administrative data between 1993 and 2009

2. Foundation Skills Assessment (FSA) data: Grade 4 (1999-2003); Grade 7 (2001-2005)

3. Data on provincial Grade 10 examinable courses (2004-2008), and Grade 12 selected subjects (2004-2008)

4. Selected Statistics Canada census socio-economic indicators at school level (based on 2001 and 2006 Census)

<p style="text-align:center">Sample</p>

The student population includes those born between January 1, 1990 and December 31, 1990 who were enrolled in the B.C. K-12 school system. The most likely grade progression for this age cohort is that students enter kindergarten in September 1995, are in Grade 4 in 1999-00 and in Grade 7 in 2002-03, enter high school (Grade 8) in September 2003, are in Grade 10 in 2005-06, and graduate in June 2008 at age 18. Since students are considered "regular" students in BC up to age 19, we include an additional year of achievement data in the study. We also take into account that a few students start school at age less than 5. Thus the administrative student data will cover the enrolment period 1993-2009. This means that graduation information from 2008/2009 (one year after the normal graduation date), as well as September 2009 enrolment, is included in the data. The entire 1990 age cohort consists in N=70,655 students. Of those, 1,396 students are enrolled in British Columbia Certified offshore schools[2] and will be excluded from analysis. The population of interest consists in N=69,259 students. The sample defined for this study differs from that employed in previous cohort analyses which eliminated students who entered the system in junior or senior high school years (see e.g., Garnett, Adamuti-Trache, and Ungerleider 2008). A detailed description of the sample and the relationship of selected sample features with age at entry (to the school system) and high school completion is provided in Appendix 1.

<p style="text-align:center">Variables</p>

The variables and constructs employed in the analysis describe student characteristics, enrolment in the BC K-12 system, academic history and outcomes, ESL support, and school socio-economic status. These are described in Appendix 2 (Table A6).

The outcome variable is a four-category variable that describes high school CSP's. This course choice typology (Adamuti-Trache, 2003) is based on Grade 12 course selection that emphasizes math and science preparedness. Besides Math 12, three main Grade 12 science

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(unique to all BC students) with a unique Student ID that allows the linkage of data.

2   Students registered at a British Columbia Certified offshore school receive instruction in English by BC certified teachers. Graduates from this program are issued a British Columbia Certificate of Graduation (Dogwood Diploma).

courses that enrol the largest percentage of BC students are taken into consideration: Biology, Chemistry, and Physics. The CSP's are combinations of these four courses that reflect students' readiness to engage in PSE in science-related fields:

1. Non-science (NS): no Math 12. It includes students who take chemistry or physics courses that, however, cannot lead to a science-related pathway without a mathematical foundation. This could be the choice of students oriented toward non-scientific fields like humanities, social sciences, arts, etc.

2. Mathematics (MA): Math 12 and none of the three science courses. This could be the choice of students interested in business, commerce, finances, computer sciences, etc.

3. Life sciences (LS): Biology 12, with or without mathematics or chemistry, but no physics. This could be the choice of students interested in agricultural and biological sciences.

4. Physical sciences (PS): Math 12 is the essential ingredient of a PS pathway when combined with at least one of the hard sciences (chemistry or physics). This could be the choice of students interested in engineering and physical sciences.

The focal variables in the analysis were gender and ethnicity or ethno-linguistic group. There are twelve linguistic groups. Some merging of related languages (e.g., Cantonese and Mandarin) was necessary to ensure an adequate number of students in each of the categories.

The remaining variables were used as statistical controls in the analysis. They included: school and family SES, students' achievement record, grade level at school entry, and ESL support. All were chosen for their relevance to educational outcomes in general and course choice decisions in particular. These relationships to high school planning and PSE transitions were reported in the literature.

Prior achievement is not easy to include in the analysis without losing a significant part of the research sample. For instance, if only students with available data on FSA (Grade 4 or 7) as well as Grade 10 courses were considered, the sample would be reduced by 15%. The main problem is that the sample reduction would eliminate exactly those newcomer students who are more likely to belong to the ethnic groups of interest. Therefore, we create an 'unknown' category for achievement which labels those who are missing, mostly because they are not yet in the BC school system.

The school SES variables are based on 2001 Statistics Canada census indicators. The school level indicators are averages based on the census indicators corresponding to the home postal codes of all students enrolled in a particular school in 2001. When the matching was not possible (i.e., the school did not appear in the BC Ministry of Education 2001 Census data, or the student was not in a BC school), we chose the school closest year available. Year 2001 marks the midpoint of the BC 1990 age cohort's presence in the BC school system, which makes the 2001 Census data appropriate to describe the school SES environment over the period 1995-2008. We employed the 2006 Census data only if the 2001 Census data was not available for a particular school.

It is important to point out that BC K-12 data do not include any information on stu-

dents' place of birth. Therefore, there is no indication that students who report a language other than English or French are foreign born. Although the combined information on home language and late entry could be used as proxy for immigrant status, we avoid this assumption because ethnic students may move between provinces.

ANALYSIS and RESULTS

High school course selection patterns

The analysis is based on a research sample of N=44356 high school graduates for whom information on all variables was available. The organization of the analysis is consistent with previous assessments of educational outcomes that take into account basic social as well as student ability and effort expressed in achievement. The latter includes early, subject-specific and aggregate achievement measures. The underlying assumption is that student high school course selection patterns, defined by Grade 12 course choices, are an important complement to achievement in PSE admissions decisions. The study is grounded in previous research that demonstrated that math and science-based high school course work is not only a strong indicator of PSE participation and attainment, but also of students' PSE fields of study. It expands the research on gender in science by including ethnicity in the examination of high school course choice patterns and defining these in terms of STEM subjects.

