A Landscape of Choices: The Academic Journeys of 15 University Students

by

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Ethics Statement

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Abstract

This thesis describes the life experiences of 15 young people as they transitioned from being students in K–12 schools into university and college-level studies. The research was conducted at a regional university located in British Columbia, Canada. The thesis focuses on how the study and career plans of the participants changed directions from high school into university. Specific attention was paid to understanding the various factors that were perceived by the participants as having been significant influences on their plans for academic studies and for future careers. The participants in the study were recruited because they had initially intended to major or focus their studies in fields of science or science-related professions. The interview conversations also explored why some participants had persisted in their pursuit of sciences after entering university while others had decided to change emphasis from science to non-science programs. The interview conversations reveal the complex life spaces through which the students navigate as they developed their university programs and experiences. The interview data also demonstrates that many students currently enrolled in university also engage in significant part-time work and that they have various forms of engagement with their families and communities outside campus life.

Keywords: Persistence, STEM, Science Education, Major choice, Phenomenological interview, Tinto, Astin.

Dedication

To Susan, Madison, and Hayden,

You are proof miracles do come true. I couldn't have done it without your love and support.

I would also to give a special thank you to my Mom and Dad for always believing in me and making the effort to set me up to succeed.

I love you all so much!

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My thanks are also extended to my committee — your time and dedication were greatly appreciated.

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List of Acronyms

AP   Advanced Placement

BC   British Columbia

BCRU   British Columbia Regional University

BSc   Bachelor of Science

BSN   Bachelor of Science in Nursing

GPA   Grade-point average

I-E-O   Inputs–Environment–Output Model

K–12   Kindergarten to Grade 12

NSERC   Natural Sciences and Engineering Research Council of Canada

NSSE   National Survey of Student Engagement

OECD   Organization for Economic Cooperation and Development

STEM   Science, Technology, Engineering, and Mathematics

1. Introduction

1.1. Purpose of the Study

Working in post-secondary for the last 15 years, I have assisted students at many different points of the student-life cycle and have learned that students are always challenged with the transition of moving from high school to university. While the transition itself sounds simple enough, the data show that regardless of major choice, students must overcome a variety of challenges. In conducting the research for this thesis I explored the perceptions of a group of university undergraduate students regarding their experiences in moving from pre-college school curricula into a regionally based university.

The initial focus of the study was to examine the factors that were influential on participants' choices to study courses and programs in the areas of science, technology, engineering, and mathematics (STEM), and also to discover their reasons for either persisting with or changing directions in their major studies. This inquiry was also conducted in an effort to develop an understanding of participants' future goals post graduation from university. The stories of the 15 participants in the study revealed not only their choices and decisions around studies in science- and mathematics-related university subjects and programs, but also the circumstances that affected their choices of university, their level of engagement with the university as a learning environment, as well as their larger life experiences and demands during the transition.

My purpose in writing this thesis was to examine common themes across the various participant descriptions and to show unique elements in the personal narratives. The interview conversations were framed somewhat chronologically into three broad phases: (a) participants' education and life experiences prior to entering the university, (b) their university experience, and (c) participants' future plans and directions.

1.2. Personal Context

From 2002 to 2008, I was an Academic Advisor and Director of the Science Advice Centre for a regional university, which I will refer to throughout this report as British Columbia Regional University (BCRU). In that role, I worked with students who entered the university with different diverse academic backgrounds and with intentions to pursue of a variety of academic programs. For example, BCRU's Bachelor of Science (BSc) program generally attracted students with a strong secondary school background in science and mathematics. However, I noted that students entering the BSc program with similar levels of secondary school academic preparation, including some students with A-grade averages, ultimately chose to switch to non-science majors. In other cases, students with the minimum requirements for high school graduation would enter BCRU and flourish. At the time there seemed to be no way of knowing which students would persist and complete a degree and which students would leave. I began to wonder what factors and experiences had the greatest influence on students' decisions to enrol in the university and persist to degree completion. Further, I wondered about the factors that might influence their decisions to switch directions in pursuit of degree major.

1.3. Description of the Study

The thesis presented here is a qualitative phenomenological study examining the factors that were seen by the participants as being important influences on their educational journeys. The research conducted for the thesis was designed to explore the perceptions of a group of university undergraduate students as they reflected on the transition from secondary school and other post-secondary experiences into university programs.

The study describes the results of a series of one-to-one interviews with two groups of university students, reflecting the initial focus of the research to explore of the factors that had influenced their decisions in choosing to enter the sciences and persist in that choice with the goal of earning a BSc contrasted with the experiences of those who entered science programs initially but changed their majors from science to a non-science areas. However, as the interviews progressed, the conversations yielded rich information

in areas beyond the original focus of my study on the decision to either persist or not in a science major.

The semi-structured nature of the interviews permitted students to move the conversations into directions and topics of personal interest and significance. Thus, participants often offered their perceptions about why they chose to further their education, why they chose a regional university versus a large provincial research university, as well as comments regarding how their educational choices integrated with their overall life experiences and demands. The following topics were employed as broad frames for the one-on-one conversations with the student participants:

1. How do you describe your general school experience from elementary school through to high school? Did you have a favourite subject as you moved through school? How did you feel about your experiences with school science and math?

2. What factors did you consider when choosing your major at university?

3. Has your university experience so far been what you expected? Has it been different from high school?

4. Do you have a favourite subject (or subjects) in your university program now?

5. Are you planning on continuing with your current choice of major?

To provide context, in writing the thesis I also reviewed current research on the factors affecting students' choice of majors and specifically influences on decisions to pursue college-level science education. Additionally, current research on student persistence and retention in university studies in general was also reviewed.

Information about persistence in science degree completion is limited. I attempted to make no presumptions about the factors that might be involved, and I used the framework outlined in the list presented above in the semi-structured interviews to learn more about the participants' personal journeys from their pre-university educational and life experiences and through the transition into BCRU and their experiences in the university environment. I used a phenomenological approach on the basis that the participants were viewed as best positioned to comment on the meanings of their lives

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and academic experiences and to consider the weight they gave to those experiences when deciding their choices of major.

1.4. Overview of the Study

The main questions originally addressed by the study were: Why do students choose to enter and complete a STEM-related university major? The sub-questions related to the main question were as follows:

1. What influences do students who enter university intending to major in sciences or science-related fields perceive as having affected their choices of major?

2. What influences do students who have chosen to change from science and science-related majors perceive as having been influential on their choices to change programs?

3. Have students' plans for post graduation studies or career choices affected their decisions to persist with science majors or to change from sciences to non-science fields?

As noted above, during the interviews, students' descriptions of their education experience from Kindergarten to Grade-12 (K–12) schooling into university revealed a rich variety of experiences and an array of factors that affected their choices in proceeding to post-secondary education. While many of the participants had intended to pursue studies in sciences at the university level, some were less clear in their directions from entry to university, while others clearly elected to change from science to non-science studies. The interviews showed that the factors affecting students' educational choices were complex, with some being grounded in the university experience, and others being influenced by family, peers, and work experiences outside or prior to university. Some students' choices were influenced by very practical factors, such as general lifestyle, personal life situations, or the demands of commuting distances.

This chapter described the purpose of the study, provided the personal context, and offered a description and overview of the study. Chapter 2 provides a literature review

on the topics of student majors and career choice as well as student persistence in and engagement with university studies and with the university experience. The methodology of the study is discussed in detail in Chapter 3, and a profile of the BCRU is provided to set the context of the study. Chapter 4 provides profiles of each of the interview participants. Also in Chapter 4, I attempt to present the students' voices in reporting the results of the interviews. Chapter 5 includes the results of the interviews and is organized by the interview topics and emergent themes. Chapter 6 offers an interpretation of the study findings, discusses the limitations of the study and possible directions for future research, and suggests possible policy implications from the results.

2.   Literature Review

2.1. Overview and Introduction

This chapter provides a review of the literature with respect to the topic of student engagement, persistence, and retention of a choice of major within a college or university. For this study I have reviewed student persistence research on models that focus on both student characteristics prior to and upon entry into the institution and the impact of an institution's environmental factors on a student's choice to persist. A number of the studies outlined in this chapter have provided the foundation for research on student departure and have explored both the environmental and sociological factors that impact students' choice to persist in their college or university programs of study. Furthermore, I also sought to explore why students choose to enter and persist in the sciences, or leave the sciences for other majors or areas of study. I have also included a definition of STEM programming and compared the factors described as affecting persistence and retention within the sciences.

I will also make an effort to distinguish between the concepts of retention and persistence. Andres and Finlay (2005) have noted that many studies have focussed on what schools can do to help prevent students from dropping out (i.e., on student retention). For example, Tinto's model (1993) focussed on an institution's ability to retain students by creating an environment that allows them to integrate both academically and socially. However, most studies have not focussed on the sources of the students' determination and internal motivations for persisting with their chosen programs. This thesis explores the perspectives of 15 students during their period of transition into a university to learn from them about their motivations and decisions about continuing in particular program choices or deciding to change directions. Crissman Ishler and Upcraft (2004) claimed that the belief persists that students who enter university and have basic academic ability will maintain an adequate grade-point average (GPA) and will sustain their level of performance through to degree completion. However, academic ability and work ethic are not the entire story, and many factors play a role in student persistence (Crissman Ishler & Upcraft, 2004). A goal of this thesis was learn more about student persistence within the context of a BCRU and describe the variables that influence students' choices to persist.

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2.2. The Construct of Student Engagement

Student engagement has been studied for years, and it has become an important way to measure the success of an institution. Despite the years of research, engaging students remains a challenge for all institutions. Kuh (2009b) does an excellent job outlining how engagement, persistence, and retention literature are all connected and have evolved over time (see also Astin, 1993; Pace, as cited in Kuh, 2009b; Pascarella & Terenzini, 2005). The literature discussed the following main elements of student engagement:

- Time on task (Tyler, 1930s)
- Quality of effort (Pace, 1960–1970s)
- Student involvement (Astin, 1984)
- Social and academic integration (Tinto, 1987, 1993)
- Good practices in undergraduate education (Chickering and Gamson, 1987)
- Outcomes (Pascarella, 1985)
- Student engagement (Kuh, Schuh, Whitt, and Associates, 1991; Kuh and others, 2005). (Kuh, 2009b, p. 6)

These researchers have all made significant contributions to the field of student engagement through their work. For example, Astin (as cited in Kuh, 2009b) "popularized the quality effort concept with his theory of involvement and its role in student achievement" (p. 6). Furthermore, Ernest Pascarella, Gary Pike, Patrick Terenzini, and Vincent Tinto have contributed scores of papers addressing different dimensions of student effort and time on task and their relationship to various desired outcomes of college (Pascarella & Terenzini; Pike; Tinto, as cited in Kuh, 2009b, p. 6).

Kuh (2009b) outlined what he referred to as the "Student Engagement Trifecta" (p. 17), which encompasses three elements:

1. Students dedicating their time and energy to educationally purposeful activity.
2. Institutions using effective practices to induce students to do the right things.
3. Institutions effectively channelling student energy toward the right activities (p. 17).

In short, Kuh (2009b) stated there is a logical connection and relationship between engagement, retention, and persistence. An engaged student, both in and out of the classroom, is less likely to dropout or leave the institution and, therefore, is more likely to persist with his or her studies and to be retained by the university. It can be argued that engagement is the cause or source of and persistence and retention are its effects.

2.2.1. *Significance of the Engagement Construct — Why does it Matter?*

The topic of student engagement has been explored at both the secondary and post-secondary level. Appleton, Christenson, and Furlong (2008) explored the different constructs of student engagement in secondary schools. Despite their focus on high school, they provided an excellent summary of how the student engagement construct developed. They stated that student engagement models were described as having a behavioural component and an emotional component. However, as researchers continued to explore the area of engagement, they learned that third "cognitive" (Appleton et al., 2008, p. 370) component of the model should be accounted for in the model. However, the engagement construct has evolved again, and it is now acknowledged as having four components with four distinct subtypes: academic, behavioural, cognitive, and psychological (Reschly & Christensen, as cited in Appleton et al., 2008, p. 370). This model aims to provide an understanding of student levels of engagement and to acknowledge the fit between the student, the learning environment, and the factors that influence the fit (Reschly & Christensen, as cited in Appleton et al., 2008, p. 370). Variables for measuring academic, behavioural, cognitive, and psychological engagement were all developed. For example, time on task and credits earned towards graduation were used as variables to measure academic engagement, while attendance and

extracurricular activities were used to assess behavioural engagement (Appleton et al., 2008, p. 372). Relevance of schoolwork to future endeavours and personal goals and autonomy were used to assess cognitive engagement, while feelings of belonging and relationships with teachers and peers were used to measure psychological engagement. It is important to understand the student engagement construct, as allows educators to learn more about the student persistence and retention puzzle.

In focusing on the engagement construct in post-secondary settings, there are numerous similarities between student engagement at the secondary and post-secondary levels. George Kuh (2009b) has extensively explored the student engagement question. Kuh (2009b) wrote,

> When the history of American higher education is rewritten years from now, one of the storylines of the first decade of the twenty-first century likely will be the emergence of student engagement as an organizing construct for institutional assessment, accountability, and improvement efforts. (p. 5)

Kuh (2009b) contended that student engagement becomes the key indicator of an institutions "health" (p. 5) or success. Furthermore, institutions use engagement leading to student persistence and institutional retention as a way to define and validate a quality learning experience. Therefore, as student retention becomes a concern for university administrators, the focus on student engagement is emphasized because systemic changes to student experiences are seen as having the potential to improve student engagement, and thus student persistence and retention. Kuh (2009b) stated,

> Institutions cannot change who students are when they start college. But with the right assessment tools, colleges can identify areas where improvements in teaching and learning will increase the chances that their students attain their educational and personal goals. (p. 6)

2.2.2. Definitions of the Construct of Engagement

Through exploring definitions of engagement it became clear that engagement is a process that has multiple dimensions. However, how engagement is defined can be driven by a person's role or position in the engagement, persistence, and retention equation. For example, Kuh (2009a) has defined engagement by taking a student's perspective:

The engagement premise is straightforward and easily understood: the more students study a subject, the more they know about it, and the more students practice and get feedback from faculty and staff members on their writing and collaborative problem solving, the deeper they come to understand what they are learning and the more adept they become at managing complexity, tolerating ambiguity, and working with people from different backgrounds or with different views. (p. 5)

Earl and Lee (1998) also described the construct of student engagement from a student's perspective: students' active involvement, commitment and concentrated attention to their own learning (p. 30). This definition reflects a need for students to have a strong internal locus of control.

However, when looking at the definition of student engagement, the role of the institution cannot be ignored. For example, in a recent Canadian Education Association report on Canadian students, Willms and Flanagan (2007) argued,

Student engagement is an important schooling outcome in its own right. It is "a disposition towards learning, working with others and functioning in a social institution, which is expressed in students' feelings that they belong to school, and in their participation in school activities." (p. 47; see also Cardwell, 2012, p. 23)

This definition reflects the need for institutions to measure student engagement as an outcome of a quality education.

2.2.3. What are the Elements or Components of Engagement?

As discussed above, student engagement can be explored from different perspectives. These perspectives may be seen as lenses through which student engagement can be viewed. I discuss the following lenses within this section: conservative traditional, social-democratic, and student centred. I also discuss measures of engagement and limitations of the construct.

A. Conservative Traditional

Cardwell (2012) proposed that the conservative traditional perspective is the most common. Proponents of this view posit that schooling is a technical problem and engagement is an instrument to effectively address schooling, achieve good test scores, enable students to go to university, and get jobs (McMahon & Portelli, 2004, p.73). This

lens finds a positive correlation between participation and achievement (Cardwell, 2012) and asserts that without a student's effort student engagement is not possible. Finn and Voelki (1993) defined engagement "in school terms as a behavioural element (participation) and an emotional element (identification)" (p. 249). Time spent on school activities is an example of one measure of participation, with identification being measured by a student's sense of belonging to the institution.

B. Social-Democratic

The social agenda, social justice, democracy, and sometime controversial matters of concern are taken up through the critical transformative lens of this perspective (Cardwell, 2012). The focus of this particular lens is the connection between a student's life and learning experiences. Portelli and Vibert (2002) explored the connections between "students' communities and the classroom" (p. 36). Portelli and Vibert coined the phrase "Curriculum of Life" (p. 36) for describing the interconnectedness of students' lives and the larger social and political contexts (p. 36). McMahon and Portelli (2004) studied engagement and called for more "focus on the relationship between the underlying goals and purposes of education in a democracy, and conceptions of engagement, teaching and learning" (p. 73).

C. Student Centred

Viewing student engagement from a student's perspective is paramount to understanding the components of engagement. Willms (2003) found that Canadian students did not have a strong sense of belonging in the school and had a low level of participation. According to the School Leavers Survey (Statistics Canada, 1993) and the Youth in Transition Survey (Bushnik, Barr-Telford, & Bussière, 2004), most students drop out because they report feeling bored or being challenged by their schoolwork. In essence, the overall lack of engagement leads to students' choosing to leave school. Willms (2003) pointed out that without understanding how school connects to the bigger picture students are less likely to attach to the institution. A key aspect of engagement from a student's point of view is relevancy, and without it students' participation in school is far less likely.

D. Measures of Engagement

Many instruments have been designed to measure student engagement with the hope of learning how to address the problem of student retention and departure particularly at the post-secondary level. Instruments such as the National Survey of Student Engagement (NSSE) are now widely used in universities in Canada and the United States. The survey explores the following areas: student behaviours, institutional actions and requirements, reactions to college, and student background information (Kuh, 2009b, p. 21). The survey is sent to first- and fourth-year students to assess their level of engagement. Participating institutions are sent their results for the NSSE and comparison data are shared on 10 engagement indicators: higher-order learning, reflective and integrative learning, learning strategies, quantitative reasoning, collaborative learning, discussions with diverse others, student-faculty interaction, effective teaching practices, quality of interactions, and supportive environment (National Survey of Student Engagement, 2015). Each indicator is measured on a 60-point scale, with each score being given a numerical weighting, a process designed to provide information to participating institutions on distinct aspects of student engagement.

Another instrument designed to assess engagement at K–12 levels is the "Tell Them From Me" survey, developed by Willms and Flanagan (2007), which provides data about student engagement, wellness, and school climate. A similar survey titled "What Did You do in School Today" explores the effects of home and school on student engagement (Willms, Friesen, & Milton, 2009) this survey focuses more on the activities in the classroom and their impact on overall engagement.

E. Limitations of the Construct

As Kuh (2009a) noted, the student engagement construct is very valuable but there are limitations to its framework:

> While it is gratifying that engagement is widely recognized as a desirable educational condition, the construct can be misinterpreted and misused. Indeed, proponents of popular ideas sometimes adopt a hegemonic, one-size-fits-all way of thinking. Student engagement is too important, as well as too complicated, for the educational community to allow this to happen. For example, as with other college experiences, engagement tends to have conditional effects, with students with certain characteristics benefiting from some types of activities more so than other students. In addition, the variance within any group of students, such as men

and women or African Americans and Latinos, is almost always greater than between the groups (Kuh, 2003, 2008). We must be ever vigilant to be sure we are interpreting and using engagement data appropriately and continue to learn more about what forms of engagement work best under what circumstances for different groups of students. (p. 19)

Kuh (2009a) made an important point that, although surveys such as the NSSE provide valuable information, institutions cannot simply take a magic-bullet approach and apply wide-sweeping changes. The information must be viewed within the context of the institution. The assessment instrument is simply a tool designed to gather data, and understanding the data is essential to making positive changes. Kuh (2009a) went on to clarify the value of instruments such as the NSSE: Institutions cannot change who students are when they start college. However, with the right assessment tools, colleges can identify areas where improvements in teaching and learning will increase the chances that their students attain their educational and personal goals. NSSE and its 2-year counterpart, the Community College Survey of Student Engagement, provide high-quality, behaviourally oriented data about aspects of the student experience that are related to student success. Moreover, the results can be used almost immediately, enabling educators to focus on areas where emphasizing good educational practice could yield more robust student outcomes. In this sense, student engagement is a construct whose time has surely come (Kuh, 2009a, p. 19). The study described in this thesis was designed to provide an in-depth look at the personal views of a small group of university students about the factors that influenced their choices of major and their decisions about whether to persist in their choices or to switch directions.

2.2.4. *Student Retention and Persistence*

A. Retention and Persistence in Relationship to Student Engagement

Engagement can be regarded as the general process by which students construct and self-manage their relationships with the university experience (Cardwell, 2012). Where engagement is high or reasonable, students can be expected to persist; where there is limited engagement or disengagement, then it is likely that students may not persist and may not be retained and will drop out (Kuh, 2009b). In short, engagement drives student persistence and ultimately retention. It is important for educators to understand that engagement is required for any student's choice to persist; however, the

meaning of engagement will differ student to student. For example, some students may require intellectual engagement, whereas others require academic or social engagement. For some students all three of the engagement dimensions need to be fulfilled in order to choose to persist.

B. The Retention–Persistence Equation

University administrators' interests in the topics of student persistence and student retention have often been driven by a combination of factors, including academic curiosity, the goal to better serve students, and economic reasons, since decreases in enrolment may have impacts on a school's overall revenue (Leppel, Williams, & Waldauer, 2001, p. 374). The development of enrolment management as an administrative division within many universities has contributed greatly to the field of research on student retention and persistence (Berger & Lyon, 2005). Andres and Finlay (2005) noted that most theoretical models explore the role of "fit" (p. 2) between students and the university environment. Andres and Finlay proposed that students enter the university with a set of characteristics, such as academic preparation, family background, and past school experiences, and each student's background impacts how they engage with the institution. Graham (2007) explored the role of students' internal locus of control and their sense of control over their own performance. Downing (as cited in Graham, 2007) used the term "creators" (p. 5) to define students who have a strong desire to change in order to create the best situation possible. In contrast, Downing (as cited in Graham, 2007) used the term "victim" (p. 5) to describe students who blame others for their situations or refuse to make changes even though their past approaches did not work out.

The term *retention* can largely be associated with processes and policies developed and implemented by an institution in order to retain students after they enrol. In other words, retention reflects the perspective of the institution in their goal to retain students (Hagedorn, 2012). On the other hand, the term *persistence* refers to decisions made by students to continue to pursue their studies within an institution or program and to eventually complete and graduate. Thus, persistence conveys more of the perspectives of students in the retention-persistence equation. For the purposes of this study, I have chosen to utilize Crissman Ishler and Upcraft's (2004) definition of student persistence situated in the retention-persistence equation and in which retention applies to students

who continue from entry to the institution into completion of their second year of studies, while persistence refers to students who continue their studies to graduate at the same institution. This definition will be used as a framework to discuss student persistence and retention.