The specific objectives of the analysis are:

a) For each ethno-linguistic group, determine the probability of their selecting courses from one of math, life sciences, physical sciences, or non-science clusters.

b) Further examine differences in course choice patterns in relation to combined ethnic-gender divisions.

We employ a multinomial logistic regression to predict course choice decisions from ethnicity and gender when controlling for early achievement, family-school socio-economic characteristics, grade level at entry, and ESL support.

Table 1 shows descriptive statistics (proportions and means) of the sample used for modeling course choice. We note that the model is based on 44,223 valid cases for which data are available for all variables. The observed proportions of the four-category outcome variable indicate that 39.3% of students are in the non-science path, 6.5% in the path, while over half of students choose science-related pathways: life sciences (33.6%) and physical sciences (20.6%). However, almost 40% of the BC 1990 age cohort do not take mathematics in Grade 12 and may only enrol sporadically in chemistry or physics. The most popular math or science-related CSP is life sciences, which is based primarily on coursework in biology.

Table 1: Descriptive statistics of variables used in the model (N=44223)

Variable name	Categories	Percent/Mean
HS course choice pattern	Non-science	39.3
	Mathematics	6.5
	Life sciences	33.6
	Physical sciences	20.6
Ethno-linguistic groups	English	72.1
	French	.7
	Spanish	.9
	Portuguese	.9
	European	2.3
	Persian	.8
	Punjabi	4.1
	Chinese (& Cantonese & Mandarin)	10.5
	Korean	2.7
	Tagalog	1.3
	Vietnamese	.9
	Other	2.7
Gender	Male	50.5
	Female	49.5
Grade level at entry	Primary	85.8
	Elementary	5.0
	Junior/Secondary	3.8
	Sr./Secondary	5.5
Percent of years in ESL programs	Continuous	.093
Early Numeracy achievement	Meet & exceed expectations	74.1
	Not meet expectations & no data	16.3
	Unknown	9.6
Grade 10 English achievement	High achievers	69.1
	Low achievers	22.6
	Failed course	3.8
	Unknown	4.4
Grade 10 Math achievement	High achievers	43.4
	Low achievers	43.4
	Failed course	7.8
	Unknown	5.4
Grade 10 Science achievement	High achievers	44.0
	Low achievers	36.1
	Failed course	14.7
	Unknown	5.2
GPA	Continuous	2.805
School SES		
Percent Population University	Continuous	.168
Percent population non-English speakers	Continuous	.115
(LN) income	Continuous	10.942*

* The corresponding median income is $56,500

Over one-quarter of the research sample has an ethno-linguistic background other than English or French. The gender composition is evenly divided. While the majority of students (over 85%) were enrolled in BC primary schools, some 5.5% of students entered the system in Grades 10-12 during their senior high school years. On average, students participated in ESL programs for about 9% of the years enrolled in BC schools.

Probabilities

We present the results of the multinomial logistic regression by showing adjusted probabilities obtained from the coefficients of the regression model and the means of the sample (see Appendix 3). Probabilities are shown for high school CSP's based on specific student characteristics of interest in the study – ethnicity and gender – when all other explanatory variables in the regression model are held at average values.

Table 2 shows these adjusted probabilities for the ethno-linguistic groups and gender categories. The first row gives the course choice probabilities for an average student profile – most likely to choose Life science (.414), followed by Non-science (.382), Physical sciences (.122) and Math (.081). The predicted probabilities are slightly different than the unadjusted observed percentages previously shown in Table 2: Non-science (39.3%), Math (6.5%). Life sciences (33.6%), and Physical sciences (20.6%). Nevertheless, there is about a 60% chance that an average student would engage in math or science-related course work.

Table 2: High school course selection probabilities				
Variables	Non-science	**Math**	**Life Science**	**Phys Science**
ALL	.382	.081	.414	.122
Ethno-linguistic groups				
English	.446	.071	.380	.104
French	.475	.119	.302	.104
Spanish	.446	.091	.387	.076
Portuguese	.431	.070	.415	.084
European	.407	.111	.371	.110
Persian	.231	.098	.487	.185
Punjabi	.252	.117	.500	.132
Chinese	.151	.101	.492	.256
Korean	.199	.134	.428	.239
Tagalog	.280	.058	.587	.074
Vietnamese	.256	.137	.450	.157
Others	.315	.099	.451	.134
Gender				
Male	.396	.099	.299	.206
Female	.342	.062	.528	.068

There is much variability in the predicted probabilities when students are differentiated by ethno-linguistic groups. The probability of choosing Non-science is higher than average for all students with European backgrounds (first five groups range between .407 and .475) and is significantly lower for non-Europeans (as low as .151 for Chinese). The highest probability of choosing Math is noticed for Korean (.134) and Vietnamese students (.137) as compared to English (.071) and Portuguese (.070). Tagalog students show the highest probability of choosing Life science (.587) as opposed to French students who have the lowest rate (.302). Finally, for Physical sciences two ethno-linguistic groups are distinguished: Chinese (.256) and Koreans (.239) as opposed to Spanish (.076), Portuguese (.084) and Tagalog students (.074).

Not surprisingly, gender differences are most visible in the choice of Life science and Physical sciences courses. The probability of choosing Life science is .299 for male students and .528 for female students, and the values are reversed to .206 and .068 for Physical sciences. These results are consistent with previous research that shows gains in women's representation in science are almost entirely situated in biology-related disciplines (Adamuti-Trache 2003).

High school course selection for combined ethnic and gender groups

Table 3 shows the observed frequency of high school course choice patterns by gender and ethno-linguistic group.

For most ethno-linguistic groups, the percentage of females is lower than males in the Non-sciences. Among males the differences across ethnic groups are more extreme. For example, there are very high percentages of male students in Non-science courses for the English and Spanish groups and very low percentages among Chinese and Korean males.

Some of the highest percentages in Math are evident for French and Vietnamese male students, or for Korean female students. Although the percentages in Math are generally higher for males, the situation is reversed for ethno-linguistic groups such as: Spanish, Portuguese, Persian, Chinese, and Korean.

Pursuing coursework in life sciences is more likely for female students: unadjusted percentages are more than twice as high for female as for male students; and this pattern is consistent across all ethno-linguistic groups. Both male and female Tagalog students are the most likely to choose life sciences. Among the lowest percentages pursuing this path are French and Korean male students, or Korean female students. Overall, life sciences are the most popular among female students, regardless of ethnicity.

Male students are consistently more likely to choose physical sciences over life sciences. In particular, Persian, Chinese, and Korean male students show large participation rates in Physical sciences coursework. The same ethno-linguistic groups appear to have high Physical sciences percentages for female students.

Table 3: Percentage of students by high school pathways, gender, and ethno-linguistic groups (row %)

Variables	Male				Female			
	Non-science	Math	Life Science	Phys Science	Non-science	Math	Life Science	Phys Science
English	51.3	7.1	20.6	21.0	41.0	4.8	45.0	9.3
French	40.9	14.0	17.7	27.4	39.9	7.4	40.5	12.3
Spanish	54.3	5.4	23.9	16.3	39.2	9.4	42.0	9.4
Portuguese	44.8	5.7	28.6	20.8	34.6	7.3	50.3	7.9
European	37.2	10.7	23.9	28.3	32.9	8.8	43.2	15.1
Persian	23.1	6.6	29.1	41.2	25.7	8.9	42.5	22.9
Punjabi	38.6	10.7	28.6	22.2	25.4	5.8	55.3	13.4
Chinese	9.5	5.9	23.2	61.4	8.4	8.0	44.4	39.1
Korean	8.4	9.5	15.5	66.6	12.0	11.5	29.9	46.6
Tagalog	31.8	7.2	44.4	16.6	24.3	3.3	60.7	11.8
Vietnamese	33.5	12.6	27.5	26.4	20.9	7.6	52.6	19.0
Others	36.4	9.8	24.8	29.0	31.0	6.2	44.5	18.3
ALL	**43.6**	**7.4**	**21.7**	**27.2**	**35.1**	**5.6**	**45.1**	**14.1**

Figure 1 shows the high school course choice distributions by gender for the two most populous ethno-linguistic groups -- English (about 70% of the research sample) and Chinese (about 10% of the research sample), and All Other ethno-linguistic groups. These results demonstrate marked differences between the groups: 85% of the Chinese students, regardless of gender, engage in life science or physical sciences. In the case of English students and for all other ethno-linguistic groups, these rates are clearly lower. Preparedness in math and science is a good indicator of readiness for post-secondary education especially at university level. As expected, there is a gender effect for all ethnic groups: female students are dominant in life science and male students in physical sciences. However, almost 40% of Chinese female students engaged in physical sciences, which is significantly higher than the percentage of male students in English of All other groups.

Figure 1: High school course choice patterns for selected ethno-linguistic groups by gender
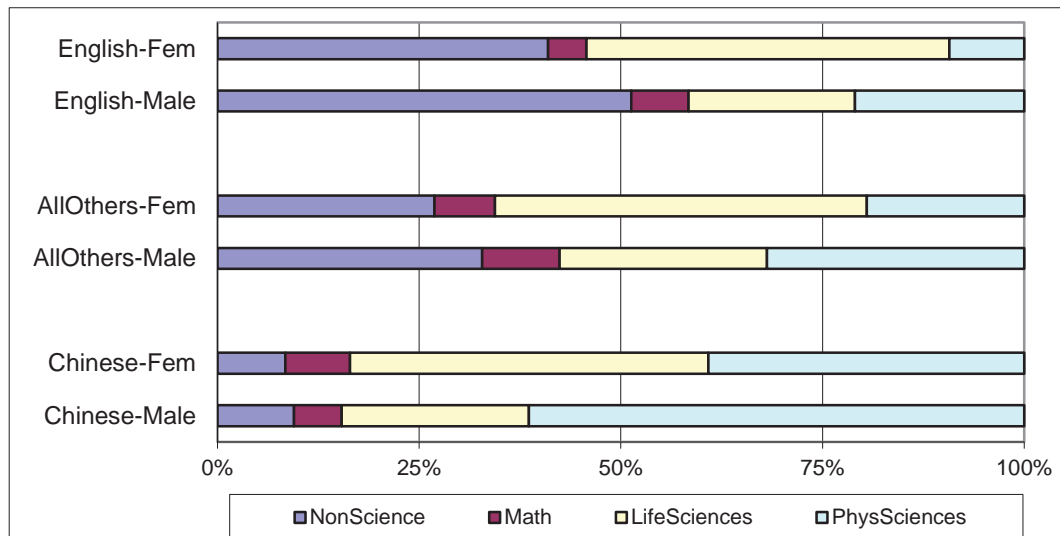
SUMMARY