C. Research on Retention and Persistence

Research on student retention was in its infancy in the mid-1900s, and it was not until the 1960s that the systematic study of undergraduate retention began to take shape as multiple publications appeared (Demetriou & Schmitz-Sciborski, 2011, p. 1). Important publications included Gekoski and Schwartz's (1961) article "Student Mortality and Related Factors" in the *Journal of Educational Research*, Panos and Astin's (1968) "Attrition Among College Students," and Feldman and Newcomb's (1969) *The Impact of College on Students.* These three articles became the foundation for Vincent Tinto's work, which started in the 1970s (Demetriou & Schmitz-Sciborski, 2011). Tinto (1975) articulated a theory of student departure that proposed social integration was a key component of student persistence to graduation.

As the impact of student enrolments on university budgets increased, institutions were forced to review their support services for students, and in particular for first-year students. Astin (1993) and Tinto (1993) believed that support services must be provided by colleges and universities to assist students in transitioning from high school. These authors proposed that the support services should include a series of profound academic, social, and emotional supports to assist with students' adaptation to the new environment (Astin, 1993; Tinto, 1993). Students who were in particular need of support services were those who performed below the expected academic level (Tinto, as cited in Tinto, 1993). Further complicating the support paradigm was the fact that an increasing number of students were not taking full-time studies (Tinto, 1993). The reasons proposed for the different patterns of registration included working part-time and struggling academically (Crissman Ishler & Upcraft, 2004).

In 1993, Tinto theorized that students enter post-secondary education with a commitment to an institution based on an educational goal. However, that commitment could be enhanced based on the student's subsequent academic and social experiences. A positive experience helped further integration and persistence while a negative

experience contributed greatly to a student leaving the institution. An important aspect of persistence is the fact that students can choose to leave institutions for a variety of reasons such as a lack of social engagement. While many students would like to persist, their academic achievement prevents them from continuing because institutional policies require them to withdraw, as they do not meet the minimum academic standards. Early intervention strategies explored how to both prevent students from choosing to voluntarily leave the institution while at the same time trying to establish support programs that help to prevent students from experiencing any academic difficulty. To that end, Tinto (1993) advised, "The social and intellectual development of individuals, rather than just their continued presence on campus should be the goal of retention efforts" (p. 145).

Tinto's (1993) student integration model has changed over the years with the inclusion of motivational goals such as commitment (see also Demetriou & Schmitz-Sciborski, 2011). Over the last decade, motivational theories from multiple fields of study, including educational psychology and social psychology, have been applied to practice in classrooms at both universities and colleges resulting in theoretical and practical changes to concepts concerning how best to approach undergraduate retention (Demetriou & Schmitz-Sciborski, 2011).

Research on student persistence indicated that the majority of student dropouts occur during or after first year (Crissman Ishler & Upcraft, 2004). This research also has moved away from judgemental language like dropout and shifted responsibility to the institution through the use of language such as retention. This distinction is important, as it indicates that institutions can help encourage if not ensure a student's choice to persist. The rate of persistence has been found to be influenced by the exclusivity of the institution. For example, first- to second-year retention rates were 19.8% higher at 4-year universities compared to 2-year colleges (Crissman Ishler & Upcraft, 2004, p. 29). This differential was even greater when private doctoral-level research universities were included in the data set. Bisset (in Nakajima, Dembo, & Mossler, 2012) has referenced the effects on retention of the so-called open-door policies of smaller institutions. Open-door policies require community colleges to provide access to a wider variety of students. The missions of these colleges support the enrolment of students who are less prepared academically and are at risk of dropping out (Bailey et al., as cited in Nakajima et al., 2012, p. 592). Particularly challenging are government requirements for accessible policies and admission criteria,

while accountability frameworks look specifically at student retention rates. At the same time, providing wider access to under-represented students can help to lead to more non-retention by these groups (Nakajima et al., 2012), unless policies that provide access are accompanied by support systems that can help students adjust to university academic and social environments (Nakajima et al., 2012).

Data provided in the *Strategic Enrolment Management Plan* for BCRU found that students who were admitted to the university under its Community Access mandate (which required that they have high school graduation or be more than 19 years of age) had a dropout rate that was 22.5% higher than that for students who entered degree or diploma programs and met the normal admission requirements.

BCRU's unique history of moving from a college to a regional-based university with a community access mandate demonstrates that students' high school background does have a role to play in student persistence, at least initially. The diverse nature of BCRU's student population offered a unique opportunity to explore the reasons students have for persisting.

2.3. Prevailing Theorists

2.3.1. Alexander Astin

Alexander Astin (1993) developed a research framework for studying college persistence by exploring what matters to college students. Astin stated that his research published in *Four Critical Years* (Astin, 1977) generated more interest than all of his other research combined (Astin, 1993, p. xi). Astin (as cited in Astin, 1993) stated that students entered university with pre-existing beliefs and characteristics that significantly influenced their expectations of university. In short, Astin (1993) sought to enhance his understanding of how undergraduate students were affected by their college experiences. He described the choice of going to college as being the most significant decision anyone can make other than getting married and choosing to be a parent. Astin (1993) proposed that the decision involves addressing three questions:

1. "Whether or not to go?" (p. 1). Should the student enrol in a college or a university?

2. "Where to go?" (p. 1). Which school, college, or university should the student attend?

3. "How to go?" (p. 1). Should the student stay close to home or live in residence away from home?

Further complicating these three questions is knowing or believing in one's ability to succeed and being able to afford post-secondary education (Astin, 1993). Astin's (1993) main theory is framed as the inputs–environment–outputs (I-E-O) model. Astin (as cited in Astin, 1993) first developed the model in 1970, with revisions in 1977. However, Astin (1993) noted that the core concepts have remained the same over the years (p. 7). He identified several "input" (p. 7) variables that refer to the characteristics students possessed upon entering college, including high school grades, admission test scores, and parental education levels. Astin (1993) viewed these factors as being useful in trying to understand students' commitments to their academic choices. In addition, Astin (1993) also identified environmental factors that may influence student success, such as size of institution, students' peer groups, choice of major field, and student involvement. The final aspects of Astin's (1993) model were the possible outcomes attained by students after they had attended university, including satisfactions with chosen major and retention. The basic purpose of Astin's (1993) I-E-O model was to assess "the impact of various environmental experiences by determining whether students grow or change differently under varying environmental conditions" (p. 7). Further, Astin saw the I-E-O model as providing educators, students, and policymakers with a better basis for knowing how to assist students in meeting their goals. A main challenge with the model is to identify the inputs and environmental experiences that can have the most significant impacts on persistence and that can be duplicated in a variety of college and university settings (Astin, 1993).

2.3.2. Vincent Tinto

Tinto's (1993) theory of interaction is one of the most discussed and reviewed theories on student departure. A student's decision to leave or dropout of an institution or

whether to persist is often driven by the student's overall situation. However, in some cases students are asked to leave an institution because of their inability to meet certain academic standards. As such, the question becomes, how can students be retained when they may or may not have been prepared for post-secondary education? Tinto's (1993) theory proposed that student departure from college or university is a process that occurs over time, and the student's ultimate decision to persist or not is affected by the types of interactions they have with peers and university personnel. Tinto (1993) claimed that the nature of these various interactions could directly influence a student's choice to remain. Furthermore, the individual characteristics of the students themselves have direct effects on how they interact with the institution, their long-term commitment to their educational goals, and overall commitment to the institution. In Tinto's (1993) model, commitment to the school is influenced by a student's academic and social integration.

As defined by Tinto (1993), academic integration, is concerned with the student's ability to engage with the formal education system (p. 106). The activities of academic integration are situated in the classroom and laboratory settings and comprise the more formal interactions students have with instructional faculty and staff in those physical settings. The social integration of students is concerned with the informal and casual interactions by students. Tinto (1993) identified locations such as residences, cafeterias, and other generally non-instructional meeting places as being important. This aspect of the theory focuses on both the social and intellectual needs of students. Tinto (1993) claimed that it was very important to understand that these two aspects of integration exist, and that a negative or positive experience in either system could lead to a student leaving the institution. It is important to understand that the meaning of a positive experience is driven by the student. For example, Walmsley, Wilson, and Morgan (2010) described a student who had a positive experience with an internship. The positive experience actually helped the student to decide to leave his original major and pursue a new major because of his positive workplace experience. The student was able to connect his college life to a workplace context. Although the student was not retained in the original major, the student persisted at the institution and was satisfied with his overall experience.

By applying his theory of interaction, Tinto (1993) tried to identify measurable variables that could be assessed in order to provide college and university administrators with data to help develop intervention programs. These included exploring the

characteristics possessed by students upon entry into the university that could impact commitment to the school as well as affecting the goal of graduation itself. Furthermore, Tinto (1993) posited that the greater the student's academic and social integration with the institution, the greater the likelihood of attaining the long-term goal of graduation (see also Braxton, Hirschy, & McClendon, 2004). In 1993, Tinto's book *Leaving College: Rethinking the Causes and Cures of Student Attrition* further explained the roles and impacts of interactions among the academic and social systems of the institution (p. 113). Tinto described integration as being "sociological in character" (p. 113), as it explores both the informal and formal environments that students interact with throughout their academic careers at an institution. In the longitudinal model, Tinto (1993) argued that individual departure is a process that takes place over time, and the combination of individual attributes and engagement with the institution's systems affects a student's ultimate choice to persist. In short, positive experiences and full academic and social integration reinforce a student's decision to persist. However, a negative experience, with little to no integration within the institution's academic and social community contributes to a student's choice to withdraw or "stop out" (Tinto, 1993, p. 115). As mentioned earlier, there are some cases in which a positive experience can lead to the choice to switch majors or to choose to take a break from school while still increasing a student's overall engagement. A choice to withdraw is accelerated when students fail to connect early in their academic career with their chosen major or the institution. Tinto (1993) pointed out that it is not enough for colleges and universities to simply establish a chance to engage with the community. Instead, students must feel a genuine connection through the engagement (academic or social or both) or else the connection will not inspire students to persist. Tinto (1993) stated that in many cases student perceptions of the interactions are as important as the actual interactions (p. 136).

Institutions vary considerably in the measures and approaches they take to help students integrate or engage, whether academically or socially or both. For example, traditions by which new undergrads (frosh) are inducted into the culture of the school are all intended to foster this sense of integration (membership, belonging, attachment). However, over recent years, the role of hazing in induction has come under great criticism. As Moreland and Levine (as cited in in Dias & Sá, 2012) noted, hazing can create an unhealthy social dependence on superiors of the group. However, the need to belong can

help to create some important interpersonal links (Dias & Sá, 2012). In many cases this need for belonging is exploited through the use of hazing rituals, which use threat as method of creating a social dependence. It is in pushing the envelope to create the environment of threat that hazing rituals can go too far. The challenge for universities and colleges is to create an environment that allows for induction into the university environment but does not actually drive new students away. BCRU has a strict no-hazing policy governed by the non-academic misconduct policy. In addition, BCRU has many activities designed to induct students into the university environment, including orientation, movie nights, and other off-campus activities.

2.3.3.   *John Bean*

In the 1980s, John Bean contributed greatly to the study of student retention, as he focussed on the role of background characteristics, such as prior academic performance, distance from home, socioeconomic status, as well as student satisfaction, in attempting to determine the reasons students leave university or college (Bean, 1980; see also Berger & Lyon, 2005). Bean (1980) found that background factors such as parents' education, high school grades, and whether students worked had influence on how students integrated into university life. Factors such as on-campus friendships, the helpfulness of an academic advisor, as well as informal contact with a faculty member all had roles to play in a student's persistence. Personal determinants such as commitment to a major or career in conjunction also had significant influence. An example of this type of commitment can be seen in the student who must complete a science major because he or she intends to enter medical school. Bean applied empirical research approaches to test his theories at a Midwestern university. He found that the variables he had identified had a 9% greater influence on women than men (Bean, 1980). Bean also found that attitudinal variables such as loyalty and certainty of choice were good predictors of persistence. However, they were not the only factors, as grades and opportunity to transfer also had an effect on persistence. As inquiries continued through the 1990s into the early 2000s, researchers found a holistic approach that included all members of the campus community was important to understanding the factors affecting undergraduate retention (Demetriou & Schmitz-Sciborski, 2011).

2.3.4.   Ernest T. Pascarella and Patrick T. Terenzini

Pascarella and Terenzini's (2005) book, *How College Affects Students*, had a significant impact on research on student retention and persistence. They found that the growth and change in college and university students is "interdependent" (Pascarella & Terenzini, 2005, p. 629) on a series of factors and learning is holistic rather than segmented. Furthermore, Pascarella and Terenzini found that in-class and out-of-classroom experiences are interconnected and part of a complex process that helps shape student change (p. 629). This is consistent with Tinto's (1993) findings that student departure (or persistence) is a process that takes place over time and entails academic and social integration. For example, failure to get a good mark in a class or having the belief in one's ability to succeed can lead to disengagement in academics. Furthermore, a failure to connect with peers can lead to choosing to leave the institution. Pascarella and Terenzini indicated that the complexity of the relationship between the interconnectedness of the in-class and out-of-classroom experiences is difficult for policymakers to isolate, and thus the development of comprehensive programs to assist students are difficult to develop. They argued that focusing on only one aspect of students' interactions with a institution will lead to only partial findings, leaving educators with questions and possibly resulting in poorly designed intervention programs (Pascarella & Terenzini, 2005).

Pascarella and Terenzini (2005) acknowledged the improvements in data on minority student groups, but have called for additional research in that area in order to reflect the more diversified student body found at institutions across North America. Furthermore, they highlighted the need to learn more about community colleges (Pascarella & Terenzini, 2005). For example, the need to explore whether open access admission criteria for colleges creates an environment in which many students enter post-secondary education at a higher risk of withdrawing in comparison to highly selective institutions.

2.3.5.   Wes Habley

In 2004, Wes Habley found that the interactions students have with key campus personnel, such as advisors, faculty, and staff, contributed to the student's decision to persist or not. Establishing a key personal connection with the institution through a faculty

or staff member can help students to find the right person to ask for help. This finding was supported by Tinto's (2004) research, in which he suggested that improved access to academic advising and support centres were key components of undergraduate retention, as these centres connected students to their overall college community. Tinto (2004) believed all institutions of higher education should offer students easily accessible academic, personal, and social support services.

2.4. Changing Theoretical Orientations

All of the theorists listed above primarily focussed their research and theoretical models on traditional university students aged 18 to 24 in more selective residential universities. These studies typically included students who were full-time and who had goals to complete their degrees in 4 years (Andres & Finlay, 2005). However, today's student is far more likely to be taking part-time studies while also working at a part- or full-time job. Andres and Finlay (2005) pointed out that although Tinto's (2004) model has been modified to study non-traditional students, these models fail to offer any deep understanding of why these students persist. Andres and Finlay (2005) claimed that current models fail to acknowledge the complicated "dynamic relationship between students as agents within societal institutions and institutions as living structures that impact on the lives of students" (p. 3). The role of students as agents within a living structure (post-secondary) as described in sociological literature (Archer; Coleman; Giddens, as cited in Andres & Finlay, 2005) has not been fully studied. Students as agents, enter universities or colleges and are enabled or hindered based not only on their own characteristics but also the characteristics of the structure itself. Andres and Finlay (2005) drew on Bourdieu's proposition (as cited in Andres & Finlay, 2005) that universities and colleges can be conceptualized as a "field" (p. 3) within the multidimensional space of the social world. A given institution, based on the support systems and the people within those systems, can either create a "field of forces" (Andres & Finlay, 2005, p. 3) and/or "field of struggles" (p. 3) in relation to the environment itself. Furthermore, students (agents) have a "relative position" (Andres & Finlay, 2005, p. 3) in the institution in relation to university personnel, such as faculty, advisors, and support staff. Students' positions are further influenced by other fields such as family, friends, and work (Andres & Finlay, 2005, p. 3). Consequently, students are influenced at different points within the institution based on

their relationships and relative position within their various fields, and as such results of interventions vary based on each student's experiences.

2.4.1. Student Engagement and Its Role in Persistence

Some clear connections emerge from exploring student persistence and retention research, in particular the work of Astin (1993), Tinto (1993), and Pascarella and Terenzini (2005) and comparing their findings to the research on student engagement described above in detail in the opening sections of this review. For example, Astin's (1993) I-E-O model states specifically that both a student's background and environmental factors influence his or her ability to succeed. Furthermore, Tinto (1993) stated that persistence is associated with the synergistic relationship between academic and social integration in and out of the classroom. Pascarella and Terenzini (2005) proposed that the in-class and out-of-classroom experiences are interconnected and part of a complex process that helps shape student change (p. 629). Based on a study of high school students' relationships and engagement with their schools, Cardwell (2012) described engagement as having three main dimensions: social, academic, and intellectual. This is consistent with the early work of Tinto (1993), who discovered that social and academic integration were required for long-term persistence.

2.4.2. Academic Engagement

Academic or institutional engagement refers to participation in the formal requirements of schooling and expectations for academic success (Cardwell, 2012) and builds on the work of Astin (1993), Tinto (1993), and Bean (1980), who found that academic preparation had a significant role in a student's desire and ability to persist. Cardwell (2012) found that credits attained, post-secondary plans, having a responsibility for learning, homework completion, work performed in class, attendance, tardiness, participation in class and impressions concerning the value of education, all reflected a student's academic engagement (p. 31)

2.4.3. *Intellectual Engagement*

Intellectual engagement refers to the deep "emotional and cognitive investment in learning, using higher-order thinking skills (such as analysis and evaluation) to increase understanding, solve complex problems or construct new knowledge" (Willms et al., 2009, p. 13). This form of engagement entails knowledge building, problem solving, conceptual thinking, and learning with confidence. This dimension of engagement is linked to the research on academic performance and goal attainment and its role in student persistence. As Nakajima et al. (2012), Tinto (1993), and Pascarella and Terenzini (2005) found, students' academic success in the classroom creates more commitment to a chosen major. The more success students have, the more their self-efficacy improves; thus, new goals are developed and commitment to the major is reaffirmed (Pintrinch & Schunk, 2002). This is of particular importance in subjects such as mathematics and science that require a high level of academic and intellectual engagement (Seymour & Hewitt, 1997) and success in the classroom is a significant factor in long-term persistence.

2.4.4. *Social Engagement*

Social engagement refers to "participation in the life of school" (Dunleavy & Milton, 2009 p. 8). It is a "combination of students' sense of belonging at school, their acceptance of the goals of schooling, feelings of being connected to and accepted by peers, and experiences of relationships with adults" (Dunleavy & Milton, 2009, p. 8). Cardwell (2012) surveyed students and learned about their needs to have a personal connection to the school through clubs and committees. Through a survey, Cardwell learned that student engagement required an environment in which cognitive learning was required and that social engagement was another aspect of persistence. This is consistent with the early work of Tinto (1993), who discovered that social and academic integration was required for long-term persistence.

Each aspect of student engagement contributes to an individual learner's commitment to degree or program completion. The level of commitment to any of the social, academic, or intellectual aspects of engagement can vary depending on the student's experience, context, and general life situation. For example, one student may choose to persist because of a strong level of intellectual engagement, whereas another student may persist due to a strong level of social engagement. However, total

commitment to one dimension does not mean a student will persist. Most often, persistence is a combination of engagement across all three dimensions (Dunleavy & Milton, 2009). This is consistent with the work of Tinto (1993), who proposed that social and academic integration build on each other and asserted that success in the classroom typically leads to social investment, which then furthers academic integration and so on.

2.5. Student Factors in Persistence

A review of college impact models, in which institutions establish specific programming to help improve student persistence, revealed a common set of student or self-directed variables. The following subsections discuss the variables thought to have the most influence on students' choices to persist, either within their original major choice or within the institution itself.

2.5.1. *Changing Concepts of the Nature of University and College Students*

The traditional concept of a university or college student is based on the idea that students complete their high school education, enrol in post-secondary immediately after high school graduation, are between the ages of 18 to 24 years of age, are completing studies as full-time students, and are often living on campus in student residences. Many of the studies conducted by Astin (1993), Tinto (1993), and Pascarella and Terenzini (2005) were largely based on this traditional view of a student. However, over the years, as a diversity of institutions with a variety of admissions criteria and policies developed, the traditional student demographic has changed. For example, students are more likely to be older, work part-time, and may be the first members in their families to attend post-secondary (Friesen, 2009, p. 9). Therefore, models such as Tinto's theory of interaction fail to acknowledge the new and diversified student populations attending many institutions today. However, Tinto (1993) has stated that his theory should be applied within each school's context and is not designed to give insight on systemic retention challenges. Based on research into the success or failure of first-year university students, Friesen (2009) found that the socioeconomic status of the students' neighbourhoods was

a significant predictor of student persistence. She claimed that pre-college characteristics have the most significant impact on students' persistence in university or college. BCRU's open access admissions policy provided an opportunity for the research in this thesis to involve members from many segments of the newly emerging student demographic.

2.5.2. Students' Self-Efficacy and Goal Attainment

A student's belief in self has a significant role to play in student persistence. Students are more likely to persist if they have clear academic and career goals (Nakajima et al., 2012). Pintrinch and Schunk (2002) found that as goals are completed students' self-efficacy improves, and thus more goals are developed and students are more likely to engage in activities that will help in goal attainment. Bers and Smith (1991) found, for students' enrolled at a community college, an academic objective or goal was the most significant factor in distinguishing between persisters and non-persisters.

2.5.3. Prior Academic Preparation

Academic preparation prior to entry to college or university has also been demonstrated to have an impact on students' choice to persist (Crissman Ishler & Upcraft, 2004). Pascarella and Terenzini (2005) noted that strong high school grades had an influence on whether students persisted from first year to second year of university. Nakajima et al. (2012) found that the effect of high school preparation is even stronger in community colleges, as admission criteria are not as selective, so students often enter community colleges with less preparation, and as a result the dropout rate is higher in colleges in comparison to universities with more selective admission criteria.

2.5.4. Parents Academic Background

Students' choice to persist has been found to increase if their parents have post-secondary experience (Lang & Nora, as cited in Crissman Ishler & Upcraft, 2004). Stage and Hossler (2000) found that the higher the parents' academic attainment and income, the more likely a student was to persist to graduation. This pattern seems to be of particular importance for younger students.

2.5.5.   *Personal Experiences With a Variety of Learning Environments*

Lederman, Antink, and Bartos's (2014) assertion that students learn science by doing science was consistent with the findings of Walmsley et al. (2010), who reported students who have an opportunity to participate in experiential learning often cited this approach as being an important factor in their choice of major and persistence. For example, students who participated in a work experience course in high school, a cooperative education program, or in an internship in university felt they benefitted from the experience. In some cases, students were led to a career that they had not considered prior to their work experience. As one student in Walmsley et al.'s (2010) study stated, "My internship got me interested in marketing" (p. 38). The experiential learning opportunity allows students to make connections they would not be able to make in a classroom environment. Even if a student has a negative introduction to a career through a work experience, the newly developed understanding provides a chance for the student to reconsider and choose another major that better suits his or her interests, skills, and ability (Walmsley et al., 2010).

The opportunity to conduct research also provides students with the chance to learn more about a subject and to verify a genuine interest in that subject (Adams, Pryor, & Adams, 1994). This is of particular value in the STEM disciplines, such as biology, chemistry, and physics, because research is a cornerstone of any graduate program in STEM fields. Walmsley et al. (2010) provided an example of a chemistry undergraduate student who had the opportunity to solidify his choice of major through his research experience. In that case, a research project provided the student with the chance to collaborate with a senior student attending medical school. The timing of this opportunity is also important, as it could impact a student's long-term choice of major (Beggs, Bantham, & Taylor, 2008). Students who had research and work opportunities were more likely to persist in their chosen major.

As Tinto (1975, 2004), Bean (1980), Habley (2004), and others discovered, a combination of these influences such as knowledge of the profession or a personalized experience with the field had the greatest impact on providing a student with the most accurate information possible. Understanding how these key influences work together can

assist advisors, instructors, and other university staff to better help students with the challenge of choosing a major.

2.6. The Transition from High School to Post-High-School Life: Views of the Class of '88

The transition to post-secondary from high school can be challenging for any student. Gabriel Pillay (2005) investigated these challenges with the class of 1988. Pillay examined the transitional experiences of British Columbia (BC) high school students by utilizing data generated from the *Paths on Life's Way Project.* This longitudinal study of a large sample of BC high school graduates from the year 1988 includes follow-up surveys conducted in 1989, 1993, and 1998. Specifically, responses to open-ended survey questions collected over all three surveys explored students' perceptions of high school and its role in preparing them for the transition to post-secondary life, and their experiences of the transition to postsecondary education and life after high school. The participants' written comments provide some insight into the subjective perceptions, meanings, and interpretations that students have about their transitional experiences after high school graduation. The aim of the project was to assess how the transitional experiences of BC graduates surveyed from the class of 1988 could help to inform policy and practice and ensure students make a successful transition from high school to post-secondary education and life.

2.6.1. Perceptions of Changing Relationships with Instructors

Pillay (2005) found that in many cases students do not get the support in high school required for moving into post-secondary. She learned that the change in interactions with university faculty, compared to their previous interactions with teachers in the K–12 system, was viewed as quite dramatic for most students, as they moved from having the support of high school teachers to feeling that university instructors ignored them or offered little to no support. Furthermore, Pillay also found that students felt that high school did not prepare them adequately for the abstract thinking required to be successful in a post-secondary environment.

2.6.2. High School Counsellors and Counselling

Of particular note, students in Pillay's (2005) study commented on the need to have more access to high school teachers and counsellors. As one of Pillay's participants stated, "I found in my high school that there weren't enough counsellors or teachers with enough time for students. I had a hard time deciding what to become as did other students and there wasn't enough information given to us" (p. 221). Pillay's findings indicated that received very little support from counselling services.

Pillay (2005) noted, "The lack of influence by secondary school personnel is startling. Fifty percent of female and 52% of male nonparticipants reported that secondary school counsellors had no influence on their educational decisions and secondary teachers fared only slightly better" (p. 23). Of particular concern is that fact that by virtue of their roles and responsibilities in preparing students through planning and guidance, it would be assumed that high school counsellors would significantly influence the lives of students. However, a prevailing theme in Pillay's study was the belief by participants that counsellors were inadequately prepared to support students through the university or college admissions process. One participant in Pillay's study stated,

> My high school counsellor did absolutely nothing for me including telling me wrong information. Because of that misinformation I almost didn't make it to college my first year. She almost told me directly she didn't think I should go to college. She hinted a lot and right now I get C + and Bs. (p. 221)

This perceived lack of support may have a significant impact on the success of students moving into post-secondary, given that they may lack confidence about the quality of their high school counselling advice. However, it is important to make the distinction between the quality of counselling services provided and the quality of instruction at the high school level. It is possible that despite a lack of support from counselling that a student may feel adequately prepared for post-secondary studies.

2.7. Environmental Factors

In regard to student persistence, Tinto (1993) and Astin (1993) have claimed that social integration must take place in conjunction with academic integration. In addition to identifying a common set of student or self-directed variables, several additional

environmental variables have been identified by other researchers. Outlined below are the environmental variables identified in some studies as having the greatest influence on students' choices to persist.

2.7.1. Part-Time Work

A key aspect of student persistence is connection to the institution. However, increasingly, students need to work part-time while attending post-secondary programs. King and Bannon (2002) learned that full-time college students with part-time jobs often experienced negative impacts on their academic performance. Finding a balance of working part-time while attending school was too difficult for many students and contributed to their decisions to dropout. Furthermore, students who worked off campus felt more disconnected from the institution (Presley, 2013), and may be more likely to dropout.

2.7.2. Hobbies and Activities

Social integration is an important aspect of student persistence. Pascarella and Terenzini (2005) found that the more involved a student was in recreational or vocational activities outside of the classroom, the more likely they were to complete a degree. This is consistent with the research of Astin (1993) and Tinto 1993), which indicated the more positive the experience outside of the classroom, the more involved students would be inside the classroom. In most cases participation in a club or team helped to provide a connection (social integration) to the institution (Tinto, 1993).

2.7.3. Career Expectations and Parental Advice

Choosing a university or college major is one of the most important and difficult decisions a student will ever have to make and has an impact on student persistence. The difficulty with this decision for many students revolves around the fact that students often enter university without having decided on a choice of major (Gordon, 1995). Even the students who enter university with a firm choice of major in mind are not necessarily any better prepared to pursue that major, because many make their choices based on limited or unrealistic expectations of the requirements of the major field of study or about the

career opportunities (and demands) that it entails (Freedman, 2013). This unrealistic understanding of career requirements and options has been attributed to many factors, including parental influences. Some studies have found that parental influence is an important factor in students' choice of major (Chung, Loeb, & Gonzo; Keillor, Bush, & Bush, as cited in Beggs et al., 2008). This influence can be positive or negative, because parental advice, although well intended, can sometimes lead students to misunderstandings of the responsibilities of certain careers (Walmsley et al., 2010). In other cases, parents can pressure students when they disagree with the choice the student is making (Walmsley et al., 2010). In 2001, Leppel et al. found students with business majors were more affected by their parents' influence than students studying for other majors. Green (as cited in Leppel et al., 2001) speculated that socioeconomic factors of business majors contributed to their choosing to persist in business. Parental influence was particularly significant in male students, who typically came from more affluent homes than their female counterparts.

2.7.4. Teacher and Faculty Relationships

According to Beggs et al. (2008) and Walmsley et al. (2010), students' relationships with their teachers and faculty members significantly influence students' choice of a major and the likelihood that students will persist. Students with a positive or negative relationship with a teacher or faculty member often made major choice decisions based on that relationship (Habley, 2004; Tinto, 2004; Walmsley et al., 2010). Students who had a positive interaction with their teachers or faculty members often chose their major because of that positive interaction (Beggs et al., 2008). Students often cited a faculty member's enthusiasm for the subject as an important factor influencing their choice of major (Walmsley et al., 2010). This is also consistent with the findings of Habley (2004), who found that access to university personnel, including faculty, advisors, and other staff, contributed to a student's decision to persist. On the other hand, students who had negative interactions and felt unsupported by certain teachers or faculty members often chose majors that differed from those of the specific teachers and faculty members (Walmsley et al., 2010).

MacFadgen (2008) explored persistence among mature students and found that the impact of a positive relationship with a faculty member was even more significant than

in the case of younger students moving directly from high school. MacFadgen derived eight main themes from the qualitative data analysis: (a) major life transitions, (b) multifaceted educational goals, (c) awareness of personal assets, (d) relationships with professors, (e) peer relationships, (f) life-role conflicts, (g) supportive institutional infrastructure, and (h) experiential learning opportunities (p. 119). Of the eight themes, the mature student's relationship with faculty was found to be most significant with the greatest contribution to persistence among participants (MacFadgen, 2008). The results from a faculty focus group corroborated the main findings from the individual student interviews. In particular, faculty members recognized that mature students are more diverse, discriminating, determined, and goal-directed than their younger counterparts. Faculty members placed a similar emphasis on the importance of student–faculty relationships as a means to instil confidence and to support students' academic progress. It was also evident that faculty members gave serious attention to incorporating experiential learning opportunities into their classroom activities and course designs. Furthermore, experience-based teaching and learning practices appeared to validate mature students' life experiences and prior learnings and had positive effects on their learning outcomes (MacFadgen, 2008). Results from the statistical comparison of the self-reported persistence, commitment, confidence, and satisfaction ratings for traditional and mature students indicated mature students were less inclined to change their programs and more determined, confident, and satisfied with their relationships with faculty and classroom experiences than their younger counterparts (MacFadgen, 2008).

2.7.5.   Academic Performance

Academic performance has a significant role to play in student persistence. Tinto (1993) proposed academic integration is a cornerstone for the overall integration of a student within the university. In some cases academic integration leads students to further their social integration with the institution. However, poor academic performance, often considered a negative interaction with the university, can lead to an early choice to drop out (Tinto, 1993). Academic performance is important in that many institutions have a minimum academic standard set for continuance in a program or the institution. As Tinto's (1993) model suggests, as students engage more in the classroom they are more likely to

integrate outside the classroom, reaffirming an institutional commitment, which furthers their academic commitment (Tinto, 1993).

2.7.6.   Socioeconomic Factors

Friesen (2009) explored the link between socioeconomic background and academic performance. Willms (2004) found that students from less advantaged families tended to perform poorly compared to their more advantaged counterparts. Furthermore, Friesen (2009) noted that middle-class students were more likely to graduate from high school than lower-class students. Friesen summarized her study findings, stating,

> Consistent with the literature, students living in neighbourhoods with higher proportions of affluent households, residential stability, household income and professionals generally enrolled in more academic courses in high school, attained higher grades, participated in post-secondary, and persisted longer than their peers in lower-class neighbourhoods. (p. 167)

Friesen further noted that this factor is of particular interest for institutions with open admissions policies — a policy also applied at BCRU, the institution in this study.

Families from with lower economic backgrounds and minority groups have been a concern for researchers for many years, as they are generally underrepresented in university populations (Walpole, 2003). These student populations are less likely to attend post-secondary, and when students from these underrepresented groups do attend, they are much less likely to persist (Walpole, 2003). The combination of having limited academic goals and an overall lack of understanding of post-secondary environments contributes to their lack of persistence and drive (Walpole, 2003). In many cases expectations of the parental support group contribute to the student's goal aspirations (Walpole, 2003). For example, in lower-class families a high school diploma is seen as the norm, whereas in middle- and upper-class families a bachelor's degree is the norm (Halle; Lareau; MacLeod; Rubin; Sennett & Cobb; Willis, as cited in Walpole, 2003, p. 48). These findings are consistent with Tinto's (1993) work, in which academic integration and social integration are key aspects of persistence. Without a significant academic goal, students are less likely to integrate academically and, having very few peers from the same financial and cultural background in attendance, students fail to integrate socially as well, often resulting in a decision to leave the institution.

2.7.7. *International Student Persistence*

The new Canadian post-secondary landscape includes the presence of international students. The benefit of International students includes providing different perspectives on issues in and out of the classroom as well as the sharing of cultures (Andres, Lukac, & Pidgeon, 2005). However, the presence of international students does require post-secondary educators to think about how best to support this group of students (Andres et al., 2005). Like domestic students, international students need to integrate both academically and socially (Andres et al., 2005). However, there is a limited body of research on this area, and in most cases studies failed to compare the experiences of international students directly to those of domestic students (Andres et al., 2005).

Andres et al.'s (2005) study confirmed Tinto's (1993) finding that the first introduction to post-secondary education, whether a student is domestic or international in origin, is very important to their persistence in the long term. Andres et al.'s (2005) study also identified and confirmed faculty and teaching assistants as fulfilling very important roles in students' choice to persist. Specifically, "professors who took the time to learn students' names, prepare and deliver clear and informative lectures, create an interactive setting within the classroom, and communicate with students outside the classroom were considered 'amazing'" (p. 78). Furthermore, professors who made a point of learning students' names and had consistent office hours had a positive influence on students' experiences (Andres et al., 2005).

Many participants in Andres et al.'s (2005) study chose to participate in athletic activities, with resulting positive effects on their social integration. In most cases, domestic students considered their residence experiences to be positive, but international students did not share this view (Andres et al., 2005). In most cases international students felt isolated from their domestic peers, and as result "sought out the company of those from their own cultural background" (Andres et al., 2005, p. 79).

2.8. Issues of Student Retention Specific to the STEM Context

2.8.1. *What is STEM?*

As noted in Chapter 1, STEM is an acronym referring to the academic disciplines of science, technology, engineering, and mathematics (Gonzalez & Kuenzi, 2012). In the United States, the term is typically used in discussions of the need for competitiveness in technology development and when addressing education policies and curricula choices in schools from K–12 through to college. However, Canada and other countries have also adopted the STEM acronym (Casey, 2012). Despite the broad use of the term, there is no common definition that defines a STEM occupation (Langdon, McKittrick, Beede, Khan, & Doms, 2011). Some vocations in science, technology, engineering, and math are commonly accepted as being in the STEM category (e.g., professional engineers, professional biologists, or agronomists); however, there is less consensus on whether managers, technicians, and health care professionals other than physicians and registered nurses should be included (Langdon et al., 2011, p. 2). Some scientists and science educators have criticized the definition and use of the term STEM, reflecting the varied opinions on how best to define the field. Eric Lander (as cited in Angier, 2010), Co-Chairman of the President's Council of Advisors on Science and Technology and Head of the Broad Institute of the Massachusetts Institute of Technology and Harvard University, has been critical of the STEM designation, as have Sally Ride and Elizabeth Stage (as cited in Angier, 2010). Ride (as cited in Angier, 2010), a former NASA astronaut, explained that she does not use the term STEM at speaking engagements promoting science to young girls because she believes the term is not helpful when talking with the public. Elizabeth Stage (as cited in Angier, 2010), who is Director of the Lawrence Hall of Science at the University of California, Berkeley, feels that the term STEM creates a "false distinction" (para. 13), and it would be more accurate to simply refer to science education, as it better reflects the scope of size of the discipline.

Despite the differing opinions about the definition and use of the acronym STEM, the abbreviation is used widely and is, therefore, employed throughout this thesis. For the purposes of the research reported here, STEM careers are defined as those that require university-level education within the core STEM fields, including biology, chemistry,

computer science and computer information systems, engineering, mathematics, and physics.

2.8.2.   *Factors that Influence Students' Choice of a STEM Major*

As with all students entering university or college, students choosing a STEM major often cite relationships with parents, friends, and relatives as being influencers (George, Wystrach, & Perkins, 1985). However, these authors also found that students choosing to pursue a chemistry major cited a "high aptitude for science" (George et al., 1985, p. 501) as the most important influence in their decisions. This is consistent with Astin's (1993) and Nakajima et al.'s (2012) work, which indicated that academic preparation and belief in one's ability played important roles in academic persistence. Participants in George et al.'s (1985) study reported being "turned on" (p. 502) by laboratory work, which was found to be an important influence. The importance of exposure to laboratory work is consistent with other studies that have identified direct experience with the subject (Walmsley et al., 2010) as playing an important role in the choice process, regardless of discipline.

The need for middle and high school preparation for pursuit of the sciences at the post-secondary school level cannot be overstated. Astin and Sax (1996) discovered that past academic achievement and ability in the sciences in high school played an important role on students' decisions to enter into the sciences at college and were of particular importance for women. For example, Kinzie (2007) found that achievement in STEM subjects at the Grade-8 level played a very important role in whether students chose to pursue the sciences in university. Overall, achievement in mathematics in middle school often determined whether mathematics courses were taken in high school, thus causing students either not to choose, or to be unable to choose, a STEM major in college due to lack of preparation or prerequisites. Kinzie found that women were particularly impacted by a negative experience with math and science and often chose to not pursue sciences at the post-secondary level. In a different study, Shapiro and Sax (2011) reported that female students who attained positive achievements in high school STEM subjects felt that that they could successfully pursue a STEM major in university.

2.8.3.   *Student Persistence Within STEM Subjects*

The issue of increasing the rates of university and college degree completion has always challenged post-secondary administrators (Berkner, He, & Cataldi, as cited in Hudson, Kienzl, & Diehl, 2007). Tinto (1975, 2004), Bean (1980), and Habley (2004) spent years investigating this challenge across all university majors offered. However, persistence in the sciences is particularly challenging, as students' experiences with middle and high school mathematics and science courses can have a lasting impact on their sense of self-efficacy as well as beliefs about whether they are prepared for post-secondary studies. The sense of self-efficacy or adequacy to undertake STEM-related studies at university or college seems to apply in particular to decisions about university-level calculus (Seymour & Hewitt, 1997). Further, Bean and Eaton (2000) reported that self-efficacy plays an important role in college student retention. They proposed that when students have a strong belief in self they are more likely to persist in their classroom studies (Bean & Eaton, 2000). In turn, this commitment and confidence inside the classroom makes students more likely to engage socially outside of the classroom, increasing the overall likelihood that they will persist to graduation (Bean & Eaton, 2000; Tinto, 2004). The role of self-efficacy appears to be very important in a student's choice and persistence within a major. Shapiro and Sax (2011) claimed students will only remain in pursuit of a major area of study if they believe they can succeed in that chosen field. Furthermore, once students experience success, it affirms their choice, contributing to the chance that they will remain in their major. As Tinto (1993) proposed, this results in a virtuous spiral effect that leads to further social integration because of positive academic integration, which further solidifies the student's choice to persist.

In 2011, President Obama (as cited in Kanter, Ochoa, Nassif, & Chong, 2011) stated publically that increasing college completion rates is a priority for the United States. This is of great importance, as only 24% of students entering college are pursuing a STEM major (Pryor, Hurtado, DeAngelo, Blake, & Tran, 2009), and, of that intake cohort, 50% change their majors to non-STEM fields or leave post-secondary education altogether (Chen & Weko, 2009; Sax, as cited in Shapiro & Sax, 2011). Goldberg (as cited in Drew, 2011), an Emeritus Engineering Professor, stated that many students "wash out" (p. 3) of the sciences because of the difficulty many first-year students have with calculus, physics, and chemistry. Drew (2011) reported that up to 40% of students leave their intended

engineering or science majors despite having the strong math and science preparation in high school. A significant departure rate was also found to be prevalent among pre-med students (Drew, 2011).

Failure to acquire strong study skills in high school also contributes to student choices to persist in the sciences. Seymour and Hewitt (1997) found that high school students with a strong aptitude for math and science often failed to develop the required study habits to be successful in university or college. Ironically, having a high aptitude for math and sciences created problems for some students at the university level. Students who were praised for their talent in high school sometimes developed a false sense of confidence, and did not develop the work ethic or the study habits required to meet the achievement expectations required in their chosen university-level STEM majors (Seymour & Hewitt, 1997). These students were subsequently at "high-risk" (Seymour & Hewitt, 1997, p. 46) of abandoning their plans for a STEM major. Seymour and Hewitt conducted interviews with students who either started in the sciences and persisted, or those who ultimately switched to a non-science major. Students in their study most frequently (66%) rated "loss of interest in the sciences" (Seymour & Hewitt, 1997, p. 46) as the reason they switched, with curriculum overload being rated second at 55%. Discouragement and lack of confidence due to poor grades were also cited as reasons 40% of the time (Seymour & Hewitt 1997, p. 46).

2.8.4.   Gender Issues in STEM Fields

For years participation in the sciences has been associated with success in mathematics at the middle and high school level (Davis, 2010). Students with a strong belief in their math abilities are far more likely to enrol in both a 4-year degree and persist until completion in comparison than those who have a weak math background or poor sense of self-efficacy (Davis, 2010, p. 36). Oakes (as cited in Davis, 2010) reported that students in underrepresented groups are more likely to take courses outside of the "science pipeline" (p. 37). This effect is particularly noticeable in young woman, who are far more likely to switch to a non-science major, than men. Davis et al. (as cited in Adamuti-Trache, 2005) and Hanson (as cited in Adamuti-Trache, 2005) found female students start moving away from the sciences throughout high school. Various factors are associated with these students' choices to opt out of the sciences, including gendered curricula,

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student self-esteem, societal stereotypes, and career decision-making processes. Female students who enter the sciences at the university or college level typically enter with a strong high school background in math and sciences. However, despite this strong background, many young women choose to switch majors (Adamuti-Trache, 2005). Academic science is known for its traditional values and the resulting barriers this creates for women (Hyde Gess-Newsome, as cited in Adamuti-Trache, 2005). Although higher education does not actively discriminate against women, the culture of science classes does work against many young women's persistence within the field, because the presentation and format of science courses is often not inclusive, a condition that contributes to a student's choice to move into other disciplines (Adamuti-Trache, 2005).

Adamuti-Trache (2005) suggested that if STEM programs were to follow the lead of disciplines such as the arts and social sciences and create a more supportive learning environment, this would, in the long term, help increase both participation and diminish the leakage seen in the science pipeline. An example of how a more positive and supportive environment can have a positive impact is seen in the field of biology, which maintains a far greater portion of the female students enrolling in comparison to mathematics, physics and engineering. Adamuti-Trache (2005) proposed that for a true understanding of this pattern a detailed study should explore each stage of the "science pipeline" (p. 14) and attempt to discover why a student, regardless of gender, leaves a STEM field for another major. That type of research could provide insights that would help institutions implement intervention programs.

2.9. The Role of Barrier Courses in Student Persistence within the STEM Fields

Students' sense of self-efficacy in their ability to succeed is a key component of student persistence. When students' do not feel comfortable about their competence with a subject it can lead to the choice to leave a major or drop out of post-secondary altogether. In some cases, courses develop a reputation for being difficult and are seen as barrier courses. An example of such a barrier course is calculus, which has a reputation among students for being very difficult. It is important to note that barrier courses can vary from student to student, depending on their levels of interest in a subject area. Thus, a

student with a keen interest in sciences and math might view a required English literature course as a barrier.