Post secondary education (PSE) systems are characterized not only by institutional type (university or college), but also by field of study (Davies and Hammack, 2005). Field of study choices are of some consequence. At the college level they prepare individuals for direct entry to specific occupations; at the university level they determine entry to various professional schools or graduate study programs. PSE fields of study are diverse in their content and distinct in their intellectual origins and traditions, but they are increasingly being described in terms of their relationship to technology and its effects on economic organization and social structure. The emerging perspective on PSE curricula is stated in terms of "STEM education" and denotes the content and concerns of three broad fields of study: mathematics, the physical sciences, and

the life sciences.

Meeting the entrance requirements for PSE fields of study in either (or both) science or traditional liberal arts courses assumes the necessary plans and investments were made early in the individual's high school experience. Specifically, these preparatory strategies involve taking a sequence of courses linked to college or university programs, as well as achieving the required grades (marks) in those courses. Senior high school course selection patterns (CSP) are viewed as comprising four domains: Math, Physical Science, Life Science, and Non-Science. We use CSP's rather than students' PSE aspirations or the high school curricular track to which they were assigned. CSP's are assumed more closely aligned with the dimensions of post-secondary STEM education and therefore more informative with respect to the eventual PSE pathways of students.

The analysis compared the CSP's of ethno-linguistic and gender groups, controlling for the effects of family and school SES, students' prior achievement, as well as their age at school entry and whether or not (and for how long) they received ESL support.

Course selection patterns varied widely across ethnic groups in the study. There were, however, some obvious group preferences. After controlling for the variables in the regression, relatively few students were likely to choose coursework based on mathematics,. Those groups most likely involved in math-science areas included the European and French-speaking students and students speaking Punjabi, Korean, and Vietnamese. Those most likely involved in Physical Sciences which rely on prior and/or concurrent mathematics coursework – the Chinese and Korean speakers -- were also those least like to be involved in the Non-Sciences. Chinese speakers were also highly likely to choose life sciences courses, as were Persian, Punjabi, and Tagalog speaking students. These results indicate a greater degree of interest in and commitment to the study of the Physical Sciences among Chinese and Korean students than all other groups. However, Chinese students were also more likely than most other groups to choose the life sciences.

Gender by itself plays a predictable role in relation to students' course choices. Males were more likely than females to undertake coursework in the physical sciences while females were more likely to enrol in the life sciences. Interestingly, males were more likely than females to enrol in non-science courses.

We next examined more closely the course choices of groups formed by combining gender and ethnicity information. These are results that do not control for the effect of other variables but do show gender differences in students' course choice patterns for each ethno-linguistic category. Here, English-speaking students are the largest student group, and so establish a 'baseline' in the pattern of course choices. For this group, males more than females favour the non-science courses; and within the science areas, English-speaking females prefer the life sciences while males prefer the physical sciences. The greater number of females in the sciences suggests the possibility of change to the current stereotypical field of study choices made by women at the PSE level (Andres and Adamuti-Trache 2007). There is a distinct ethnic dimension to the relatively large number of female students who choose science courses – large numbers Punjabi, Tagalog, and Vietnamese-speaking females chose courses in the life sciences; and females who spoke a European language were similarly inclined to choose courses in the life sciences. Of particular note is the large proportion of Chinese and Korean-speaking females who selected courses in the physical sciences.

This study extended existing analyses of the relationship between ethnicity, gender, and school performance. By examining course choice patterns we add an important outcome to the analysis of students' educational trajectories and transitions. We also contribute to the assessment of educational equity by relating high school course choice to ethnicity and by qualifying this relationship with the additional consideration of gender.

LIMITATIONS OF THE STUDY

The data for this analysis employed provincial government administrative data. Because B.C. does not gather the relevant information, it was not possible to identify immigrant status. Having information on ethnicity alone ignores the adjustment period that is necessary for the successful integration of immigrant children in schools. Both types of information are needed. Further, immigrant status requires disaggregation – usually by ethnicity or region of origin – in order to be meaningful in social analyses.

The data used in this analysis were obtained from administrative records and did not contain any information on personal perceptions, attitudes or dispositions. Subjective factors play an essential role in individual decision-making, and their absence from this analysis limits our ability to more effectively predict high school course choice patterns and, ultimately, PSE pathways.

POLICY AND PRACTICE

These results suggest at least two areas of policy and practice where change could improve the opportunities for adolescents to expand their curricular opportunities. In the analysis, ethnic differences remain a significant factor in course choice despite holding other relevant variables constant. This indicates that factors such as cultural values present in families and ethnic communities exert considerable influence on the school engagement and accomplishments of children and youth. In some ethnic communities, educational effort and investments in future learning – i.e., post-secondary education – are important and consequently encouraged by parents. Others have different priorities or may value alternative pathways involving workplace training or apprenticeships.