Tinto (2004) posited that the transition to university from high school is very important, and that a positive classroom experience is a key aspect of that transition, particularly during the first couple of months of college. If a barrier course is required to be taken in the first year or semester it can have a negative impact on the persistence–retention equation. This is of particular importance to early academic integration within the STEM majors. For example, Calculus I is often taken in the first semester, and in many cases students struggle academically with the course, which leads not only to a negative experience in the classroom, but also often impacts a student's choice to integrate socially within the university (Ellis, Kelton, & Rasmussen, 2014). As a result, the choice to persist both within the STEM major and within university overall can be affected (Ellis et al., 2014). Seymour and Hewitt (1997) found that students' experiences with calculus were a significant factor in their choices to leave STEM disciplines. This is important because calculus is an integral part of all STEM majors. In a study that asked students why they left their majors, Seymour and Hewitt (1997) found that a negative experience with calculus was a primary reason for choosing not to persist within a STEM major. Although there are many factors that contribute to a student's decision to leave the sciences, performance or success in introductory calculus courses appears to often play a significant role in the decision.

Given findings that suggest that calculus can have a significant role in a student's choice to persist in STEM studies in university, there is a need to explore the general mathematics preparation of students in high school as well as their first-year experiences with calculus (Rasmussen & Ellis, 2013). The research reported in this thesis provides an opportunity to learn about whether students' perceptions of their high school experiences with mathematics positively or negatively affected their university experiences with calculus. The results from this study may provide an opportunity to suggest changes to current teaching methods for calculus courses. Ellis et al. (2014) found that a progressive teaching approach such as in-class problem solving and use of technology was associated with lower switch rates among STEM majors. Their study also indicated that students who were engaged by faculty were less likely to feel lost (Ellis et al., 2014). However, a recent study by Sonnert, Sadler, Sadler, and Bressoud (2014) did not give high ratings to the

impact of "progressive teaching methods" (p. 385) such as the use of technology or activities designed to initiate student engagement as improving students' attitudes toward mathematics. The variation in findings between the works of Ellis et al. (2014) and Sonnert et al. (2014) magnified the need for more research on the impact of calculus being a barrier to STEM degree completion as well for better understanding of the overall effects of university-level math curricula on student attitudes and decisions. Ellis et al. (2014) also noted assessing the classroom experience is challenging, because controlling for how switchers and non-switchers experience the overall learning environment is difficult. For example, does a student's natural aptitude for a subject exempt that student from needing a progressive teaching approach? Furthermore, would a student who lacks ability in mathematics fail to succeed regardless of the effort put into the learning environment by a faculty member? This thesis attempted to explore these questions within the overall context of learning more about each student's post-secondary learning experiences.

2.10. Curriculum Structures and Undergraduate Teaching in STEM Fields

Adamuti-Trache (2005), in looking at the general issue of student persistence in STEM fields, described the pattern as a "leaking science pipeline" (p. 16). Adamuti-Trache also claimed that university and college math and science programs need to explore the current structure and delivery of STEM programs. For example, she noted that current STEM programs often appear to continue to offer programming on the basis that students are undertaking full-time studies and prioritizing school over everything else in their lives (Adamuti-Trache, 2005). She asked whether students are switching their majors because they want to or because they need to. Adamuti-Trache also stated that overall student choice is likely driven by a number of factors, some outside institutional controls, although the lack of flexibility in science programming is factor that should be considered. Adamuti-Trache argued that STEM programs must shift the focus from influencing students' choice in selecting STEM programming to a greater focus on retaining the students who have elected STEM studies, in particular by adjusting program structures to the needs of today's students. Unfortunately, Kober (2014) found that many students reported their undergraduate experiences to be a "turn off" (p. xi) point:

A single course with poorly designed instruction or curriculum can stop a student who was considering a science or engineering major in her tracks. More than half of the students who start out in science or engineering switch to other majors or do not finish college at all. Maybe they failed a crucial prerequisite course, or found little to engage their interest in their introductory courses, or failed to see the relevance of what they were being taught. For non-majors, an introductory course that confirms their preconception that they are "bad at science" may be the last science course they ever take. (Kober, 2014, p. xi)

This is a significant issue, as without changes, the science pipeline will continue to leak, and Canada will be increasingly at risk of being unable to meet the demands of the knowledge-based economy. Similar to other researchers such as Adamuti-Trache (2005), Kober (2014) noted that faculty can have a significant impact on improving the classroom environment to foster students' academic integration with the institution.

2.11. Attrition Among STEM Majors versus Non-STEM Majors

A 2010 Natural Sciences and Engineering Research Council of Canada (NSERC) report *Women in Science and Engineering in Canada* showed that there is an adequate supply of potential STEM graduates entering the K–12 system across Canada. In addition, as students move through the K–12 schools, fewer choose to study science or engineering. The NSERC (2010) report stated,

The odds of a female child enrolled in 1st grade going on to receive a Ph.D. in the sciences or engineering are approximately 1 in 286 (the odds for a boy are 1 in 167). Today, in an average-sized Canadian elementary school, only 1 child will go on to receive that Ph.D., and it is likely to be a boy. (p. 3)

The 2010 NSERC report cited Bussière, Cartwright, and Knighton's (2004) Statistics Canada report, which stated that 15-year-old "students' mathematics confidence, their perceived abilities in mathematics, and their beliefs in the value of mathematics for future work and education may have an important impact on their course selections, educational pathways and career choices" (p. 47). This is consistent with Bean's (1980), Tinto's (2004), and Habley's (2004) findings that self-efficacy has a role in the choice of major. In their report, Bussière et al. stated,

Girls [in particular] reported lower levels of confidence in their ability to solve specific mathematical problems, lower levels of their perceived ability to learn mathematics and higher levels of anxiety in dealing with mathematics. Girls were also less likely to believe that mathematics will be useful for their future employment and education and were more likely to report lower levels of interest and enjoyment in mathematics. (p. 47)

The declining engagement with the sciences, and mathematics in particular, further supports Seymour's (2006) findings that a negative experience with mathematics, especially calculus, caused students to leave the sciences. As Astin and Sax (1996) discovered, a perceived negative experience in high school can prevent a student from even considering the sciences. The 2010 NSERC report confirmed Seymour's finding and indicated that young females are particularly sensitive to a perceived lack of self-efficacy:

In the last year of high school, a greater proportion of boys consistently report that they perceive themselves as doing well in mathematics and science, and that skills can be acquired through work. In comparison, the majority of girls tend to believe that success in math and science is a question of natural abilities. Furthermore, girls consistently dislike math, physics, and chemistry more than boys, and have a greater affinity to life and earth sciences. A lack of female role models in science and engineering is commonly cited as a major reason contributing to attitudes and performance of high school girls in math and science. (p. 7)

A 2013 study by Chen and Soldner for the United States Department of Education found as students move into university attrition in the sciences continues. Chen and Soldner reported nearly 48% of students who entered STEM majors from 2003 to 2009 left the field (p. 14). Approximately 28% switched to a non-STEM major, while the other 20% left post-secondary education all together. Interestingly, the attrition rates among non-STEM majors were similar to those of STEM majors (Chen & Soldner, 2013). These authors also reported that more females left an originally chosen STEM major than males (Chen & Soldner, 2013). In findings similar to those of Bean (1980), Chen and Soldner found that the academic preparation of students entering university influenced their choices to persist in the sciences. Chen and Soldner's findings were consistent with earlier work by Seymour and Hewitt (1997), who discovered that students with less experience or success with high school mathematics were approximately 11% more likely to switch to a non-STEM major than those students who took calculus in high school

2.12. Changing Expectations About the Role of Contemporary Universities and Colleges

During the last decade, the provincial governments of Alberta, BC, Newfoundland and Labrador, and Ontario have all conducted extensive reviews of post-secondary education in their respective provinces (Kirby, 2007). The major theme addressed in the final reports of each of the reviews included affordability, accessibility, accountability p. 2), institutional collaboration, diversity, funding and quality (Kirby, 2007, p. 2). These reports together provide an excellent summary of Canada's current post-secondary environment. A common theme is that economic globalization has had an impact on post-secondary institutions and the types of programs they have developed (Kirby, 2007).

Canada does not have a formal accreditation body and has provisioned the responsibility of post-secondary oversight to the provinces (Kirby, 2007). In 2008, that ability was demonstrated when the provincial government of BC granted full-university status to several university-colleges, including BCRU. In addition, some private institutions were also given the authority to offer degrees as well as other credentials (Kirby, 2007). At present, Canada has the third highest expenditure on post-secondary education among Organization for Economic Cooperation and Development (OECD) countries, at 2.4% of gross domestic product (Kirby, 2007, p. 4). Among its OECD partners, Canada also has the highest percentage of post-secondary enrolment, with approximately 50% of citizens between the ages of 25 to 64 enrolled as students at a post-secondary institution (Kirby, 2007, p. 4).

2.13. Globalism, Relevance, Corporatism, and Their Curricular Implications

There is a prevailing belief that a country's success depends on the education of its citizens. With the development of the knowledge-based economy the pressure to educate the population to meet the changing demands of industry has never been greater (Kirby, 2007 p. 5). The need to meet economic demands has shifted the focus of post-secondary institutions from providing programming that educates the population to developing programs that fill an economic need (Kirby, 2007). This shift in focus is

particularly strong within the STEM disciplines as post-secondary educators continue to approach teaching with a traditional view of education, while the schools themselves see STEM as being the cornerstone of the knowledge-based economy. However, there is evidence to support that STEM education is just one aspect of a successful Canadian economy (Council of Canadian Academies, 2015). This does not mean STEM education is not an important aspect of Canada's economic future, but rather that it is one aspect of many factors which will drive both Canada's education and economic direction moving forward (Council of Canadian Academies, 2015).

A challenge for Canada, and many other countries, is to determine how best to move forward with curriculum design, not only for STEM but for all disciplines, as this has a direct impact on the contributions made to the knowledge-based economy. Furthermore, students' enrolment patterns are changing, as students must work off campus to help offset the rising tuition costs (King & Bannon, 2002). For example, as government funding has been cut over the years, post-secondary institutions have responded by increasing tuition fees (Kirby, 2007). Currently, Canada is about 20% above other OECD nations in the proportion of tuition funding contributed by students (Kirby, 2007). Therefore, a curriculum designed for full-time study is not the best approach for students' who are taking part-time studies, as it impacts students' choice to persist in the long term (King & Bannon, 2000).

2.14. Summary

This chapter has provided a general overview of the literature with respect to the possible factors influencing students' choices to persist within their original majors, switching to another major, or leaving higher education altogether. Of particular importance was the role of student engagement and the need for students to be engaged with the university academically, intellectually, and socially. Student engagement often leads to a student's choice to persist, as students are connected to the institution in many different ways. Furthermore, the student engagement construct provides institutions with clues on now to provide the appropriate in-and-out of classroom environment that improves students' engagement and overall experiences. The review placed some focus on the issues of retention and persistence within the STEM-related fields of study,

although the richness of the participant interviews (presented in Chapter 4) reveals that student decisions are affected by a wide range of forces, operating both in and outside of the institution's influences.

This literature review considers variables of student attributes and environment that have been found to have the most impacts on students' choices to persist. Factors considered included students' perceptions of efficacy, their prior academic ability and experience, as well as the academic backgrounds of their parents' and environmental factors such as part-time work, hobbies and recreational activities, interactions with teachers and faculty, and personal relationships. All were examined in the light of what is known or claimed in regard to their roles in students' choices to persist with their academic programs. As Tinto (1993) noted, the effects of both social and academic integration on retention and persistence are clearly interconnected, and exploring one without the other is not truly possible.

This review did not delve into psychosocial theories of individual and personal development in relation to college and university persistence. Furthermore, the research conducted for this thesis was not designed to study cognitive-structural theories of development that propose that a student must move through a series of stages, with each stage being in a hierarchy. The research reported for this thesis was primarily concerned with exploring the student holistically, as I sought to understand students' experiences and the meaning given to these experiences by the students themselves. My intent through this chapter was to review relevant literature concerning student engagement and the various factors that may impact students' choices to persist within their selected majors and with the institution itself.

The construct of student engagement and its relationship to student persistence and retention was explored. In short, a student needs to be engaged either academic, intellectually, or socially. Engagement in all three areas increases the likelihood of persistence, and without engagement in at least one of these areas persistence is doubtful. Three theoretical perspectives were reviewed as backgrounds to the study. Astin's (1991) I-E-O model, which focuses on three elements, was described as addressing (a) the experiences that students possess when they enter university, such as their past academic and social experiences and family background; (b) the environment

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that the college or university provides, such as the classroom experience, social engagement opportunities, and overall culture of the school; and (c) the final outcome of how students' attitudes, beliefs, and understandings of the world change after or during their post-secondary experience. Tinto's (1993) seminal work was reviewed and outlined that the choice to leave post-secondary or change a major takes place over time. Tinto (1993) noted that student departure is a process that is influenced by both academic and social integration within the college or university environment.

In summary, in conducting this literature review I found that current research broadly proposed that students' decisions around their programs of study or academic majors in college and university are the result of complex interactions among a series of factors operating in their lives (Astin, 1993; Bean & Eaton, 2000; Kuh, 1991; Tinto, 1993). Some of these are factors situated within the institutional environment (Astin, 1993; Bean & Eaton 2000; Kuh, 1991; Tinto, 1993), while others operate outside the campus-based aspects of the students' lives. The contemporary Canadian university student is different from the typical undergraduate of a few decades ago. Undergraduates often work part-time while attending university. They have often taken a gap year between leaving high school and entering university or college or have left the institution at some point (during their overall university experience (Andres & Finlay, 2005). They may have attended other post-secondary institutions prior to their current situation. Many students, especially in Canada, commute to campus rather than living in residences on campus, so their engagement with activities other than academic classes may be less significant than those in their off-campus lives (Andres & Finlay, 2005). The participants interviewed for this study confirmed many of these features and influences in their accounts of their academic choices.

Chapter 3, which follows, describes the research methods employed in this study. Following a brief outline of the phenomenological approach, the nature of the research setting is described. I then explain who participated in the study and how research study participants were invited to participate. The chapter ends with details on how data were analyzed.

3. Methodology

This chapter outlines the methods used in this study initially to investigate the phenomenon of student retention within science majors. As the research interviews proceeded, it became clear that the phenomenological approach permitted the participants to discuss not only their decisions regarding choice of university programs, but also their general experience of the university and the larger contexts of their lives during times of choice and transition as well as the decisions they made along the way.

In short, the participants were whole people, with all their complexities and situational differences, who had made decisions about attending university or pursuing particular career paths. Their specific decisions about science and science related-programs were parts of their larger experience. Phenomenological inquiry is holistic in nature and the interviewee drives the process.

This chapter describes my chosen methodology, participant selection process, data collection and analysis, and my preconceptions of the phenomenon under investigation. I close this chapter with a discussion of the limitations of the study design.

3.1. Defining Phenomenology

Phenomenology is different from almost every other science, as it is focussed on people's "lived experience" (van Manen, 1997, p. 5). The goal of phenomenology is to gain understanding of an experience without any prejudgement or classification. According to van Manen (1997), the goal is to "question the way we experience the world" (p. 5).

Stake (1995) described qualitative research as a genre that encourages the "understanding of the complex interrelationships among all that exists" (p. 37). In essence, phenomenology expects the unexpected with no preconceptions. Creswell (2005) stated that qualitative research "emphasizes the importance of the participant's view" (p. 42). This approach gives meaning to the views expressed by study participants (Creswell, 1998). In order for this to happen, the researcher and the method must be open and allow the participants to tell their stories the way they want to tell them, rather than simply

responding to a pre-set questionnaire. That phenomenological requirement resulted in implications for the design of the interviews.

Phenomenology is rooted in the work of Edmund Husserl (1859-1938), a German Mathematician who wrote extensively addressing phenomenological philosophy, beginning in 1913 until his retirement (Creswell, 1998). According to van Manen (1997), phenomenological studies explain "the meaning embedded in lived experience" (p. 100). Creswell (2005) contended that the aim is to study how human phenomena are experienced in the minds of individuals, how this experience relates to their actions, and what meanings are constructed by the people living the experience. As a researcher, the quest is for discovering the meaning that a particular experience has for the individual engaging in the experience (van Manen, 1997).

Engaging in the lived experience does not allow for empirical generalizations, the production of law-like statements, or the establishment of functional relationships. The only generalization allowed by phenomenology is this: "never generalize" (van Manen, 1997, p. 22). Phenomenology explores the differences of those individuals who are living the experience (van Manen, 1997). Focusing on the difference and what is unique about the journey and providing meaning to the experience (van Manen, 1997). A phenomenologist is not interested in a set of empirical facts; rather, a phenomenologist is interested in the experience itself and the revelation of the hidden meaning (van Manen, 1997, p. 27): "A good phenomenological description is something we can nod to, recognizing it as an experience that we have had, could have had" (p. 27).

Phenomenology investigation is not infallible; in fact a phenomenological study can fail in many respects. As van Manen (1997) noted,

> (1) A description may fail to aim at lived experience, and instead have the character of conceptualization, journalistic accounts, personal opinions, or descriptions of some other state of affairs. Sometimes the experiential interest of phenomenological inquiry is confused with journalistic, biographic, or other types of writing.
> (2) A description may properly aim at lived experience but somehow fail to elucidate the lived meaning of that experience. In this case the description simply fails to accomplish its own end.
> (3) A description may elucidate, but what is elucidated is not lived experience; instead a description may succeed in conceptual clarification or theoretical explication of meaning. (p. 27)

In the case of my study, all participants described their lived experiences, and their particular choices were clarified. In Chapter 4, I share the experiences that I believe will resonate with the reader.

Furthermore, van Manen (1997) outlined a framework for methodological themes as a method to assist researchers in their approach. For example, my study shared many of the of the six research activities van Manen outlined as being part of hermeneutic phenomenological research (p. 30). For example, Item 1, "turning to a phenomenon which seriously interests us and commits us to the world" (van Manen, 1997, p. 30), is what drew me to this study. As an Academic Advisor, for many years I saw many students enter into university and choose to switch their major or leave the institution altogether with no apparent reason. This lack of understanding drew me to this study to learn more about how students' life experiences influence their choices for persistence. This study has allowed me to reflect and dig deep on the reasons why students choose to persist or not. Throughout out this process, I have reflected on the key themes that describe the phenomenon of student departure, and this process is also consistent with van Manen's framework (p. 30). Although I followed van Manen's framework as part of my process, I did not utilize the outline "blindly" (p. 34). I attempted, as van Manen described, to follow the outline as a method to embrace "the spirit of this kind of inquiry" (p. 34).

The design of this study was guided by the hermeneutic phenomenological research approach, as articulated by van Manen (1997). My goal was for this study to be both descriptive (phenomenological) and interpretive (hermeneutic) in nature (van Manen, 1997 p. 180). As van Manen (1990) stated, the "facts" (p. 181) of lived experience are always already meaningfully (hermeneutically) experienced.

3.2. Why I Chose a Phenomenological Approach

Social science relies on several methods of inquiry for qualitative studies. Creswell (1998) described five main methods of inquiry: grounded theory, ethnography, the case study, the biography, and phenomenology. According to Creswell (1998), understanding the focus of each method is the key to appreciating the differences of each approach.

Phenomenology attempts to learn about the meanings a person experiencing a phenomenon gives to the phenomenon itself.

I chose a phenomenological approach for two main reasons. First, it was well suited to the research topic, which was to examine the factors that are perceived by university students as contributing to their decisions to persist in the sciences or switch to other major programs. I designed my research to conduct semi-structured interviews with two groups of students: those who began university in a BSc program and persisted in their studies in that area and those who started university in a BSc program or in general pre-science studies and switched to a non-science program. As the interviews progressed, I gained a deeper understanding of the wide range factors that students' considered when choosing a science major or when they ultimately chose to persist or switch to a non-science major, as well as why they chose to attend university in the first place. Further, the interviews revealed the personal stories of 15 students (not just as students, but in wider contexts as well), as they negotiated their lives during a period of transition from school-level experiences into post-secondary education. I discovered the complexity of their life experiences, not just in particular university programs or courses, but rather in a more holistic sense.

Last, a phenomenological approach was best suited to my interest in the topic. I am "deeply interested" (van Manen, 1997, p. 43) in the question of why students choose to persist in the sciences, based on my own experiences as both a General and Faculty of Science Academic Advisor. My experiences with students drew me to this study, as I wanted to know why students made certain choices. This inquiry also gave meaning to my own life through the work I completed as an Academic Advisor.

3.3. Data Analysis Procedures

The process of bracketing and horizontalizing, as guided by Moustakas (1994), was used to assist with identifying key themes and common experiences with regard to student choice. The study interviews were audiotaped and transcribed for the purpose of horizontalizing as well as for the creation of individual and composite textural descriptions (Creswell, 1998). According to Creswell (1998), the process of horizontalization entails

separating all the statements about an experience from the individual interviews and listing them. The statements are separated from the interviews to eliminate the contextual clues about the person who made the statement and what part of the experience it described. The purpose of horizontalization is to allow the researcher to eliminate his or her own biases and treat each statement with equal value (Moustakas, 1994).

From this newly created list, the statements were subsequently grouped into what Creswell (1998) called themes. This grouping was achieved using van Manen's (1997) detailed or line-by-line approach, through which I examined what each statement revealed about the phenomenon. This process included also the reading, rereading, evaluating, re-evaluating, comparing, and reflecting upon each statement. The statements were then clustered into themes or potential units of meaning that emerged. These clusters were described my study participants and created profiles of the participants based on their experiences as they entered the university, the BSc program, and the majors that they ultimately chose to pursue. This process was consistent with phenomenological research, as it both described the phenomenon and interpreted it. In following the work of van Manen (1997), I have used "the term 'description' to include both the interpretive (hermeneutic) as well as the descriptive (phenomenological) element. . . . Often the terms are used interchangeably" (p. 26).

3.4. Research Site and Participants

My research study took place at a regional university in BC, Canada. Participants were recruited through the Science and Arts Advice centres via an email invitation (see Appendix A) that included a description of the study. Students were invited to participate in a semi-structured one-on-one interview, and I conducted all interviews. I interviewed two groups of students: (a) students who had enrolled in a BSc program within the last 3 years and were completing a science major and (b) students who had initially enrolled in a science major and had switched to a different program and were now completing a major other than science. Students were offered a series of dates and times to meet on the main campus of the university in an attempt to accommodate their class schedules.

A choice of gift card for either an online music download site or a popular Canadian coffee shop chain was offered to the students who chose to participate in the study. I used a classroom for all of the interviews, and each interview was recorded with the permission and signed consent of the participant. At the time of the interviews, I explained that all participants would have the opportunity to read the transcripts of the interview at a later date. My supervisor helped me determine my broad interview topics. I completed one dry run (i.e., pilot test) of the interview with a colleague, which provided me with information on how to pace the interview to ensure participants did not feel pressured or badgered. This process also helped me to ensure the questions were clear and that they would garner responses relevant to my inquiry topic.

3.5. Ethical Considerations

Due diligence was taken to protect the identity of the students involved in the study through the use of pseudonyms for both the university and the participants. Any individual names or other references that might identify the student participants or other persons were removed from the transcripts. It was also important that participants in the study understood the purpose and scope of the study. To this end, project information and consent forms were provided to all participants (see Appendix B), and they were asked to sign the forms prior to the beginning of the interview. The consent forms included information about the purpose and goals of the study, any risks to the participants, and the potential benefits of the study. All participants were offered the opportunity to ask questions regarding the scope and purpose of the study. The consent forms also clearly indicated that participation was entirely voluntary, and participants could withdraw from the interview at any time if they wished to do so. Since I am in a position as a senior administrator in the university, the participants were informed that their decision to participate in the study (or not) would have no influence on their evaluations or acceptance to courses or programs of study.

3.6. Limitations of a Phenomenological Study

Phenomenological studies have limitations because of the risk of researcher subjectivity and bias influencing the data analysis (van Manen, 1997). Of note, a researcher may have trouble ensuring pure bracketing, which is a difficulty that can lead to interference in the interpretation of the data. Furthermore, there can be challenges in making empirical generalizations from this type of study. However, as van Manen (1997) stated, phenomenological approaches seek deep meanings and are not intended for making empirical generalizations. Although empirical generalizations cannot be made, it is possible to generalize the meaning of the experiences to others that are have similar experiences.

3.7. Defining the BC Regional University

The BCRU is a regional university focusing on providing students with an undergraduate education. This institution provides upgrading preparatory course work, bachelor degree programming, and also offers two masters' programs as well as trades programming.

The Bachelor of Arts program is its largest program at BCRU, with 1,195 full-time equivalent students registered with majors in English, history, psychology, and criminal justice (BCRU Institutional Research Data, 2014).[1] The BSc program is BCRU's second largest bachelor degree program, with 662 full-time equivalent students registered in a science major in 2014 (BCRU Institutional Research Data, 2014). Science majors include biology, chemistry, computing science, physics, and mathematics.

BCRU's largest student group is comprised of females, between the ages of 18 and 24 years, with a headcount of 4,649 students falling within this category (BCRU Institutional Research Data, 2014). The second largest student group is composed of male

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[1] To maintain participant anonymity, this and all subsequent BCRU sources cited within the report have been omitted from reference list.

students, between the ages of 18 and 24 years, with a headcount of 3,663 students (BCRU Institutional Research Data, 2014).

The university draws a majority of its student population from the region of BC that it is located in. At one time, the region was predominantly agricultural, and this field of study is still important. However, many of the communities now have a large percentage of people who work in the Vancouver metro area and commute into work daily. Some communities in the region are also important providers of health care and K-12 schooling, as well as providing retail services. Of the local communities, five municipalities represent approximately 54% of BCRU's enrolment (BCRU's Strategic Enrolment Management Plan, 2014). Neighbouring communities make up an additional 31% of BCRU's core student population (BCRU's Strategic Enrolment Management Plan, 2014).

Universities across North America focus many of their student support initiatives on student retention (BCRU's Strategic Enrolment Management Plan, 2014). BCRU surveyed its own retention rates in the period from fall 2010 to fall 2011 and found that new students had an attrition rate 13.4% higher than continuing students (BCRU's Strategic Enrolment Management Plan, 2014). Furthermore, students who chose to withdraw from the institution had a GPA .56 lower than those students who chose to persist (BCRU's Strategic Enrolment Management Plan, 2014). The disciplines with the greatest attrition were the sciences, with students in this program being more likely to switch to a non-science major.

4.   The Participants

The group of students who participated in this study was diverse and spoke with enthusiasm and passion about their academic journeys. BCRU's emphasis on community access and being a teaching intensive university with programming from developmental (high school equivalents) to graduate level at the master's level is reflected varied academic background of the study participants. This level of diversity in academic qualifications is not commonly found in the provincial research universities, as the admission criteria at most large universities create a more homogenous student population. The purpose of this chapter is to provide background information about the study participants so that the reader has a context when considering the individual participant responses. The chapter also provides the reader with demographic and other information about participants' backgrounds and experiences.

The study participants ranged in age from 18 to 28 years. Four of the participants entered the BCRU directly from high school with a self-reported strong high school academic background. Two of the participants took more than a 2-year break before enrolling in BCRU, while the other nine participants enrolled at either BCRU or another post-secondary institution before choosing their current program.

Although each student's personal context was different, there were some common characteristics. First, all of the participants were very clear about their choice to attend the BCRU rather than other post-secondary institutions. Some chose BCRU because they had experienced programs at other institutions and had determined that those programs were not suited to their needs, preferences, or goals. Others had determined prior to leaving high school that a smaller university with a focus on teaching was the right choice for them. Another shared characteristic among participants was that at some point each person had tried to pursue sciences at the post-secondary level. Approximately 47% of the participants entered the sciences and changed directions to pursue a non-science major, while others continued to pursue a science program or major.

In this report pseudonyms have been used in order to protect the identities of the participants. In the following section I have provided an introduction to each participant. The students fell into two main categories, which I have designated as (a) switchers,

students who started within a particular major and chose to leave that major, and (b) non-switchers, who entered university to pursue a science major and chose to persist.

4.1.1.   Switchers

As previously stated, switchers are students who entered university with one major and chose to leave it. Table 1 provides the profiles for the eight participants who switched programs.

Table 1

Student Profiles for Switchers

Student Demographics	Student Information
Student Pseudonym	Aaron Head
Age	24
Entered BCRU	2007 and returned in 2012
Current Major and/or Minor	Psychology
High School Location	Local high school in BCRU's catchment area
Grade 12 or higher math in High School	Math AP
Work/Volunteer Activities	Working part-time off campus. Is part of the Psychology Association.
Career/Educational Goal	Graduate school with a psychology focus
Summary	Aaron is pursuing a psychology major. He is interested in graduate school after his undergrad.
Student Pseudonym	Sally Washington
Age	20
Entered BCRU	2012
Current Major and/or Minor	Sociology major
High School Location	High school in Africa
Grade 12 or higher math in High School	Math 12
Work/Volunteer Activities	Working part-time off campus
Career/Educational Goal	Graduate school or working for United Nations

Summary	Sally entered BCRU to pursue the sciences but switched to sociology.
Student Pseudonym	Madison Taylor
Age	23
Entered BCRU	2011
Current Major and/or Minor	English
High School Location	Local high school in BCRU's catchment area
Grade 12 or higher math in High School	Math 12
Work/Volunteer Activities	Works for the school newspaper
Career/Educational Goal	Writer
Summary	Madison is a multiple switcher. Despite not having a strong science background, she pursued the sciences until the semester before my interview with her.
Student Pseudonym	Margret Peters
Age	27
Entered BCRU	2011
Current Major and/or Minor	English
High School Location	Local high school in BCRU's catchment area
Grade 12 or higher math in High School	Math 11
Work/Volunteer Activities	Working part-time off campus
Career/Educational Goal	Secondary school teacher
Summary	Margret is completing a Bachelor of Arts degree with a major in English. She is exploring her options and is considering pursuing a master's degree in English or possibly entering Teacher Education.
Student Pseudonym	Tina Dodson
Age	23
Entered BCRU	2011

Current Major and/or Minor	Undecided
High School Location	Local high school in BCRU's catchment area
Grade 12 or higher math in High School	Math 11
Work/Volunteer Activities	Working part-time off campus
Career/Educational Goal	Undecided
Summary	Tina Dodson is a multiple switcher with no clear academic or career direction. Tina actually has switched program majors as well as post-secondary institutions. Tina also had to manage a significant health issue during her Grade-12 year.

Student Pseudonym	Hayden Polowski
Age	27
Entered BCRU	2011
Current Major and/or Minor	Psychology
High School Location	Completed high school in Ontario
Grade 12 or higher math in High School	Math 12
Work/Volunteer Activities	Working part-time off campus
Career/Educational Goal	Law school
Summary	Hayden started his academic career in the sciences, and he has now switched his major to psychology. Hayden always enjoyed math and sciences through high school. Hayden would like to enter law school after university and is preparing to write the Law School Admission Test.

Student Pseudonym	Samantha Gill
Age	27
Entered BCRU	2011
Current Major and/or Minor	Psychology
High School Location	Local high school in BCRU's catchment area
Grade 12 or higher math in High School	Math 12

Work/Volunteer Activities	Working part-time off campus
Career/Educational Goal	Graduate school with a psychology focus
Summary	Samantha currently completing a Bachelor of Arts in psychology. She originally started her academic career in sciences with the goal of going into dentistry.
Student Pseudonym	Heather Hinchcliffe
Age	22
Entered BCRU	2012
Current Major and/or Minor	Global Development
High School Location	Local high school In BCRU's catchment area
Grade 12 or higher math in High School	Math 11
Work/Volunteer Activities	Working part-time off campus
Career/Educational Goal	Graduate School with a Global Development focus
Summary	Heather is pursuing a Bachelor of Arts in Global Development at BCRU. She originally entered university to pursue a Bachelor of Science in Nursing. Heather did not have a strong background in the sciences at the high school level. Her favourite subject in high school was English, and she described herself as not "a math person." In high school, she completed Math 11, the minimum level for entry into a nursing program.

Note. BCRU = British Columbia Regional University; Math AP = Mathematics Advanced Placement.

4.1.2.   Non-Switchers (Persisters)

As stated earlier in this chapter, non-switchers are students who have chosen to continue with the major that they first selected when enrolling in their university program. Table 2 provide profiles for the seven participants who remained in their chosen programs.

Table 2

Student Profiles for Non-Switchers

Student Demographics	Student Information
Student Pseudonym	Sohani Toor
Age	18
Entered BCRU	2013
Current Major and/or Minor	Chemistry
High School Location	Completed high school in BCRU catchment area
Grade 12 or higher math in High School	Math 12
Work/Volunteer Activities	None
Career/Educational Goal	Medical or graduate school
Summary	Sohani is pursuing a Bachelor of Science with a chemistry major. She is open to pursuing either medical school or graduate school.
Student Pseudonym	Jessica Haven
Age	23
Entered BCRU	2012
Current Major and/or Minor	Agriculture
High School Location	Completed high school in BCRU catchment area
Grade 12 or higher math in High School	Math 12
Work/Volunteer Activities	Working part-time off campus
Career/Educational Goal	Working in the Agriculture field
Summary	Jessica is intending on completing a Bachelor of Science in Agriculture. Jessica has completed a certificate and diploma in agriculture and would like to continue her education in that field.
Student Pseudonym	Ted Hough
Age	28
Entered BCRU	2013
Current Major and/or Minor	Chemistry

High School Location	Completed high school in BCRU catchment area
Grade 12 or higher math in High School	Math 12
Work/Volunteer Activities	Working part-time off campus
Career/Educational Goal	Teaching
Summary	Ted took a 10-year break after high school graduation before enrolling at BCRU. Ted is pursuing a chemistry degree.

Student Pseudonym	Christina Valet
Age	22
Entered BCRU	2012
Current Major and/or Minor	Biology major with a psychology minor
High School Location	Completed high school in BCRU catchment area
Grade 12 or higher math in High School	Math 12
Work/Volunteer Activities	Working part-time off campus
Career/Educational Goal	Graduate school
Summary	Christina is currently pursuing a biology major and a psychology minor at BCRU.

Student Pseudonym	Marshal Tizzard
Age	18
Entered BCRU	2013
Current Major and/or Minor	Biology
High School Location	Completed high school in BCRU catchment area
Grade 12 or higher math in High School	Math 12
Work/Volunteer Activities	Working part-time off campus
Career/Educational Goal	Medical school
Summary	Marshal is currently pursuing a biology major with a long-term goal of going to medical school.

Student Pseudonym	Jennifer Rouleau
Age	21
Entered BCRU	2012
Current Major and/or Minor	Physics
High School Location	Completed high school in BCRU catchment area but took elementary school in Russia.
Grade 12 or higher math in High School	Math AP
Work/Volunteer Activities	Working part-time off campus
Career/Educational Goal	Teaching or graduate school
Summary	Jennifer is currently completing a physics major with the goal of entering teaching. However, she is open to graduate school and will explore that option over the next year or so.
Student Pseudonym	Charles Wong
Age	18
Entered BCRU	2013
Current Major and/or Minor	Biology
High School Location	Completed high school in BCRU catchment area
Grade 12 or higher math in High School	Math 12
Work/Volunteer Activities	None
Career/Educational Goal	Pursue pharmacy major at a larger university
Summary	Charles is pursuing a Bachelor of Science with a major in biology. Charles' long-term goal is to apply to a larger research university and pursue pharmacy as a major. Currently, he is taking the required prerequisite courses for pharmacy and plans to transfer after 1 year.

Note. BCRU = British Columbia Regional University; Math AP = Mathematics Advanced Placement.

5.   Overview of the Interview Results

The research conducted for this thesis was designed to explore the perceptions of a group of university undergraduate students as they reflected on their experiences in moving from pre-college school curricula into university programs. The initial focus of the study was to examine factors that were influences on the participants' choices to study university courses and programs in the areas of science, mathematics, and technology. Research goals were also to discover potential influences on the participants' reasons for persisting with, or changing directions in their major studies and to develop an understanding of their planned post graduation goals.

The interview transcripts, which present the stories of the 15 participants in the study, revealed not only influences on their choices and decisions around decisions concerning their studies in science- and mathematics-related university subjects and programs, but also the circumstances that affected their choice of university, their level of engagement with the university as a learning environment, and something of their larger life experiences and demands. I found the participants to be rich with opportunities and options, while also functioning in very complex decision spaces. It is the purpose of this chapter to explore and illustrate common themes across the various stories and also to show the unique elements in the personal narratives. In a sense, the conversations put the participants' decisions as to the directions for their university studies and their decisions about whether to continue with studies in the sciences in a broader context — one that included their current work outside university, community and family influences, and their general engagement with the university experience.

The interview conversations were framed somewhat chronologically into three broad phases: the participants' education and life experiences prior to entering the BCRU, their university experiences, and their future plans and directions. Hence, the interview data as presented in this chapter are also broadly organized by these phases.

5.1. Participants' School Experiences Prior to Entering University

5.1.1. Participants' Elementary and High School Attendance

Most of the participants in this study attended elementary and high schools in BC although two of the participants had school experience outside Canada, in Africa in one case and in Russia in the other, while one had attended Canadian schools in another province. The majority of the participants attended public high schools, although one participant had attended a small private school. Most of the participants had also attended high schools in communities that were in geographic proximity to BCRU and within commuting distances of their homes.

5.1.2. General Impressions of School Experiences Prior to Entering University

The study participants' impressions of their elementary and high school experiences were generally favourable, although there were notable differences in their individual descriptions. Positive views are seen in the comments of Jessica Haven and Aaron Head. Haven remarked, "Very rewarding. I really enjoyed school. Every day, I'd want to go to school. I never hated it per se. It was a good experience for me." Aaron Head extended this positive note, stating, "I really enjoy learning and I enjoy knowledge, and just learning about everything, right. So, for me, it's kind of like there's not enough time to fit everything in or worrying about having too many credits." To this he added,

> Especially in high school, I guess, a lot of opportunities for me to kind of pursue what I wanted to pursue . . . taking courses from all academic areas and, yeah, it's been a good experience. . . . I had way over . . . way more credits than I actually needed to graduate. (Aaron Head)

However, some participants were less enthusiastic, at least about some aspects of their experiences. For example, Christina Valet described a change in attitude as she progressed through school.

> I didn't like school for a long time, but at the end of high school, I had a lot more options. I switched schools, and I had a lot of extra courses and had a lot of really

awesome teachers and became a lot more interested in what I was doing. (Christina Valet)

A similar switch in attitude was found in comments made by Madison Taylor, who initially described her school experience as "boring," but then added,

> Well, I was a daydreamer through . . . up until high school, and then I found it very easy to hit the honour roll in high school and [I] haven't really met any challenges here yet. I think that was my decision alone, just, "Okay, I'm in high school. I have to smarten up."

Some participants noted that they particularly enjoyed the social aspects of school life. Ted Hough expressed this perception and noted the interaction between his social and academic engagement with school: "Always enjoyed the social aspect. I always enjoyed school but my work ethic, in terms of schoolwork, has certainly changed since high school." Heather Hinchcliffe also expressed a positive view of her school experience: "I like learning and I liked the social aspect of school. I always liked all my teachers, my classmates. I thought school was . . . especially from elementary to high school, it was just fine."

However, other participants indicated less positive experiences with the social aspects of the school culture. For example, Hayden Polowski noted, "I was somewhat maybe bullied a little bit in elementary days, but that kind of declined throughout . . . once I got into junior high and high school." Tina Dodson made a stronger claim, stating, that her school experiences were "not the best":

> I was bullied a bit in elementary school and high school, so I didn't really like going to school at all just because of the social aspect . . . especially in high school, I used to skip a lot. I just wouldn't go to class because I didn't want to deal with the people there.

However, in spite of this unfortunate experience, Tina Dodson remarked, "But I've always really enjoyed learning and doing the actual work involved with education." Despite reporting being bullied, Hayden Polowski also claimed, "But I love school."

5.1.3. Specific Experiences with Science Subjects in the High School Curriculum

In terms of participant views of favourite school subjects, it is not surprising, given the recruitment criteria for this research, that many described science courses as favourite elements of the school program, especially in high school, although for some their enthusiasm for the sciences was apparent even in the early grades. A comment by Samantha Gill reflects this early enthusiasm for the sciences prior to high school.

> I've always loved sciences as well . . . I would say . . . before Grade 10, I liked it a lot more. . . . I would even do experiments at home like, you know, the one where you mix the baking soda and . . . vinegar. (Samantha Gill)

Unfortunately, Samantha's early enthusiasm for the sciences was not sustained as she moved into the higher grades:

> And then sciences was very difficult for me in Grade 11, I think, because switching schools and new profs, new students, that could have been a factor, I think. But sciences became difficult for me then whereas I used to enjoy them before. . . . It was specifically biology and chemistry was my hardest; I still liked physics a lot, and I think it was mainly to do with the pro . . . the teacher.

This group of participants listed preferences that included all the major science subjects conventionally found in the BC curriculum: physics, chemistry, and biology. Some BC high schools have more specialized high school science offerings such as Earth Sciences and Environmental Sciences, but the only special offering mentioned in this study was a high school Agriculture course, described by Jessica Haven as being of particular importance to her school experience.

Ted Hough reflected on his view of physics, stating, "I really thought physics was really cool. I wasn't necessarily getting all the A's, but I thought it was really cool. And so I applied myself to that a little bit more than other stuff." However, he had a very different view of chemistry: "Chemistry, I should mention . . . chemistry, I hated it in high school. I just didn't like it one bit; it put a bad taste in my mouth" (Ted Hough). However, as described later in this chapter, his preferences were significantly revised after returning to studies at university.

> Coming back to university here, the reason I decided chemistry might be my major is almost for that exact reason . . . is because I didn't like it before and I was like,

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"Okay, well, there's a wealth of knowledge there. I had better pick up some of that." So coming back and thinking, "Okay, like, fresh start with chemistry. Let's go." Straight from the get-go, I thought it was so cool. (Ted Hough)

On the other hand Charles Wong discovered a passion for chemistry: "And then in high school, I figured out chemistry is my favourite science and probably my favourite subject as well."

In some cases participants described early interests in particular sciences that they decided not to pursue further for practical reasons. Marshal Tizzard's experience reflects this pattern.

> I never lost interest in it [astronomy]. It's just that . . . I think the thing that pushed me away was I wasn't sure if there was like a . . . there was a lot of jobs available in it. . . . So I guess that just kind of overweighed kind of the . . . it seemed to me like the benefits of going into medicine outweighed that of going into astronomy. (Marshal Tizzard)

However, Marshal then recognized the potential of a different career path still located with science: "I've always been good with numbers so I'm like, 'Well, why don't I look into the physics and math?'" Jennifer Rouleau described a somewhat different, less positive influence by a specific subject on her decisions about with which aspects of science to pursue into a possible career.

> I've always been good with kids; I wanted to be a paediatrician. However, I hate biology. . . . And I couldn't see myself sitting down for 10 years and doing just biology just to get to that career; I didn't think it was worth it. (Jennifer Rouleau)

Some participants combined science and non-science courses in their description of favourites, as in the case of Margret Peters (art and biology), Tina Dodson (math, science, and drawing), Christina Valet (writing and science), and Aaron Head (English and math). Valet, who described both sciences (biology and animal science) and writing as personal favourites, referred to thinking about career options in which a choice to emphasize the pursuit of one field of interest professionally still left open the possibility of engagement with the second, less practical area of endeavour.

> Specifically, I want to do research in fieldwork-related stuff because I want to travel, and I'm not particularly a person who likes staying in one place, and it kind of offers me that opportunity. . . . Plus there's a lot of different things you can do with a biology degree, and I tend to have a lot of interests. And there's always something

new to look into . . . you can do writing, you can do all kinds of things. (Christine Valet)

Tina Dodson also noted her appreciation for math and science and for drawing: "I have pretty broad interests. I've always really enjoyed math and science but I love drawing as well."

5.1.4. Experiences with Math Subjects in the High School Curriculum

The participants in this study expressed a range of personal perspectives about the math curriculum as they experienced it in school prior to university. While math is sometimes described as a significant barrier for high school students and as a shaping force in their choice of university majors, the participants in this study were generally not highly negative about the math courses that they encountered in high school, although there were some exceptions. Of the 15 participants, seven identified math as a favourite subject or as one of several subjects rated equally as favourites. Two participants combined math as a favourite with history or with English. Again, given the selection criteria applied to recruiting participants in this study, this is probably not surprising.

Participants gave a variety of opinions about math as a component of their educational experiences prior to university. Aaron Head, for example, valued math for "the problem solving and all that, just working with numbers," while Hayden Polowski stated, "Math was always my favourite; I always excelled in math. Yeah, it was always math right up until Grade 11 or so, 12."

Samantha Gill mentioned having been placed during the elementary grades in a special Kumon® math program (at the initiative of her mother), and she attributed that experience to some of her proficiency in math in the later school grades:

> And then my Mom put me in Kumon®, the math program . . . outside of school and that's what really pushed me. And then that became my favourite subject because I was doing really good in it. So I would say math was my favourite subject even up until high school.

Samantha Gill also noted that she continued to do well in math throughout elementary school and into the senior grades of high school.

Other participants had less positive opinions about their school math experiences. Margret Peters, for example, stated, "Math was not my favourite. I think the first C I ever had was in Grade-4 math," and added, "I struggled in math after Grade 9." Heather Hinchcliffe remarked tersely, "I only took Math 11. I stopped."