While all parents hope their children will do well in school, not all have the inclination or means to foster the necessary skills and dispositions for academic success. How to align the home learning environment with the operating principles and practices of the school in a diverse society is a challenging task (Suarez-Orozco, Suarez-Orozco and Todorova 2008). One of the principal conduits for effective home-school communications is the homework assignment. Homework allows for participation by teachers, parents, and students; and programs exist that promote this three-way interaction (Epstein and Lee 1995). In such supportive relationships, homework can be embedded in a larger strategy of parenting that not only encourages children's immediate commitment, but is also directed more generally toward planning for their educational or occupational futures. However, additional efforts are needed to include ethnically diverse immigrant families in effective home-school partnerships aimed at improving learning (Sweet et al. 2007).

Many of the non-English-speaking students in the sample are recent immigrants. Age at school entry largely determines the availability of ESL instruction. For those entering in high school, there is too little time to acquire an *academic* language competence (Roessingh and Douglas 2011). Garnett (2010) suggests special programming for these students that would merge ESL and content area instruction.

The analysis shows that, in general, gender differences in course choice follow an expected "stereotypical" pattern (Andres and Adamuti-Trache 2007). There are, however, variations across ethnic categories. Among some cultural groups, girls are strongly encouraged to plan for PSE, and family resources are made available for this purpose. In others, females are viewed as less deserving or entitled and lack encouragement or any significant investment of family resources. Here the task facing educators is how to raise and level the learning bar imposed by the combined cultural differences of gender and ethnicity. Boys and girls, then, vary in their course choice patterns, and the analysis in this report shows that ethnicity imposes further variability in decision-making.

Course choice is largely dependent on achievement; and boys' achievement is consistently below girls, especially in language courses. This limits their access to advanced coursework (Drewes 2010). However, although boys also received lower grades than girls in their grade 8 and grade 11 science courses, they outperformed girls on standardized tests (Sweet and Adamuti-Trache 2009). How to improve boys' performance in language and better align girls' grades and test scores while taking into account ethnic differences are substantial educational challenges. There is much debate around 'gender-specific' instruction, and science educators are exploring innovative ways to present science material to students using experiential learning methods. Others propose developing curricular materials based on the notion that females 'do science' differently (Brotman and Moore 2008; Duschl 2008)

FUTURE RESEARCH

There are particular issues arising from this analysis that should be addressed through further research. These include an examination of the process by which students develop curricular interests that lead to the investments seen in their course choices. Most models of high school planning and preparation are focused on the antecedents of PSE institutional choice (Hossler, Schmit, and Vesper 1999; Louie 2005). Recent research by Finnie, Childs, and Wismer (2010) indicate that PSE students typically decide they want to attend PSE at a young age – in most cases before they reach grade 9. Many adolescents do not, however, possess the information about PSE prerequisites to focus their interest and strengthen commitment to a curricular course of action (Frenette 2010).

Our sample was constructed to include students who entered the system at any time before graduation. This raises another area of concern in relation to course choice: the relationship between entry period and (math) preparation for post-secondary STEM program success. Many immigrant adolescents come from education systems that teach math more intensely or more effectively. This confers an advantage in planning and choosing a sequence of courses that varies in content and complexity (difficulty). How these previously acquired competencies in math compensate for English language unfamiliarity and facilitate course choice requires re-

search with more detailed and personalized data.

This study focussed on graduates and their PSE plans as enacted in course choice patterns. However, many immigrant students whose first language is not English leave the system before graduating (Gunderson 2007). These "dropouts" represent a significant talent loss with implications not only for the economy, but also for their own integration into society (Campolieti, Fang, and Gunderson 2009; Plank and Jordan 2001; Trusty and Harris 1999). One of the first tasks in addressing this issue is to identify those who leave the system. The current data set allows students to be located at school entry and identified at significant testing intervals throughout the K-12 grades, which may be adequate to track students from entry to leaving.

This study lays the groundwork for a second analysis that extends the educational trajectories of respondents to the PSE years. Phase 2 of this project will employ Student Transition Program (STP) data obtained from the B.C. Ministry of Advanced Education and merge these with the existing file to form a longitudinal database. These combined data sets will allow analysis of students' elementary-high school learning conditions and academic performance and their subsequent transitions to specific PSE institutional types (colleges and universities) and fields of study.

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Appendix 1: Constructing the Sample

Ethno-linguistic diversity

For several years, British Columbia has been the second province after Ontario in terms of the number of 'new' immigrants in its population. These are immigrants who come primarily from non-European home countries, and their numbers have grown steadily: as a proportion of the total BC population, immigrants comprised 22.3% in 1991 and 27.5 % in 2006 (Statistics Canada 2010). This diversity is reflected in the ethnic composition of students in the BC schools, as shown in Table A1. For instance, 28.4% of students in the BC 1990 age cohort reported a language other than English at least once during their registration in a BC school – a percentage quite similar to the Statistics Canada data. The other 71.6% of students reported only English for each year of BC school registration. The second most reported language is Chinese (9.4%), which includes Mandarin and Cantonese, followed by Punjabi and Korean (3.2%), Spanish (1.5%), Tagalog (1.2%), French and Vietnamese (1%), Portuguese and Persian (.9%), other European languages (2.8%) as well as non-European languages (3.3%).