Aaron Head, whose positive views about his math experience are noted above, also made an interesting comment about working collaboratively on math problems with a friend who had later gone into engineering at university.

> But we were friends and doing math together in high school, so it's kind of nice to have a friend to go with that . . . to go through with it. Yeah, studied and just kind of talked about it for interest, right . . . solved puzzles together, worked on math projects. Yeah, for me . . . yeah, a lot of it was the puzzle solving. (Aaron Head)

5.1.5. The Role and Influence of Teachers in the Participants' High School Experiences

One of the topics addressed in the interview conversations concerned the role of teachers, particularly teachers of math and sciences, in the participants' experiences as students in elementary and high school. This topic elicited some interesting reflections about the influence of particular teachers on the participants' educational progress and also about their preferences and opinions about effective teaching practices and learning experiences. Sohani Toor's comments indicated that the methods and styles of teachers, especially in the senior years, can help to prepare students to make the transition to university.

> We went beyond the Grade-12 curriculum for most of the subjects . . . like, for chemistry and bio. We did more into detail and then we did extra labs and stuff like that. I actually found it really similar to university . . . like, first year, so I haven't had much trouble with that. (Sohani Toor)

A number of participants mentioned teachers who had positively impacted their learning of particular subjects and influenced their general attitudes toward the subject and its potential as a possible selection as a major in university. Aaron Head, for example, mentioned the positive impact of a particular math teacher: "I had a great prof and . . . or teacher in Grade 11. He's just a great guy, a funny guy, too, and always had some kind of practical aspect to why we were learning certain math theories." In a different part of the interview, Aaron mentioned again the importance he attached to the practical aspects of

subjects that might be considered as potential areas for future university studies: "But then I was like, 'Should I stay with math because just how much practical value will this have later on?' depending on what job I get and that kind of thing."

Sally Washington referred to the importance of a particular teacher to her math experience: "I had really good professors with math. I actually used to hate math, and then I liked the teacher . . . the good teacher that I used to have." (In this quote, Sally referred to her experience in school in Senegal, before coming to Canada.) Sally's experience in Senegal also featured a program that was specifically designed to prepare students for university level science courses. The Canadian equivalent would be the advanced placement (AP) courses offered in the senior years of high school.

Tina Dodson described the important role played by teacher during a time when she could not attend school because of a serious illness.

> I had a really serious illness in the summer before Grade 12. I ended up getting a blood clot in my leg, so I had a really hard time going to school around then. And one of my biology teachers was really good as far as that went. He let me homeschool myself and was really good at getting me my homework and that sort of thing. (Tina Dodson)

Tina also commented on a less positive influence from a different high school teacher, noting, "My Math 12 teacher was just really bad. He was my Physics 11 teacher as well." However, Tina remarked on the positive influence of an instructor who had encouraged her about her interest in and talent for art.

> My art . . . drawing teacher in . . . [another post-secondary school] was really good as well. He was part of the reason why I considered going into the arts, the drawing and visual arts, because he kind of asked me, like, "Well, why are you in a program for science?" (Tina Dodson)

Jessica Haven noted the importance a particular teacher had to furthering her interest in agricultural sciences and also in her decision to attend BCRU.

> My biology teacher in Grade 11 said that I should just try out the agriculture class that was offered at the high school. And so I had known her, and I trusted her opinion, so I went into the Agriculture class and found I really enjoyed it. And then after high school, I was a little bit torn between universities, and I finally decided to go with [BCRU] with their Agriculture program because they had already made connections with my high school. (Jessica Haven)

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Jessica's example is particularly interesting because it illustrates a relationship that developed between university faculty and a program developed by the high school teacher: "When I was there, they would come and do demonstrations and little workshops with the students and helped out with the plant sales and everything. So I felt comfortable that I already knew part of it." (Jessica Haven)

Ted Hough also expressed enthusiasm for a teacher who affected his interests in physics and math: "I remember my physics and math teacher — who was the same person in high school — absolutely loved him, absolutely loved him. And the way he taught was fantastic." Some participants also mentioned the development of a friendly, more personal interaction between student and teacher as being important to how they viewed a subject. Jennifer Rouleau described such a situation in her school experience.

> He was a really good teacher, and he would always chat because we had a very small school, a small class. So whenever we had downtime, he would be able to talk, and so we talked a lot about his experience in school and the differences between math and physics and what he enjoyed, what he didn't enjoy. And so that kind of gave me an idea of what to expect. (Jennifer Rouleau)

Similarly, Charles Wong mentioned the importance of one of his high school teachers to his achievement in chemistry and transition to university.

> To make me like chemistry, maybe my high school chemistry teacher . . . yeah, she was . . . she made us learn a lot. So I think she's one of the top teachers in BC, definitely. And she was on the AP Board, so she always made sure that we learned all we needed to. And, yeah, we learned everything very thoroughly and she had really high expectations so, that, it made me work really hard. And, yeah, I was really successful in chemistry because of her, I guess. (Charles Wong)

Christina Valet's comments also echoed how a teacher can have an effect on a student's potential transition to university.

> And my biology teacher in high school, I felt that she did her course very similar to a lot of university courses. There wasn't [*sic*] a lot of assignments — it was mostly tests — and she made us do flash cards so we got into the habit of studying properly. (Christina Valet)

Christina also noted the importance of her math teachers in her preparation for university.

For the math, I did Math 11 and 12, and I had really awesome teachers for that They went out . . . I feel like I've had a lot of foundation before going into math, and I've noticed that some people don't have that. I've helped someone out and they didn't have much of a foundation in math, and it didn't make a lot of sense to them. Even though I struggled with math, they seemed to have a much harder time. (Christina Valet)

Jessica Haven clearly affirmed the importance of the high school learning experience and teaching to her university transition.

And everything that I'm doing in sciences now, I'm still remembering things from high school because I enjoyed it so much. You know, 5 years later, I'm still pulling on that information, so they did a good job reinforcing it and stimulating interest. (Jessica Haven)

This topic of the transition to university is explored in greater detail later in this chapter (see Section 4.4).

However, some participants reported less positive experiences with teachers. Jessica Haven, although making positive reference to her overall high school experience above, noted a rather uneven progression: "[I] had good math teachers in elementary school, not in middle school. That's probably why I suffered a bit. And then in high school again, I had good teachers with the exception of Grade 12."

While Madison Taylor had generally effective teachers, she recalled developing a very unfortunate relationship with a math teacher. She described the relationship as follows.

I really disliked my Grade-9 math teacher. He used to pronounce my name wrong . . . and then, when I tried to correct him, he would make it a joke, and I was [for the whole Grade 9 year]. And, to get back at my teacher, because Grade-9 logic doesn't make sense, I decided to flunk math. (Madison Taylor)

Madison's comments on the consequences of "Grade-9 logic" are certainly cogent.

Participants' statements about teachers often reflected the match between a student's preferences or learning style and the teacher's personal style and approach, as much as on particular instructional methods or learning experiences. However, Marshal Tizzard commented fairly directly about how science, as he experienced it, seemed often to be taught.

And it . . . sometimes I thought the way they taught science was a bit dry; it could have been made a bit more interesting. But I found it inherently interesting just because I like science, but I've always thought, to someone who might not be as interested, this isn't exactly going to win them over. (Marshal Tizzard)

5.2. The Role of Family and Friends in the Participants' Pre-University Experience and Orientations Toward Future Studies and Career Options

If teachers can play significant roles in the educational experience and attitudes of students as they progress through school prior to entering post-secondary education, it is to be expected that the participants in this study might also refer to the influence of family members, friends, and peers on their views of the relevance or career potential of school studies and on the potential choices of university majors or programs. In the course of the interviews conducted for this study, some participants made reference to these effects in the context specifically of their experiences in elementary and high school.

Margret Peters made particular mention of her father's influence on her choice to study sciences in school and on her choice to major in sciences at university.

My Dad was kind of really forcing it on me quite a bit. He wanted me in sciences. He wanted me to do something. . . . I guess he figured . . . , "You're the smart one. You can do it." And he seems to think that's . . . that there's more, I guess, money and prestige in science majors. (Margret Peters)

Jessica Haven also referred to family attitudes that were supportive of an interest in the sciences: "Probably because my parents, my father especially, encouraged learning and education. He's very science-oriented as well, so if we ever had questions, he'd always answer us right away and made life interesting in general."

Jessica Haven further reinforced the influence of her parents, especially in the context of selecting to study in the sciences at university:

I owe all that I am to what my parents have expected of me, and they never expect me to do less. They expect you to get good marks and to go on and to learn. And I think if parents do that and really reinforce learning, then you're going to be successful in sciences or mathematics and things like that.

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The influence of Samantha Gill's mother in placing her in a Kumon® math tutorial program while she was still in elementary school has been referenced earlier. Samantha clearly attributed much of her success in math (and sciences) to that early intervention. Marshal Tizzard also mentioned parental influences on his interest in science: "I know my parents bought me a lot of science books, so that probably helped."

In some cases parental occupations seemed also to have some influence on the participants' attitudes toward sciences and math. Jennifer Rouleau, for example, noted this effect, stating, "Both my parents are accountants, so I've grown up with numbers my whole life. And so I didn't mind being pushed that way, in that direction, and it kind of helped with problem-solving . . . like, I liked putting puzzles together."

Sometimes participants viewed the influence of parents and family friends as having influenced their ideas about future studies and potential career options. Charles Wong referred to this, stating, "I guess my Mom knew some people who knew pharmacists. And, yeah, it's a relatively stress-free job compared to doctors. And, yeah, none of my teachers could really help with that decision."

Heather Hinchcliffe referred to a similar source of influence:

In high school, one of my best friends, her Mom was a nurse. So that was . . . she was influential in me choosing nursing as a career because, you know, I grew up with her, and I always listened to her Mom talk and I always thought that'd be a cool career.

Christina Valet remarked on the significant influence of parents directly on her interest in science.

Well, I've always been kind of interested in science [laughs]. We did science in school, but I think it was more my parents that were . . . my Mom is always interested in things and interested in science. And she . . . it was always like, "Oh, this is so cool to learn about . . ." or birds or something in National Geographic or something like that. And my Dad would take me out to look at birds and the . . . you know, outside, or something. And I'd pick up books on different animals and things like that when I was younger. So I feel that it was not so much through school that I probably gained my liking of science, even though there was science exposure. (Christina Valet)

In other cases the role of parents was mainly expressed in the form of general support and encouragement. Marshal Tizzard noted, "Well, my parents always taught me

just to do what I wanted to do." However, general family support could be fairly firm, as noted by Jessica Haven.

> My family's very supportive, so whatever I choose, they're going to support me fully. But they were always there for advice if I needed it. I've always been pushed to get a degree, go to school. . . . Not going to school was never an option. (Jessica Haven)

Siblings were sometimes seen as exerting influence on students as they considered their post-high school options. Hayden Polowski referred to this in regard to the influence of his brother's choice of career and the fact that his brother acted as a role model.

> I thought I'd give science a shot because my brother did it. He completed it; he's successful in what he's doing. So I thought I'd maybe mirror that, and I saw kind of success in my family after taking that route. (Hayden Polowski)

However, Hayden also mentioned the more general support of his entire family: "I wasn't sure really what I wanted to, . . . and, I don't know, I'm pretty close to my family, so I kind of . . . they're the first people I turn to for anything."

Later in this chapter (see Section 4.4.1), I consider participants' perceptions of the sources of advice and influence they experienced in regard the choices they made about university majors and whether or not to persist in a program or change direction. In this section, however, I have mainly referred to influences mentioned during the interviews in the context of the participants' recollections of their pre-university school experiences.

5.3. The Path From High School to University

Accounts of university and college experiences often seem to present the typical undergraduate as having left high school and moved more or less directly into college or university, sometimes to study at an institution removed from their home towns and to live in residence or close to campus (Andres & Finlay, 2005). Further, the stereotype is that students will attend more or less continuously at the university of their initial choice, and complete their degrees there, often within 4 years for the typical bachelor degree. The participants' experiences uncovered in the interviews conducted for this research often differed from this pattern.

Seven of the 15 participants in this study reported having attended other post-secondary institutions prior to enrolling at BCRU. Some had started studies at other BC colleges or universities and then decided to change directions and enter BCRU. Some had attended university or college programs elsewhere in Canada. Four participants reported significant gaps in time between high school completion and entry to (or return to) BCRU. In one case, the participant began studies at BCRU and then left to go to work for a community charity for several years before returning to the university. Two other participants reported leaving formal studies for approximately 2 years and working at various jobs before returning to university. One participant even reported a 10-year gap between high school and university. Only three participants described their paths as being direct from high school graduation into programs at BCRU

It should be noted that because of the varied duration of the different routes taken between high school and university, the participants represented a range of ages from the oldest at 28 to the youngest at 18, with a mean age of 23. Further, some study participants were in the first year of their university studies, others were in the second or third years, but age did not necessarily correlate to years or semesters completed. Only one participant reported being in the fourth or final year of studies, but noted taking additional courses in order to raise his GPA. It is important to appreciate that it is now difficult to provide a definition for the term full-time student, with significant numbers of students enrolling for less than the maximum number of credit hours or courses per semester. At one time, university policies discouraged partial attendance (or even prohibited it), and students enrolling for fewer course or credit hours than the maximum were also denied the opportunity to apply for scholarships or bursaries.[2]

In a few cases participants had completed high school without the courses required for regular entry to the university degree programs. In those cases, participants had taken supplemental high school courses at Adult Education Centres operated by local school districts or by the university. Some participants coming from other provinces, especially

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[2] In fact, even today, many scholarships or other funds to support post-graduate studies are available only to those considered to be in full-time studies.

Ontario, found that they could not get credit in BC for high school courses taken in Grade 13.

The participants who reported a break or gap between high school and university, or between initially registering at another institution and applying to BCRU, were generally of the view that the experience had been useful, and not a waste of time. One participant, Ted Hough, who stepped out for 10 years, stated his attitude very clearly.

> I am glad I didn't come straight out of high school and go straight to university. I feel like my attitude towards school has certainly changed in that time period. And I don't necessarily think I had a good grasp on myself at that time. (Ted Hough)

Some participants who reported having taken a break between enrolling at the university and leaving high school did feel pressure from peers who had taken the direct path to post-secondary. Jessica Haven's remarks reflect that pressure.

> I did kind of take a year off and so I felt a great pressure because all my friends had enrolled right away and they knew what they wanted to do. They knew they wanted to be teachers, so they had that goal and they were going to do it. . . . And so I was always up in the air. And I was always so sure of myself in high school, that it was kind of difficult at that time to choose it. But there was pressure. (Jessica Haven)

For some of the participants who reported a break in their formal educational progress, the break reflected a felt need to redirect their goals for further education after first trying out their original plans or because they recognized a general lack of clarity about their goals. Aaron Head, for example, offered this perspective on the break in his formal educational process. "I graduated high school in '07, and then took a year of university because. . . I didn't know what I was going to do. And then after that, I quit university and just worked for a few years" (Aaron Head). Samantha Gill also reflected this sort of initial trial approach: "Dentistry was in the back of my mind but I didn't really know for sure, so I tried accounting [at the BC Institute of Technology straight out of high school] and . . . I didn't like it." Samantha reported that she took a break from formal studies for 2–3 years after leaving the Accounting program and then entered BCRU.

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5.4. The University Experience

Many of the study participants discussed the difficulty of their transitions from high school to university. Some of the participants deemed themselves to be unprepared for the rigour of a university program. Aaron Head was able to provide a unique perspective, as he entered university directly from high school, left university, and then returned after an absence. "I noticed a big difference then, just in my own attitude towards school, . . . I appreciated it a lot more, was more willing to do the homework and do the work, that kind of thing as well" (Aaron Head). He went on to explain how the time away enabled him to realize his need to engage socially outside of the classroom in order to be more successful.

> One thing was getting involved on campus and just learning about the different student associations. I'm involved with the Psych Association, right. So taking a break and I guess coming back kind of opened me up maybe to doing that more. . . . First year right out of high school, you're like, "Ah, you know, I don't know. This place is too big. I don't want to get involved here, scared of making friends, or kind of taking the initiative. (Aaron Head)

Sally Washington highlighted the differences in a university professor's approach to teaching versus high school teachers

> [It's] completely different, because in high school, the teachers believed you and always reminded you for everything that [was] due. But in university, it's more, you're more on your own, and you have to be . . . you can't really procrastinate as much as you used to in high school. (Sally Washington)

The impression of being on one's own or being independent was noted by most of the participants, but their feelings about it varied. Like many participants, Sohani Toor stated that this made her university experience, "A bit more demanding than school. . . . If you're having trouble with something, you have to put more work yourself." Sohani also noted that her experience of university has been different from what she expected. "It's been a bit different than what I expected. I thought I would have to put in a bit more work, but it's actually been quite easier" (Sohani Toor). When asked to explain her thoughts about why she found university to be easier, she offered, "My study habits. Oh, with the size of the classes and stuff, it's a bit different. But with the study part, it's about the same."

Marshal Tizzard referenced the independent learning environment of university as a good thing: "You don't have to spend as much time in the classroom now. . . . Then you're on your own for the rest of it, so that increased freedom is nice**."** Christina Valet's comments about the university experience extended Marshal's appreciation for the ability of students to manage their learning.

> Well, I actually really like the self-directed thing. I also like all the things . . . the options, the different things that you can learn, different courses that I can take. People that I meet that are interested in the same kinds of things is something that's neat as well. (Christina Valet)

Christina's comment indicates that she also enjoys the social side of university life. Samantha Gill discussed the change she felt between the social experience in high school compared to her university experience. "It's different than high school because I mean your friends separate. In high school, I just . . . it all [revolved around your friends]. But then university is a lot more independent" (Samantha Gill). Tina Dodson had a somewhat different perspective on the social side of university life.

> The social aspect's a lot different as well. It's . . . I guess it's not so much . . . there's not all the groups and you have to basically . . . are forced into socializing in high school. In university, you basically have the choice to or not. (Tina Dodson)

It should be noted that Tina was not keen on the social aspect of her high school experience.

> I didn't really like going to school at all just because of the social aspect . . . especially in high school; I used to skip a lot. I just wouldn't go to class because I didn't want to deal with the people there. But I've always really enjoyed learning and doing the actual work involved with education. (Tina Dodson)

Hayden Polowski also commented on how the expectations of university professors are different: "Just because you're on your own, you don't have anybody holding your hand and . . . you know, phoning home and whatnot."

Jessica Haven also stated that university involves "more self-directed work." However, Hayden extended this line of thinking, making a further comment comparing high school to university.

> But, especially here, [at BCRU] it feels a lot like high school, at this school. It feels like I haven't left high school. . . . I mean the classes are the same size. The rooms

look similar. But it's just much more independent and you're just treated more like an adult. (Hayden Polowski)

Jessica illustrated her contrasting opinions on the university learning environment, stating, "You just have to learn everything yourself. Information is just thrown at you and you have to deal with it." However, she extended this opinion, stating, "I like the independence part of it, though. I'm not complaining about it too much." Tina Dodson furthered this perspective, commenting, "You basically have to seek out the professors if you want extra attention. I've never really been a student that needs a lot of attention, though."

5.4.1. Students' Perceptions of Persistence With Their Major and Career Goals

As the interviews progressed, we moved into a series of questions that asked what major the student was in, what major the student wanted to complete, and what career goals students had planned post-graduation. For students who had switched their major, or planned to switch their major, a discussion about why and how they decided to switch their major was pursued. Furthermore, for students who did not plan to switch their major, a similar discussion developed focusing on how they knew they were they were in the "right" major for them.

The students in this study who described clear academic or career goals seemed to be less likely to want or feel the need to switch their major. Charles Wong illustrated this by clearly stating that he wanted to achieve a BSc degree in pharmacy and was very comfortable with his academic plan. For Charles, his commitment to the sciences began in high school when he realized he had an aptitude for the sciences. "I don't know why but I liked them [math and science] more than other subjects. . . . I liked doing calculations for chemistry and it was easier to just comprehend sometimes" (Charles Wong).

Some participants provided rather practical reasons for the choices they made in regard to their academic majors. For example, Madison Taylor explained that she thought she would not get a job in history and English, so she chose to enter the sciences. "I was concerned I wouldn't get a job with a history major and an English minor" (Madison Taylor).

Madison also remarked on her impressions about the nature of career opportunities should she decide to undertake major studies in history.

> And on top of that, I wasn't enjoying history as much as I thought I would. It was . . . well, whenever we had career days at . . . like, History Day, and it was . . . you go and interview a bunch of historians or something and talk to them about, "What can you do with a history major?" And all they said was, "Okay, well, you can continue to get your Doctorate or . . . and become a researcher of some kind, or you can be . . . like, it's a path to a lawyer." So there was no like, "Get your bachelor and get a job." It was like, "Get your bachelor and continue to something else." And that's something I didn't want to do. (Madison Taylor)

However, in spite of her comments above about her reasons for selecting to study in the sciences rather than history, Madison's experience with the BCRU student newspaper inspired her to switch from the sciences to an English major: "I've learnt this from working for the paper — is the only way you can handle a workload is if you really like to do it."

Margret Peters also talked about the need to "enjoy" her major choice. She defined enjoyment as "I feel good doing the assignments. I jump on them right away when I get home . . . with math and science, I would get frustrated quite easily."

Ted Hough, who entered university 10 years after completing high school, talked about his interest in Chemistry: "It's just the small building blocks of the world. I think that that's just a perfect place to start learning." Although only just starting his pursuit of an undergraduate degree in chemistry, he already has aspirations for graduate-level studies. "I have considered continuing on for my Master's and possibly a doctorate. I could also be completely satisfied with being a high school teacher in science" (Ted Hough). Ted's commitment to chemistry for the long term helps his overall dedication to undergraduate studies: "What I go on is that if I learn what I love, the jobs will come."

Jennifer Rouleau also demonstrated a commitment to her undergraduate studies because of a long-term post graduation goal: "Yeah, and it's still kind of up in the air. I mean, I have options of going into the Master of Education or Master in Physics." Although Jennifer experienced indecision around what program she wanted to complete after graduating, she was very clear on wanting to pursue further education. Marshal Tizzard's

long-term goal of entering medical school, or graduate school as a backup plan, helped to keep him focussed on degree completion.

> I'd graduate [from BCRU] with a Bachelor's and keep trying to get into med school. And if that didn't work, I might just . . . I don't know, maybe try to get even a master's degree in biology in a more specific thing or something else. (Marshal Tizzard)

Among the participants in this study, Heather Hinchcliffe was an example of a person who entered university intending to study for a Bachelor in Nursing (BSN) degree and then decided to switch directions and enrol in a newly developed program in Global Development. She undertook her original plan to complete a BSN with a fairly specific notion about her career.

> I really enjoyed medicine. I enjoyed biology. I enjoyed learning about human conditions and sicknesses and how . . . yeah, at least medicine and how it, you know, it helped. And I thought nursing was a good option because I could get a job right after, they make . . . you know, you get your degree, you have a job set up. It's not even just like getting a Bachelor of Science, right . . . this is a specific career path. (Heather Hinchcliffe)

Heather's decision to switch directions and enrol in the Global Development program resulted from several concurrent influences. First, she disliked the pharmacology component of the Nursing program, so she chose a psychology elective instead. That choice led to a personal assessment of her goals.

> So I decided to take a first-year psychology course. And, through that, I did this field trip to the Waverly. It's like a home, right, for people who are either old or have a variety of issues, right. And I really enjoyed the class, and I really realized how much I really enjoyed social aspects of things, right. I wasn't . . . and I dislike hospitals, which is something I probably should have considered when thinking [laughs] about my initial career path. And I just . . . I feel like, yeah, I really kind of thought, originally . . . before I thought about Nursing . . . I mean, I'm a big social development, psycholo– you know, more into that area of the social welfare kind of thing. (Heather Hinchcliffe)

Heather continued this reflection expanding on some of her reasons for making the shift away from nursing.

> It's like, I like science but like, not to like . . . you know, in high school, I was taking biology and chemistry but I was also taking law and English, you know what I mean . . . so I had a nice mix. And in the Nursing program, there was no mix. It was all . . . it was stats, it was pharmacology . . . it was anatomy, it was kinesiology, right, . . . it was all science, all the time. And it just got really . . . like, I missed the creative

[laughs] side of school, right . . . because I really enjoyed my high school law class as well. So, yeah, I just missed the arts. (Heather Hinchcliffe)

For Heather, her excursion into the psychology elective course appears to have been the catalyst for her change in direction, especially in that the shift from the sciences component of nursing into psychology seemed not to constitute a serious move away from sciences. She seems to have seen psychology as a sort of hybrid discipline.

It was like the first that was kind of like, you know, social . . . more, you know . . . it was more of an arts course . . . although the psychology students are very, "It's a science, like, okay" [laughs]. That's . . . you know, that's debatable [laughs]. . . . And then originally I was going to switch. . . do my Bachelor of Arts in Psychology because it. . . . I'm actually not even sure if the psychology falls under the arts or the sciences at [BCRU] because I think some universities, they play around with that. (Heather Hinchcliffe)

Heather's decision to shift into the Global Development program from nursing becomes easier to understand in the context of her own background and experience outside the university.

When I graduate, I'll probably go work with the Red Thread organization in Haiti, which is an organization . . . I've been working with for 6 years, right, and I know the founders very well. . . . And I was born there, and I have a lot of connections. . . . It's like my second home. (Heather Hinchcliffe)

The role of psychology as a sort of bridge from pure sciences into social sciences or the arts was also found in the comments made by Samantha Gill concerning her decision to change career directions.

So I came to BCRU and I chose the sciences because of my career goal . . . like, dentistry. And then I took Psychology 101, 102; I really liked it and then I took another one maybe a year later. And that was . . . so it was kind of through experience and I made my own decision. I was like, "I really like psychology and I do analyze a lot, just everything around me." So I thought that was maybe a better choice. (Samantha Gill)

Regardless of whether participants entered university and maintained their original academic and career goals or whether they switched to another major, in almost all cases, the students in this study described goals that they were attempting to pursue following their graduation. In some cases participants' post-graduation goals were clearly linked to the student's current university program, although in other cases the linkage was not as

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clear or, as illustrated by Heather Hinchcliffe's comments above, was the result of a series of decisions and influences.

Some of the participants in this study were still very much in a state of flux regarding their career directions or might best be described as trying to keep their options open. Sohani Toor's comments reflect this uncertainty or desire to "let the future unfold" while taking advantage of the diversity that can be found in university course and program offerings. "Right now, I'm taking English, I'm taking fiction, and I like that. And I'm enjoying chemistry. . . . I just like learning about science for now. . . . But I just want to complete my degree for now and then see where it goes" (Sohani Toor).

Tina Dodson is a participant who came to BCRU following a fairly convoluted path that included studies, or attempted registrations and admission, at three other post-secondary institutions. She had attended another regional university in a social sciences and arts program, with some science courses, and then applied to the provincial technical institute with a view to entering health sciences and becoming an ultrasound technician, but was rejected. She then applied to the largest research university within the province to enter the BSc program with the idea of eventually becoming a veterinarian, but was not accepted, and she is now registered at BCRU. While she is currently registered in a Bachelor of Arts program at BCRU and is not taking any sciences, she still is considering eventually applying to the ultrasound technician program at the BC Institute for Technology. As seen in her case, the path through university to an eventual career choice may not be very straight or clear.

5.4.2. Learning Environments and Curriculum

Many universities are making serious efforts to enhance the traditional classroom-based lecture-dominated university experience. Among these initiatives co-op learning and experiential learning experiences are often mentioned as means of helping students see the relevance of the skills and content they are learning in the curriculum. The role of experiential learning outside of the classroom was referenced by the participants in this study as helping them connect with lecture material provided in the traditional classroom context and as providing them with a better understanding of the demands of working careers in particular fields. When specifically asked about what she enjoyed most about

her current program, Global Development, Heather Hinchcliffe stated that the opportunities to learn outside of the classroom, found in the new Global Development program, were important to her.

> Yeah, there's a lot of opportunities as far as internships and study tours go, so that's really nice, and just a lot of flexibility there, right. Like, I'm going on a Mexican study tour at the end of this semester to go to Mexico and learn, you know . . . and then hopefully, next January, I'm going to go to India and work on a public health internship . . . so there's a lot of opportunities. (Heather Hinchcliffe)

The value that students place on learning experiences that involve laboratory or internship experiences was also reflected in comments by Sally Washington.

> There's no labs in sociology but there's some labs in French courses in the lower levels . . . which is really helpful because in French class . . . in the class, in the lecture, you just learn the concept and everything. But in the lab, you're able to actually practice it with the professor. There's an internship course that leads you to work with one of the NGOs [non-governmental organizations]. (Sally Washington)

Christina Valet also talked about how volunteering had helped her to develop a better understanding of what lies outside of the classroom. "Yeah, and volunteer stuff . . . I've done quite a bit of volunteer stuff as well, which I enjoy doing, and it gets me out and to see what the work is like, right?" (Christina Valet). The value of an applied learning experience was further illustrated by Jessica Haven, who commented,

> I like doing the labs and the hands-on portion. That's why I really enjoy the Agriculture program because you've got the background information, the thought behind what you do. But then you would also go out to the greenhouse and you'd put it into practice, so it makes what you're learning very applicable to real life, and just makes it worthwhile.

In some cases, a learning experience connected closely to an actual career appeared to have provided participants with the inspiration to switch majors and move from the sciences to the arts. For Madison Taylor, her experiences writing for the BCRU school newspaper helped her to decide to change her major to pursue of an arts degree.

Hayden Polowski made positive comments about the university classroom and lecture experience at BCRU and compared it to his previous experiences at an Ontario university.

> I love coming to school, love sitting in class, listening, engaging, you know, debating . . . listening to other people's viewpoints, trying to absorb and make sense of them, kind of see where they're coming from, give my opinion on it. So that's what I like about this school necessarily, is just the small class and you can get that interaction. Whereas like, at Brock, you're sitting in a lecture hall with 350 people or however many, you don't really get that.

While Hayden's comments above refer to his psychology classes, he was less appreciative of his experiences in science classes at BCRU.

> And I didn't really talk to anybody per se. . . . Like, I talked to different professors and just casual conversations about different political issues around the world, different cases in the courts. And, again, I just kind of . . . just through those casual conversations, it just kind of totally pushed me into the direction I'm in now. (Hayden Polowski)

It is common for science courses to be applied or required as prerequisites to careers in applied science fields such as medicine or engineering. However, if a student decides to change career directions they may drop away from taking science courses since they were only taken as prerequisites. Samantha Gill's comments are indicative of the interaction between science course prerequisites and decisions to change career directions.

> I always wanted to be a dentist. And then when I started kind of taking those pre-requirements for dentistry in university, it was . . . I would say chemistry got a lot more difficult. Obviously, inorganic . . . organic chemistry, you don't do that in high school. (Samantha Gill)

As noted elsewhere, Samantha became attracted to psychology and shifted directions away from the sciences towards psychology. However, even given the attraction that she found in psychology as a field of study, she noted the limited use of applied or more experiential research courses in that program's curriculum.

> I mean I took . . . there was only one research course required, which is Research 202. Everything else in psychology is just lecture and studies-based. . . . I really liked the research one; it was really interactive rather than just sitting and listening to the lecture. (Samantha Gill)

Even with that critical comment, Samantha still noted, "But I like them both [laughs]; I don't have really a preference."

The participants in this study were not undertaking courses in an Education Faculty, where they could be expected to acquire the professional jargon to describe their experience of the university curriculum as a curriculum or planned, coherent sequence of courses and programs. Sally Washington noted her appreciation for some level of integration in her program.

> Sociology, French, and communications. . . . So I just enjoy how some of my sociology courses intertwine with each other, and then some of my communication courses intertwine with some of my French courses. (Sally Washington)

5.4.3.   The Role of University Faculty in Student Persistence

It is not surprising that university faculty can have an impact on students' choice to persist. Whether the interactions are positive or negative, contacts with faculty can influence students' decisions. These interactions can be that much more impactful when students are early in their academic careers. Heather Hinchcliffe's comments demonstrate the influence faulty can have.

> A lot of the faculty that make up the Global Development Program, they're actually . . . like, the one, she's lived in Tanzania for 18 years. [Dave] lived in Venezuela for most of his life, and then [Fred] has spent amazing amounts of time in India, and then [Sam], he's actually from Ghana, I think it is, right. So they all have a lot of connections, so there's a lot of opportunity. And like, Stephen has tons of connections just like straight over Latin America, right. So as far as internships go, and study tours, they have a lot planned. . . . They're going to Mexico this year; they're going to Peru and New York next year. So there's just . . . yeah, I've really enjoy talking to the different profs that are kind of . . . facilitate the program. (Heather Hinchcliffe)

However, a poor experience with an instructor can also have significant impacts. Madison Taylor's comment illustrates this: "I feel like some of the quality of professors in certain situations or certain classes I've had, hasn't been the greatest. And I have filed formal complaints about professors." In spite of this negative comment about some of her experiences with university teaching, Madison also had positive comments to make.

> I like the fact that I can walk up in a classroom and just speak to the professor. I like that I have some of my professors. . . . I have some of my professors on my Facebook and we're friends and we chat [laughs]. And it's like I have . . . there's people here who have . . . who are way smarter than me, and I can just access them so easily and chat with them on a regular, casual . . . in a casual way, right. And I've had . . . I consider some of my professors friends, and I don't think you

would be able to do that at a bigger university. So I definitely love that about this university, for sure. (Madison Taylor)

5.4.4.   The Role of Personal Engagement and Relevance in Student Persistence

Making a personal connection with the material being learned was often very important to students in this study. Without a meaningful personal connection to the course material, students may struggle with learning. Jennifer Rouleau captured this in her response to my question asking what she enjoyed most about school.

> Once you have the solution and you've seen the work, you get from point A to point B, it's very, I don't know, rhythmic. And you kind of get into it, and it's very cool to see something you've seen all your life. For example, I've worn glasses all my life; I have no idea how they work. But, I've taken that one course, I'm like, "Oh, okay, now I understand." (Jennifer Rouleau)

Marshal Tizzard also referenced the importance of a personal connection to the material: "I'd just say I just find the subject matter interesting and the thrill of learning something new and the . . . 'Oh, I have this, I understand this now.'" Marshal also referenced a "hunger for new information" when asked about his current program.

Heather Hinchcliffe made a number of comments regarding her sense that she was enjoying a real sense of accomplishment in her overall learning process.

> Like, when I first came to university . . . like, I'm a good student but it's . . . you learn how to write papers. And I find . . . I mean, you get to a point when you feel like, good at it, right. Like, I don't stress out if I have a 20-page research paper to write because I know that I can actually write it with . . . you know, because I've learned how to research properly, I've learned how to do it. So just being able to notice that I'm actually improving in my academics. (Heather Hinchcliffe)

She extended this line of comment, remarking, "I don't know how to explain it, but it's just the fact that you really begin to become knowledgeable in one specific area. And just having that knowledge, it's just . . . yeah, I've enjoyed that" (Heather Hinchcliffe).

In some cases the personal connection to a subject found in high school can be carried on through university. For example, Charles Wong personifies a student who realized early in his school career that he was good at science and "liked it." In contrast, Aaron Head needed an extended period of time away from post-secondary as well as the

opportunity to try a couple of courses before, as he puts it, "finding his passion" for psychology. Furthermore, Aaron also needed to connect with his fellow classmates through the student association to engage (integrate) both academically and socially with the university. He commented on this change in his perspective as follows.

> The first time around, I . . . yeah, yeah, I expected it and I was ready for that the first time around. But taking a break . . . there are some things I didn't really realize as much . . . you know, one thing was getting involved on campus and just learning about the different student associations. I'm involved with the Psych Association, right. So taking a break and I guess coming back kind of opened me up maybe to doing that more. (Aaron Head)

Some of the participants' reflections on both their choices of major and their reasons for persisting were stated in terms of the match they perceived between their personal learning styles or preferences and the nature of the major field. This can be seen in the comments made by Christina Valet.

> Well, I'm interested in things. I like learning about things. I usually get pretty antsy if I have nothing to think about, so university offers a lot of . . . there's always new stuff. There's always something new to work on or think about or learn about or . . . and biology especially, there's always. . . . I mean, medicine and behaviour research and anything . . . there's always stuff we don't know. I like that aspect, and I think that it fits what I am, what I'm like. (Christina Valet)

Throughout her interview, Madison Taylor commented about the importance of engaging personally, and with passion, in her university program. Madison described having taken a very indirect path through university up to the point of her interview. Her path included starting in university intending to major in English, and then switching to the sciences because of doubts about being able to build a career as a writer, and finally switching back to English, while retaining considerable course work in mathematics. She remarks on her choices as follows:

> Now I have my English and my math, so I feel like that's, not only a good choice for me where my interests are, but career-wise, math is definitely sought after by employers. And English, depending on how much experience you have in journalism and that kind of thing, if you put enough volunteer hours in or whatever and make connections, you can get a job that way too. So I feel like I'm covering all my bases. (Madison Taylor)

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In closing, Madison added, "If you enjoy the courses and you're good at them as well because it is your passion, then people will start noticing that as well . . . and job opportunities open up with the connections that you have."

5.4.5. *Persistence in the Sciences*

For those who chose to persist in the sciences, in most cases, the participants had a high level of self-efficacy built through their experiences with sciences courses in high school. Furthermore, participants with a high level of academic engagement also chose to participate. Charles Wong and Marshal Tizzard provided examples of this type of engagement, as they both required specific science courses in order to pursue their long-term academic and career goal of pharmacy and medicine, respectively. The combination of strong self-efficacy and academic engagement influenced their desire to persist in the sciences. However, the participants who switched or are thinking about switching demonstrated neither the self-efficacy nor academic engagement to pursue the sciences long term. In many cases, participants chose to move towards psychology because of intellectual engagement discovered through course exploration.

The linkages reported in Chapter 2 between the construct of engagement and persistence and retention suggest that persistence in the higher-level pursuit of any field will often be associated with a personal sense of commitment to, or excitement and passion for, the chosen field. Jessica Haven's comments about her choice of major clearly reflect this.

> When I tell other people about it, I get excited about it, and that's how I know that I like what I do. If I'm explaining to somebody, and I don't like explaining it to them, I know that, "Why would I want to pursue this anymore if I don't get excited about what I'm learning?" I want to teach others what I learned and that kind of thing, pass on the information, because I found it so useful. (Jessica Haven)

Notable also here is Jessica's personal attachment to her studies, but also her desire to communicate what she is learning to others. This may be an example of the phrase, "To teach is to learn twice" (Joubert, as cited in BrainyQuote, 2015, para. 1)

Christina Valet commented on her appreciation for the pursuit of a biology major, stating,

I feel that more practical things are more relevant. Obviously theory is important. I like theory but I feel I'm more equipped for going out and actually doing something if I have experience doing it, right? . . . Yeah, I guess . . ., I like learning about the different aspects of biology. I like learning about physiology. I like the fieldwork. (Christina Valet)

Heather Hinchcliffe decided to shift from her original intent to pursue a BSN to join a newly introduced program in Global Development. She noted that she made this decision in spite of concerns expressed by her family: "Well, mostly my family because I was always like . . . they always see me like, this beautiful . . . like, stability, you know, 'Nurses make good money. They have . . . there's a lot of job opportunities.'" However, Heather remarked that her parents were less positive when she decided to switch from her BSN program into Global Development. "But when I switched into Global Development, that was kind of like . . . everybody thought it was . . . most people thought it was a terrible idea" (Heather Hinchcliffe). Heather also noted that when she decided to make a shift in direction from Nursing to Global Development she sought the advice of university counsellors.

I did a lot of talking to my advisers, figuring out . . . because I didn't want to start over, right, because I was two years in. . . . I really wanted to make sure that everything . . . like, I was going to get full credit for everything. I wanted to make sure I could take my Medical Administration. I wanted to make sure I could take my Care like, my Smart Worker certification, so I could get some . . . you know what I mean, it wouldn't just be two years that I spent in this program, and I'm getting nothing out of it. I got all the credits, I got my certification so I could do the job that I currently have . . . and just like, have that to fall back on.

In Chapter 5 I further explore the extent to which university structures enable or impede students from changing directions and majors. In the Heather's case, she clearly wished to keep her options open.

Because, you know, realistically, I could . . . like, where I'm at with my documents, I could go back if I ever decided to, right, and go back and finish my last year and a half in the Nursing program, do my practicum, and then I could get my BSN still. But I don't see that happening. But, realistically, I want it to be an option.

Hayden Polowski described the loss of his enthusiasm for sciences as a source of his decision to shift from a sciences major to a psychology major, followed by the ignition of his passion for psychology.

And then I was taking the sciences, I was. . . . I didn't find them interesting; I was bored in class. I mean, I wasn't motivated to do extra reading outside of school . . . it was just . . . it bored me, I didn't. . . . And then I took a psych class, and I found it — just an Intro psych class — and I found it really, really interesting. I was engaged, I was reading at home, I was looking into things more, looking at research. . . . And I started getting, I don't know, interested in the criminology aspect of it . . . more like human rights and the law and politics and propaganda. And that just . . . from there, it just . . . I just got super interested and started dedicating my life to it. (Hayden Polowski)

Samantha Gill's comments about her decision to leave the sciences to study in psychology have been noted before. However, while Samantha was clearly enthusiastic about her studies in psychology, she also was still keeping her options open to enter dentistry, even though that will require a return to upper-level science courses.

I want to try to take more . . . get back into science courses, but my focus just still is one more year in psychology. And then I still want to open my door to dentistry, so I do want to get back into the science, but just it would be like a minor in science. . . . But I think psychology is the right one for me just because I've learned to experience . . . like, sciences. It's different, yet it's still good to know about it, but it's still different and I just . . . I enjoy psychology, so that's the major thing is, I enjoy it. (Samantha Gill)

5.4.6.   *The Role of Mathematics as an Element in Decisions to Persist in Sciences.*

During the interviews, that math, and in particular calculus, had an impact on some of the participants' choices to persist within the sciences. Margret Peters personified those who struggled with calculus, when she stated, "I think it was calculus that kind of broke [laughs] . . . broke my dreams of doing a degree in science."

Margaret Peter noted her experiences with calculus was one reason for changing directions away from the sciences, and this was echoed by Hayden Polowski.

I just maybe wanted to add why I really went from the science to the arts, and I've actually . . . and I think they've already addressed this because a lot of students were having problems with it . . . and it was getting through the calculus. It was super-tough for me. Math was always strong for me, like I said earlier but up until Grade 11 and Grade 12 . . . which was my laziness too, I guess, and I didn't kind of really learn the core concepts that would make you successful in calculus. So that really pushed me right out of the sciences, was not being able to get through. (Hayden Polowski)

Hayden did suggest that he was aware that new courses were being developed to ease the students' experiences with introductory math and calculus courses.

> But now I think they've developed or created a special calculus for biology students or something like that. . . . Yeah, they've kind of tied it in and related it to biology, for biology students, right. Because the way it was structured before, it was just purely a math course. (Hayden Polowski)

However, as powerful as the encounter with calculus was in Margaret Peters's and Hayden Polowski's choices not to pursue a science degree, a belief in one's math skills and a positive math experience was equally as important for reaffirming Marshal Tizzard's choice to pursue a science degree. "I was always fond of science classes and math classes, so it was just something I was always good at" (Marshal Tizzard). Similarly, Jennifer Rouleau, who is pursuing a physics major, simply stated, "So math, first of all, was really easy for me." The interview transcripts revealed that it is clear that participants either liked or disliked math, and there was no middle ground for the participants in this group.

Although Madison Taylor decided to switch from a science major to an arts program with an English major, she has maintained a concentration in math also. She stated, "I'm planning to graduate with a Bachelor of Arts in . . . with a major of English and creative writing concentration — hopefully Honours — and a math minor." Of her experience with university level math she remarked,

> For math, even though I really like it, it's very challenging. And there's a class that I'm taking this semester right now, Math 265, it's Introduction to Advanced Mathematics. And it's like a pre-req for all upper-level math classes [laughs], and I'm struggling in it. So my passing or failing will be a make-or-break for my math minor.

Madison also added some interesting remarks about the difficulties that some first-year students may have as they encounter a course such as introductory calculus.

> The material is difficult. It is the first math course offered as a . . . the first lower-level math course offered that is abstract. . . . And everything up and to this point has been very mechanical, "You turn the crank, practice problems, you'll be fine." But with this one, if you don't get it, then you have to sit there and think about it, and then things start clicking. But, unfortunately, the way that math is delivered at any university, is just . . . you cover a chapter a week, so if you don't get it, you're going to fall behind. (Madison Taylor)

Madison made a side comment comparing the highly engaging Writer in Residence program of the university's English department with the mathematics department's approach to fostering student involvement outside regular classes: "I can't really say the same for the Math Department, because we have a math club that does one event a year."

Sohani Toor also remarked on difficulties with math courses: "I'm still having trouble with math. I'm repeating my course in this semester. I dropped it in the first semester, so I'm taking it again. But I'm doing fine now." Sohani attributed her progress with math to the influence of a new instructor.