Table A1: BC 1990 age cohort – Counts and percentages of ethno-linguistic groups		
	All	
	N	Column %
English	49600	71.6
French	688	1.0
European	1954	2.8
Spanish	1048	1.5
Portuguese	646	.9
Persian	590	.9
Punjabi	2220	3.2
Chinese	6506	9.4
Korean	2221	3.2
Tagalog	831	1.2
Vietnamese	665	1.0
Others	2290	3.3
ALL	69259	100

The focus of the study is the examination of the twelve ethno-linguistic groups that portray the ethnic diversity of the BC student population. Although reporting a home language other than English or French does not indicate students were born outside Canada, it may indicate they either use the language significantly at home or are willing to identify with the specific ethnic/linguistic group. Similarly, there could be students who report only English as their home language but are foreign born. In their case, consistency in self-reported home language over the entire presence in the BC school system indicates that English is the language mostly used in their homes and/or the language they identify with. For the purpose of this study, when a language other than English is reported at least once, the student is placed in the corresponding language group. A number of students reported more languages other than English. In such cases, the

language most often reported is chosen.

Ethnicity and late entry

Although late entry into the BC school system is not a certain indicator of being an immigrant, the entry-level information is evidence that the student has been exposed to other provincial or national education systems. Whether exposure to different school cultures creates an advantage or a disadvantage in high school course selection decisions and further PSE choices is an issue to be explored. Nevertheless, such exposure contributes to enriching student's experiences about schooling and understandings of education. Students bring these diverse experiences into their new schools and these experiences enrich the BC school culture.

As expected there is an association between late entry into BC schools and ethno-linguistic groups, as shown in Table A2. For instance, almost 90% of the English-speaking group register in a BC school in primary grades and only 10% arrive later. A similar pattern is noticeable for the Punjabi and to some extent for the Vietnamese groups – ethnic groups who possibly came to Canada during earlier immigration waves. However, over 20% of Europeans (most of them from Eastern Europe), Spanish, Portuguese, Chinese, and Korean students enter the BC school system during their senior secondary school years (Grade 10 or later). The data suggest that it is more likely for ethno-linguistic groups such as European, Spanish, Persian, Chinese, Korean, or Tagalog to have received significant part of their education outside Canada.

Table A2: Grade level at entry by language groups (row %)				
	Primary	**Elementary**	**Junior Secondary**	**Senior Secondary**
Approx year (grade progression)	1995-1999*	2000-2002	2003-2004	2005-2007 (2009)*
English	89.7	2.9	2.3	5.2
French	73.1	7.7	5.5	13.7
European	56.6	8.4	5.1	29.9
Spanish	52.5	9.7	10.5	27.3
Portuguese	74.1	1.9	1.1	22.9
Persian	51.4	17.6	12.5	18.5
Punjabi	86.9	4.8	2.3	6.0
Chinese	56.0	11.8	9.5	22.7
Korean	15.7	30.9	31.0	22.4
Tagalog	51.9	20.0	9.4	18.8
Vietnamese	82.3	10.1	2.9	4.8
Others	58.5	11.2	7.5	22.8
ALL	80.4	5.6	4.4	9.6

Administrative data go back to year 1993 to include 'very early' kindergarten enrolments and go until year 2009 (last year available) to include late regular school enrolments (students who did not graduate by age 19 are further enrolled as adults).

Exposure to the BC school system

Information on the grade level when students were last enrolled in a BC school (before reaching age 19) will be used to identify transfer and dropout students. Table A3 shows some ethno-linguistic group differences with respect to grade level at exit from the BC school system. Since not all students follow the strict grade progression, some may not have reached high school graduation by June 2008 when the majority finish Grade 12. However, we notice that about 87% of the English-speaking group (reference) are exiting the system during their senior secondary school year (with or without graduation). The French-speaking group is quite differ-ent because of the relatively large proportion of students who move out of the system during their primary grades. Korean, Spanish, and Vietnamese-speaking students are also likely to leave the system before reaching the senior high school year.

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Table A3: Grade level at exit by language groups (row %)				
	Primary	**Elementary**	**Junior Second-ary**	**Senior Second-ary**
Approx year (grade progres-sion)	1995-1999*	2000-2002	2003-2004	2005-2007 *
English	6.9	3.2	3.0	86.9
French	16.1	8.0	4.5	71.4
European	6.8	3.4	2.7	87.2
Spanish	5.4	5.7	10.2	78.6
Portuguese	2.9	2.0	1.7	93.3
Persian	5.8	3.4	3.4	87.5
Punjabi	2.3	1.4	1.2	95.1
Chinese	4.9	2.9	1.9	90.3
Korean	2.8	7.4	14.6	75.2
Tagalog	2.4	1.8	1.7	94.1
Vietnamese	6.6	9.2	4.7	79.5
Others	8.4	6.2	3.8	81.6
ALL	6.5	3.5	3.3	86.7

Administrative data go back to year 1993 to include 'very early' kindergarten enrolments and go until year 2009 (last year available) to include late regular school enrolments (students who did not graduate by age 19 are further enrolled as adults).

There is a visible ethno-linguistic group pattern in the above entry/exit patterns, al-though they can be caused by multiple unknown factors (i.e., out-of-province migration, school dropout). As a result, the average age ranges within which students from various ethno-lin-guistic groups are present in the BC school system during a seventeen-year period (1993-2009) vary (see Figure A1). Although the average age at exit (about 16) is quite similar for all groups, there is significant variability of age at entry ranging from six-year-old for English-speaking to thirteen-year-old for Korean-speaking students. Age (or grade level) at entry may affect student education trajectories and high school course choice as a result of differential exposure to either

single (BC) or multiple education systems.

Figure A1: Presence in the BC school system by language groups
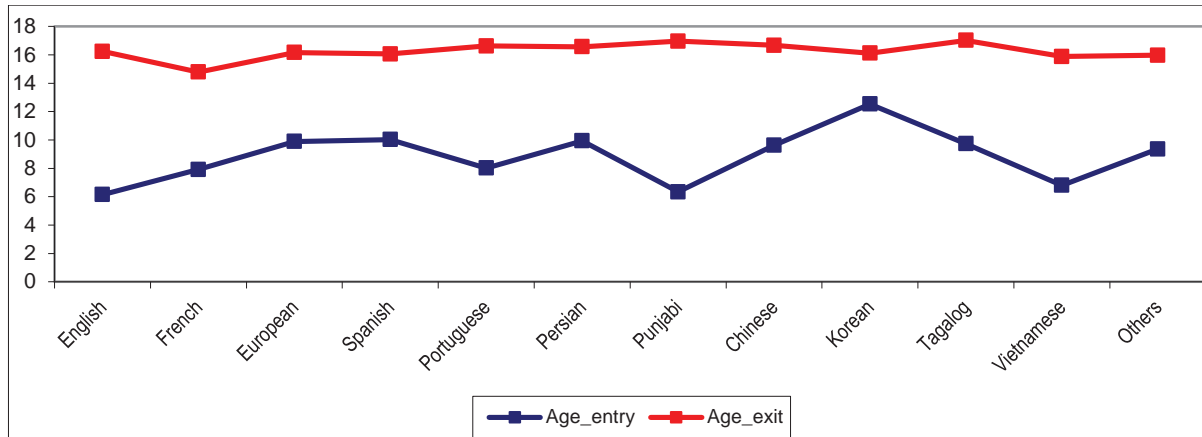
Ethnicity and high school completion

Some students transfer from the BC school system to other jurisdictions: we make the assumption that transfer students are those who exit the system during Primary or Elementary grades, during Junior Secondary in all years except 2009 (otherwise, they are still in school), or during Senior Secondary before 2005 (when students progressing normally were expected to start Grade 10). Table A4 shows that, overall, 13.3% of the age cohort meets these criteria. The other students are classified as 'non-completers' or 'completers' depending on whether they graduated or not by 2009. Overall, 64% of the 1990 age cohort has completed high school, and 22.7% are non-completers. Table A4 shows the distribution of these three school trajectories by language groups. It reveals the high mobility of French, Korean, and Vietnamese-speaking students – over 20% of them are likely to transfer from the BC schools. This contrasts with the less than 10% of Portuguese, Punjabi, and Tagalog-speaking students who leave the system during the early grades.

Table A4: School trajectories by language groups (row %)			
	Transfer	**Non-completers**	**Completers**
English	13.1	22.4	64.5
French	29.1	23.4	47.5
European	13.0	33.7	53.3
Spanish	21.6	40.6	37.8
Portuguese	6.7	34.1	59.3
Persian	12.7	26.1	61.2
Punjabi	4.9	13.8	81.3
Chinese	9.8	18.5	71.7
Korean	25.0	20.6	54.3
Tagalog	5.9	24.1	70.0
Vietnamese	20.5	20.5	59.1
Others	18.4	29.3	52.3
ALL	13.3	22.7	64.0

When graduation rates are calculated, the 'transfer' students are eliminated from the analysis which leads to a total of N=60075 students. Table A5 contains the counts and percentages of the BC student population that is likely to reach the graduation years in the province by high school completion status. Overall, the ethnic composition of the BC student population is quite similar to the original age cohort – shown by comparing percentages in the last columns of Tables A1 and A5: Both profiles consist of almost 72% English-speaking and 1% French-speaking students and over 27% of students who speak a language other than one of Canada's official languages at home.

Table A5: Student population by high school completion (as of 2009) and language groups						
	Non-completers		**Completers ***		**ALL**	
	N	% (row)	N	% (row)	N	% (col)
English	11122	25.8	31999	74.2	43121	71.8
French	161	33.0	327	67.0	488	.8
European	659	38.8	1041	61.2	1700	2.8
Spanish	426	51.8	396	48.2	822	1.4
Portuguese	220	36.5	383	63.5	603	1.0
Persian	154	29.9	361	70.1	515	.9
Punjabi	307	14.5	1805	85.5	2112	3.5
Chinese	1205	20.5	4664	79.5	5869	9.8
Korean	458	27.5	1207	72.5	1665	2.8
Tagalog	200	25.6	582	74.4	782	1.3
Vietnamese	136	25.7	393	74.3	529	.9
Others	671	35.9	1198	64.1	1869	3.1
ALL	15719	26.2	44356	73.8	60075	100

* Percentages of completers give estimates of the completion rates by ethnic groups

Table A5 provides data on high school completion rates. Overall, 73.8% of the 1990 age cohort who attended a BC high school also graduated by 2009, when this age cohort turns 19. This value is consistent with the 75.4% BC graduation rate reported in 2008 (BC Progress Board 2009). Differences are in part related to the use of an age cohort rather than a grade cohort in our study and the way in which we labelled the transfer students. We acknowledge that we lack information on the circumstances under which students exit the school system as well as the conditions under which non-completers continue to be enrolled in the system. Therefore, rather than using the term high school 'graduation rate', we use 'high school completion by 2009'. Table A5 also shows differences in the completion rate by ethno-linguistic groups. Punjabi and Chinese students have the highest rates (85.5% and 79.5%), while European, Portuguese, and Other groups have the lowest rates (61.2%, 63.5% and 64.1%). In the case of European students, the low completion could be related to their late entry into the system. Almost 30% of European students enrolled for the first time in BC during their senior secondary grades, so they may still be attending school. About 23% of Portuguese and Other groups also arrived late in the BC school system, so they too could still be attending school.

Appendix 2: Variable list

Table A6: List of variables and constructs		
Variable set	Variable description	Categories/coding
1. Socio-demographic	Gender	2-category variable: Male=0; Female=1
	Ethno-linguistic groups	12-category variable: English, French, European, Spanish, Portuguese, Persian, Punjabi, Chinese (Mandarin, Cantonese), Korean, Tagalog, Vietnamese, Other
2. Enrolment	Grade → K-12; Elementary & Secondary Ungraded (EU/SU); Home school (HO); Graduated Adults (GR)	4-categ variables Grade Level (entry/exit): Primary (K-G4 or HO if age <10); Elementary (G5-7, EU or HO if age=10-12); JuniorSec (G8-9, SU or HO if age=13-14); SeniorSec (G10-12, GR or HO if age>14)
		Derived number years in the system
	Year entry/exit	Derived ESL_primary, ESL_elem; ESL_sec to describe whether enrolled and # years in ESL
	ESL program	
3. Academic – primary school[a]	FSA G4 Numeracy/Reading	Information combined in early achievement construct that corresponds to the latest of G4 or G7 result on NU & RE → 3-categ variables: Unknown=-1; Not meet expectations/Data not available=0; Meet/Exceed=1
4. Academic – elementary school[a]	FSA G7 Numeracy/Reading	

5. Academic – Grade 10[a]	G10 Math & English & Science	Maximum final course percent → derive 4- category variables: Unknown=-1; Failed=0; Passed/Low=1; Passed/High=2
	G10 Math Curriculum	Derive 4-category variable → Unknown=-1; Essential Math=0; Applications Math=1; Principles Math=2
6. Academic – Grade 12[a]	G12 graduation	Derive variables to indicate: Transfer=No graduation & (Exit system in Primary/Elementary grades or JuniorSec before 2009 or SeniorSec before 2005) Non-completer=No graduation & (Still in the system in 2009 in JuniorSec or still in the system in 2005 or later in SeniorSec) Completer=High school Graduate
7. School SES (2001/2006 Census)	Census variables aggregated at the school level based on students' postal codes and Stats Canada Census indicators; Use 2001 data for the 2001 school (or the closest year) and adjust with 2006 Census information when 2001 school data not available	MedianFamilyIncome_01 (use LN income) PercentPopUnivDegrees_01 PercentPopHLnonEnglish_01
8. Outcomes	Course choice patterns	Derive four-category variable for completers: Non-science (no G12Math, maybe science courses); Mathematics (G12 Math & no science); Life science (G12 BI, maybe Math or CH, no PH courses); Physical science (Math & either CH or PH) Continuous variable (0-4)
	GPA	

[a] We take into account that students may not follow the grade progression and/or may take the tests and exams before or after their enrolment in Grades 4, 7, 10 and 12. To eliminate this effect, achievement data are examined over multiple years. When students take an exam or course more than once, the best mark is used to define the outcome.

APPENDIX 3: Regression Analysis

Predicting HIGH SCHOOL course selection patterns – multinomial logistic regression (Non-science=ref)			
	Odds ratios (Ref=Non-science)		
Variables (Reference category & levels)	**Math**	**Life Science**	**Phys Science**
Ethno-linguistic groups (English = ref)			
French	1.586*	.749	.942
Spanish	1.291	1.019	.733
Portuguese	1.032	1.133	.845
European	1.731**	1.073	1.163
Persian	2.671**	2.475**	3.446**
Punjabi	2.940**	2.335**	2.254**
Chinese	4.237**	3.834**	7.317**
Korean	4.258**	2.522**	5.161**
Tagalog	1.309	2.466**	1.145
Vietnamese	3.396**	2.068**	2.643**
Others	1.996**	1.685**	1.841**
Gender (Male=ref)	.727**	2.046**	.382**
Grade level at entry (Primary=ref)			
Elementary	1.592**	1.131	1.926**
Junior Sec	1.583*	1.200	2.370**
Senior Sec	3.616**	1.833**	4.601**
Percentage of years in ESL (Scale 0-1)	1.714*	1.968**	3.979**
Early Numeracy Achievement (Meet/Exceed=ref)			
Do not meet expectations & No data	.515**	.699**	.477**
Unknown	.824	.741*	.768
Grade 10 English (High Achievers= ref)			
Passed/LowAchievers	.921	.680**	.893*
Failed	.748*	.382**	.889
Unknown	.620*	779*	.411**

Grade 10 Math (High Achievers= ref)			
Passed/LowAchievers	.990	1.173**	.456**
Failed	.596**	1.053	.210**
Unknown	1.288	.781*	1.122
Grade 10 Science (High Achievers= ref)			
Passed/LowAchievers	.459**	.497**	.234**
Failed	.185**	.248**	.065**
Unknown	.363**	.487**	.427**
GPA (Scale 0-4)	2.511**	2.616**	4.731**
School SES: % population with university degrees (Scale 0-1)	2.059*	4.369**	1.351
School SES: % population HL other than English (Scale 0-1)	.661	.818	.507**
School SES: (Ln) Median family income	1.840**	.803*	1.535**

* $p < 0.05$; ** $p < 0.001$