> He's actually much better than the last instructor. . . . He goes through examples on the board, and he works through them properly, but the other instructor would just take what's written in the book and put it on the board. So it wasn't really much helpful. And I hadn't had any calculus before coming here, so it was really hard to catch up. (Sohani Toor)

5.5. Chapter Summary

This chapter shared the voices of the students who participated in the study. The interview conversations were framed somewhat chronologically into three broad phases: the participants' education and life experiences prior to entering the university, their university experiences, and their future plans and directions. Hence, the interview data presented in the chapter was also broadly organized by these phases. Given the number of interviews and the length of the conversations, the attempt in this chapter has been to represent the diversity of views and experiences of the participants regarding the topics covered by the interviews through a selection of passages taken directly from the transcripts. Of course, the selection process is subjective but reflects an appreciation of the overall interview content.

6. Results and Conclusions

As noted in Chapter 1, the initial focus of this study was to examine the factors that were influential in participants' choices to study courses and programs in STEM areas and to explore their reasons for either persisting with or changing directions in their major studies. The stories of the 15 participants in the study revealed not only their choices and decisions around studies in STEM-related university subjects and programs, but also the circumstances that affected their choice of university, their level of engagement with the university as a learning environment, as well as their larger life experiences and demands during the transition. My purpose in writing the thesis was to examine themes that were apparent across the participant interviews while inquiring into aspects of their experiences that were uncommon and unique. As the personal stories presented in Chapter 5 and the transcripts of Appendices C and D demonstrate, the 15 participants shared some commonalities but definitely demonstrated personalities, have different life situations, and interpret their contexts and options in very personal ways. It should be noted, as explained in Chapter 3, the participants were not members of a cohort group in a common program of study, so their descriptions of their experiences as reported in this thesis were not affected by social interactions with other interviewees.

This chapter discusses and interprets the data of the one-on-one interviews with the student participants. The chapter contextualizes the students' narratives in the setting of a medium-sized, Canadian, regional university, referred to in the study as BCRU (a pseudonym used to protect participant anonymity). The chapter also describes some of the ways in which this group of participants, who were all actively involved in undergraduate university studies, may differ from students enrolled in similar programs in larger, research universities or in more specialized technical institutions. In addition the chapter relates the student conversations to relevant existing research and theory on the topics of student engagement, retention, and persistence and also to current studies and proposals concerning undergraduate education in STEM fields.

The study was designed to address the following questions.

1. What influences do the students who entered university intending to major in sciences or science-related fields perceive as having affected their choices of major?

2. What influences do students who have chosen to change from science and science-related majors to study in other fields perceive as having been influential on their choices to change programs?

3. Have students' plans for post graduation studies or career choices affected their decisions to persist with science majors or to change from sciences to non-science fields?

In this chapter the interview findings are discussed in terms of their potential contributions to understanding the ways in which the students' life experiences and personal contexts appear to have affected their decisions in regard to choice of university studies, particularly in STEM and STEM-related fields. As reported in Chapter 5, the interviews revealed that the factors affecting the students' education choices were complex, being grounded in their previous schooling and current university experiences, influenced by family, and shaped by their interpretations of their potential future options. The research is in the genre of an interview-based phenomenological study. The study results are, therefore, contextualized to this specific group of participants, the particular university they attended, and the regional and cultural settings of their communities. While I have assessed the findings for their potential in identifying future directions for research and curriculum development, no attempt was made to propose wide-reaching policy generalizations.

6.1. The Participants

As summarized in the literature review presented in Chapter 2, many researchers have explored student engagement, persistence, and retention. However, as noted by Andres and Finlay (2005), much existing research on these issues focussed on younger students, aged 18–24 years, who often live on the campuses of larger universities, and assumed students enrolled in full-time studies. Andres and Finlay (2005) commented on this research focus, stating it "disregard[s] the demographic heterogeneity of today's

student population" (p. 2). They noted further that the "traditional" (Andres & Finlay, 2005, p. 2) university student was seen as male and white. However, since the 1990s students who do not fit these traditional categories are now significant and integral parts of the student population at many colleges and universities.[3]

Although BCRU's largest student group is 18–24 years in age, the current study provided a unique opportunity to investigate the motivations and goals of a group of students that included both so-called traditional learners as well as those whose attendance and engagement differed. Non-traditional students are often older, do not live in residence on campuses, and regularly combine their university studies with work and other obligations (sometimes involving child care or family support). They frequently take less than a full course load per semester, and, as a consequence, require more than 4 years to complete their undergraduate degrees. Mandery (2015) reported at the City University of New York approximately half the students work while attending the school, and half of that group work more than 20 hours per week (p. 34).

In designating former colleges and university colleges as regional universities the government of British Columbia intended to provide students in specific areas of the province with wider access to university-level education within their communities (Plant, 2007). Policies for open-access admission as applied by the regional universities have provided opportunities to many students who do not meet normal admission requirements. The sample of participants in this study represented a diverse range of qualifications for university entrance and provided an opportunity to learn more about how these sub-groups within the overarching BCRU student demographic engaged with their education, chose majors, and made choices concerning persistence in their majors and at university.

It can be argued that the BCRU student population includes a significant number of non-traditional students, although the student demographic differs from Andres and Finlay's (2005) description in that women are significant members of the category, as are

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[3] At the time of writing of this thesis the *Globe and Mail* published its *Canadian University Report 2016* (Tustin, 2015), distributed as an insert in the print version of the *Globe and Mail* newspaper and also separately as a news magazine. While the style and content of the issue reflects the cultural diversity of students, the topics covered often still reinforce the typical university student as young, in full -ime study, and living in campus residences (Tustin, 2015).

a range of cultures and ethnicities. A total of 61% of the student population, both male and female, are in the 18–24 age category (BCRU Fact Book, 2015, p. 35). However, only 47% of BCRU students across all ages and genders are considered to be enrolled full time. The average age of full-time male students is 24 years, while that of female students is 26. For part-time students the average age for males is 34 and for females it is 32. The average credit load per student is 9.3 credits per semester—equivalent typically to three courses BCRU, Fact Book). The average age for students at the time of graduation or degree completion is 26.8 years, a statistic that reflects the fact that many students enrol for less than 15 credits per semester (BCRU, Fact Book). These statistics refer to all BCRU students, with the definition of part-time students being those who enrol in fewer than 9 credits per semester. Student Aid BC (n.d.) considers 9 university-level credits as full time in allocating student loans, which is why 9 credits is typically used as the point of delineation by most universities, including BCRU. A so-called full-time student taking 15 course credits per semester or 30 credits (two semesters per calendar year) can complete a degree in 4 years. In comparison, a student taking 9.3 credits per semester and 18.6 credits per year will normally complete a degree in approximately 6.5 years. The need to balance work and study suggests that many students may not be able to commit to on-campus extracurricular activities, as they simply are not able to study, work part-time, and commit to other campus activities. Furthermore, with only 200 students living on campus at BCRU, the range of on-campus activities is very different from that of a larger traditional research university with a younger student population of which a number actually live on campus.

The diversity represented by the study participants might be considered an example of the new norm. The participants ranged in age from 18–28 years, and while several of the 15 participants had entered BCRU directly following high school graduation, others entered university several years after high school completion, having either worked, travelled, or attended other university or college programs before applying to BCRU. A total of 60% of the participant group was female. The students in this study did not live in university residences. Most demonstrated attachments to the regional setting of BCRU having grown up in the area or through marriage or family relocation. All but one participant indicated that they worked part-time while attending. Information about marital status or

family commitments was not sought in the interview process, although a number of the participants indicated that they had close family connections while attending university.

6.2. Discussion of the Participant Interviews

The interview findings were reported in detail in Chapter 5. As noted, the interviews were structured around topics that referenced participants' experiences as they transitioned from high school and into the university, with attention to their perceptions and reflections on high school science and mathematics courses, the influence of their teachers in high school, and their reasons for electing to major in STEM subjects on entry to the university. After the opening phases, the interview conversations focussed on the accounts given by the participants who continued in STEM majors and on the perceptions of those who elected to change directions in their majors. In the case of both groups, the discussion also included comments about their plans following graduation.

My approach to the analysis of the 15 interview transcripts was to read and re-read the transcripts, to seek to appreciate the narratives as offered, and to discover as much as possible the meanings the participants assigned to their various experiences. I also summarized the interviews by organizing them into a comprehensive table that enabled ready comparison across the responses for the same interview topics. The following sections discuss the implications and inferences that are supported by the data, organized broadly around the following interview topics.

6.3. Participant Perceptions of the Influences on their Initial Choices and Decisions About Major Fields of Study

I structured the interview conversations to invite the participants to comment on the experiences and contexts that they felt had influenced their initial choices of areas of study and major fields. In several cases participants' paths to BCRU were not direct from high school, and they had attempted studies at other post-secondary institutions or worked in various occupations. While these experiences were often included in participants' discussions, the focus of the conversation was on their decisions about their choice of academic program on entry to BCRU. The interviews typically included participants'

thoughts about the their high school experiences, especially in regard to science and mathematics, as well as the role of families and friends in their early decisions. Participants also commented about any sources of information that they may have used in choosing their university programs.

6.3.1.   School Experiences Prior to Entry to University

The interview conversations were structured to include participants' perceptions of their high school experiences, although many included brief comments about their elementary schooling as well. The majority of participants in this study attended high schools in British Columbia, with some having attended schools in other Canadian provinces and two having been schooled abroad. The participants made particular comments on their experiences with sciences and mathematics, noting favourite subjects and also remarked on subjects they had struggled with or developed dislikes for. They noted the influence of particular teachers on their school experiences and on their perceptions of their abilities in certain subject areas, especially in sciences and math. While biology was often reported as a favourite high school science, some participants described preferring chemistry or physics. Participant reports of their experiences with math were varied, with some enjoying high school math and others noting that they struggled with math.

Some teachers were seen as being important influences on participants' choice of major in university. For example, Charles Wong reported that his AP chemistry teacher played a significant role in guiding him towards preparation for a career in pharmacy. Charles believed his chemistry teacher to be "one of the top teachers in BC," and his interest in chemistry persisted into his studies at university. Jessica Haven was influenced by a Biology 11 teacher who had developed a high school course in agriculture that involved practical projects and visits from faculty from the BCRU agriculture program. Jessica maintained her interest in agricultural sciences into university. In some cases teachers generated positive changes in students' attitudes toward a subject, such as when Sally Washington reported initially hating math but changed her view because of the influence of one of her high school teachers. Participants' comments often indicated that their views of a subject were affected by their personal responses to their teachers' style and approach more than by teachers' knowledge of the content of a course per se.

A number of the participants also referred to the importance that they attached to whether their high school experience had helped them to develop general work and study habits that prepared them for university. A common theme in many of the interviews was that a major difference between high school and university was that students were expected to be much more self-directed and self-managed at university than in high school, so having developed effective work habits provided a real advantage in the transition. Some participants also expressed appreciation for teachers who assigned homework, made an effort to check it, and offered feedback about completed work and tests. Madison Taylor's comments reflected this perspective: "My chemistry prof in high school would assign a lot of homework, and I ended up benefitting from it. . . . I took first-year chemistry in here at [BCRU], and I didn't find the workload any different." Marshal Tizzard also remarked on the need to develop study skills in high school: "I'd say, . . . if one takes harder courses like I did in high school, you do learn how to study." Marshall also remarked, "But it wasn't ever like they had a Studying 10 course or something like that."

What emerges from the above comments is that participants sometimes treated generic skills and attitudes that they learned in high school as more important than specific content preparation. However, an exception was found in some of the remarks made about the importance of the development in high school of a good foundation of skills and core concepts in math as a preparation for university studies. Especially notable were participants' comments concerning lack of preparation for university calculus, since calculus is not offered by all BC schools as a high school math course, as it is included as an elective. Those participants who had at least some exposure to calculus in high school felt much more prepared to deal with university experiences than those who lacked any high school calculus. Samantha Gill's comments captured her experience: "I loved algebra but you never . . . it was never mandatory to do calculus. And then it was a shocker to me when I took math in university. . . . I didn't really know what calculus even was." In contrast, Jennifer Rouleau reported that she had very strong preparation in science and math during her schooling in Russia before coming to Canada. She noted that, while she struggled with some parts of the transition to the BC curriculum, she was considerably ahead of her peers in math: "When I moved here, my fourth-grade-level math was just as good as a

Grade-8-level math here." (The significance of math and particularly of calculus as an influence on persistence in science majors is discussed in section 6.4.2.

The general impression gained from the interviews with the participants in regard to their high school experiences with math and sciences was that they largely enjoyed their courses and met particular teachers who impressed them and encouraged their interest in science and in math. Many participants also reported that they had preferences for particular subjects and viewed others with less interest or enjoyment, and a few participants noted forming definite dislikes. However, some participants' interests in the sciences and math generated within high school and carried into initial university programs were not sustained over time, with some participants changing directions from STEM majors to other fields. Of the participants in this study, Marshall Tizzard offered the most detailed comments about the quality of his high school science experience:

> And it . . . sometimes I thought the way they taught science was a bit dry; it could have been made a bit more interesting. But I found it inherently interesting just because I like science, but I've always thought, "To someone who might not be as interested, this isn't exactly going to win them over."

Marshall extended his comments about teachers, noting certain attributes that he saw as important for teachers of high school science.

> Friendly and well, of course, . . . have a good knowledge of the subject matter and good at communicating it. And then if you . . . whenever you have trouble learning something, the teacher should be able to help you understand it better.

6.3.2. Influence of Family and Friends on Choice of Majors on Entry to University

Many participants reported experiencing general family support without pressure to pursue specific programs or majors at university. In some cases, the influence of parents on students' interest in sciences was exerted over time by family activities and by parents involving the young person in outdoor nature activities or by providing books about science. Christina Valet saw her parents as important general influences on her interest in sciences:

> We did science in school, but I think it was more my parents that were . . . my Mom is always interested in things and interested in science. And she . . . it was always

like, "Oh, this is so cool to learn about . . ." or birds or something in National Geographic or something like that. And my Dad would take me out to look at birds and . . . outside, or something. And I'd pick up books on different animals and things like that when I was younger. So I feel that it was not so much through school that I probably gained my liking of science, even though there was science exposure.

However, other participants indicated having received definite directions or pressure from family members. Margaret Peters saw her father as a significant influence on her choice to initially pursue a science degree: "My Dad was kind of really forcing it on me quite a bit. . . . He wanted me in Sciences." When asked why her Dad was so keen on the sciences for her, she replied, "I don't know. . . . I guess he figured I was, 'You're the smart one. You can do it.' And he seems to think . . . that there's more, I guess, money and prestige in science majors." Charles Wong was heavily influenced by his mother; she helped him to make his choice to pursue a career in pharmacy because she knew some pharmacists and understood the nature of their work.

In other instances the influence of parents and siblings was expressed through role modelling or offering examples of various careers and vocations, as in the case of a participant whose parents were accountants, or another participant whose older brother was a dentist. In some cases students' friends provided examples of career possibilities. Heather Hinchcliffe reported that her initial decision to pursue a BSN was inspired in part by the mother of one of her close friends who was a nurse. Further, Heather's interest in nursing was supported by her family who regarded that profession as a solid and respected career choice.

6.3.3. Effects of Views About the Career Potential of Possible University Programs on the Selection of Major

In the course of the participant interviews the discussion turned to how the students perceived the career potential of various university programs. Some of the participants placed importance on whether they viewed particular degree programs as leading to secure jobs and employment. Others were more concerned that completion of a potential degree program would open opportunities for interesting careers and enable them to make a useful social contribution. Still others evaluated their options in terms of whether or not they felt that a chosen vocation would be personally satisfying and enjoyable. As noted in

the previous section, parents also communicated their views of the career potential of studying sciences at university, and in some cases the students were influenced by the careers they saw actually being pursued by parents and siblings. However, the participants' initial evaluations of career potentials sometimes changed significantly as they progressed in their programs of study at university.

It was interesting to note that most of the interview participants in this study made very little mention of accessing advice from high school counsellors or other professional sources of advice about university program options or career opportunities and requirements. In many cases students simply made choices about their university programs based on the information they had at the moment and did not consult with any academic support person or advisor. This type of major choice was described by Tina Dodson, who, when asked, "Who did you consult before deciding to switch your major," replied, "Parents a bit, but that's about. . . . I just kind of made the decision. It wasn't extremely well thought out."

These results are consistent with the work of Gabriel Pillay (2005), who examined the results of a longitudinal study involving a large sample of BC high school students with data generated from the Paths on Life's Way project. The initial survey was conducted in 1988 with follow-up surveys conducted in 1989, 1993, and 1998 (Pillay, 2005). A major focus of the survey was to determine the perceptions of the respondents on the role of high school in preparing them for the transition to post-secondary life (Pillay, 2005, p. 218). The analysis of the responses to the 1989 question revealed that 48% of the respondents viewed further education beyond high school as a necessity in life to "ensure, enhance, and secure employment and career opportunities" (Pillay, 2005, p. 220). Pillay's study also found that recent grads assumed that attaining higher education would enhance "future success" (p. 220), "employment opportunities" (p. 220), and "personal satisfaction" (p. 220). Pillay reported further on the responses to the surveys in regard to the participants' experiences with high school counsellors and counselling. Pillay wrote that analysis of the survey data revealed "the lack of influence by secondary school personnel is startling" (p. 221).

6.3.4. *Summary: Initial Influences and Goals*

A common theme among the participants who initially enrolled in STEM majors was the belief that a science background offered strong prospects for future employment. In some cases students developed these views on their own, and in other students' beliefs were supported or reinforced by parents, siblings, or family friends. Most of the participants expressed views that were initially optimistic about their ability to successfully pursue science majors at BCRU. Most participants also indicated that they had at least general support from family and friends for their choices. Some participants in this study clearly selected their majors because the courses included in the proposed major were prerequisites to programs to which they intended to later apply, such as medicine, nursing, pharmacy, and law.

Wang (2013) proposed a theoretical model with which to frame the factors influencing student selection of STEM majors. Wang's model, based on social cognitive career theory and existing empirical studies, described students' intent to major in STEM subjects at university or college as being affected by their 12th-Grade math achievement, exposure to math and science courses, as well as their self-efficacy beliefs about math, with these factors being affected by prior achievement in and attitudes toward math. Wang also included post-secondary supports and barriers, some of which are described in section 6.4.2.

While the participants in this study did not mention this influence on their thinking about careers in STEM fields, popular media reports often present careers in science and technology fields as being glamorous and well paid with some high profile scientists appearing as media stars, not to mention recurring press reports of remarkable business successes in the software development and engineering fields. However, after an initial encounter with university-level science and mathematics courses, a number of participants changed directions and elected to pursue studies in non-science fields.

It is important to note that the participants in this study were invited to volunteer on the basis that they had initially entered BCRU with the intent to study in sciences or STEM-related fields, whether or not they later switched and changed directions away from sciences. Thus, the interview data did not offer much insight about the sort of information

that might actually influence a high school student to avoid selection of STEM subjects in university or college.

6.4. Inflection Points and Changing Directions

Of the 15 study participants, eight switched to non-science majors after first enrolling at BCRU with the intent to major in sciences. The reasons for the change in directions can be broadly summarized as falling into two categories: passion for a subject or dislike of or inability to pursue a subject.

Students falling into the first category appeared to make the switch in direction because they discovered a greater interest in and enthusiasm for a subject or field different from their original choice. These students' comments suggested that they did not so much reject their interest in sciences as discover a stronger interest in a different area. That is, they moved positively toward a new field, rather than rejecting their initial interest in sciences.

Students in the second category were influenced by a particularly challenging or difficult course. In these instances the students reported deciding to change directions because of poor performance in a course with a resultant loss of confidence in their ability to be successful in their initially chosen field.

A further factor in the decisions of both those who switched directions and those who persisted in their original courses of study involved the participants' personal analysis of the prospects for careers or further education afforded by their programs. Associated with the personal consideration of options around persisting or switching involved a certain amount of self-analysis and appreciation of the match between their chosen university program and self-assessment of personal styles and life preferences.

6.4.1. Discovering New Interests

It is important to appreciate that as students make the transition from high school into university they often discover opportunities to study fields that were not represented or only superficially covered in typical high school programs. A number of the participants

noted how much they appreciated these expanded options. Tina Dodson commented on this, stating, "I guess just the new knowledge that I'm gaining. And there's lots of options." Margaret Peters noted, "It's very different from high school. There's a lot more choice in what you can study . . . even within individual assignments." Aaron Head's comments clearly reflected his enthusiasm for the choices available at BCRU and the potential to move into new majors:

> I see the course list get released every semester and I'm like, "Oh, I want to take this, this and this," but I just don't have time. So, to kind of narrow it down, I was . . . I had thought of a few different majors.

Of the eight participants who switched from sciences to other majors, four cited psychology as a subject or discipline that they found to be more exciting and interesting and about which they were curious to learn more. Each of the four participants in this group remarked that initial exposure to courses in psychology caused them to take more courses in that subject and to explore the possibility of switching to a psychology major or related field (e.g., social sciences or criminology) in the longer term. Students' comments also suggested that they enjoyed initial success in their psychology courses, leading to both confidence and a desire for further study. Psychology also seemed to act as a bridge between arts and sciences. Aaron Head's comments clearly reflected this perspective:

> And I think for me it [psychology] was kind of a mixture between the arts and the sciences, which is something I like because yeah, like I said, that struggle. . . . I like both of those things, so psychology, I think, is a happy medium, because I can . . . if I focus on the research and the stats, I get kind of my fix doing the math work and analyzing numbers and things like that.

It is interesting the Aaron remarked that he did take a psychology course at his high school and disliked it. In fact, he reported, "I didn't enjoy it. I found it really boring, actually." Aaron also commented on the actual experience of discovering his interest in pursuing psychology.

> I had thought of a few different majors. I thought of doing English, I've thought of doing physics, and then while I was kind of thinking about those, I took a first-year psychology course. I was like, "Wow, this is . . . I really enjoy this part of it."

A further notable aspect of Aaron's transition to psychology was that he continued to be involved with mathematics as applied to psychology.

I guess one of my favourite parts of psychology is the . . . is statistics and research methods. So, yeah, I enjoy doing that. So I'm thinking of doing more math courses just kind of on the side just to kind of bolster my understanding of stats for psychology because I do want to go into research psychology, and I'm kind of more leaning towards that route.

Samantha Gill switched to a major in psychology after initially taking a program of science courses required as preparation for an application to a dental school. As she noted, "I chose the sciences because of my career goal . . . like, dentistry." However, she began to experience some doubts about her ability to succeed in some of the advanced prerequisites for dentistry, such as inorganic and organic chemistry.

And then I took Psychology 101, 102; I really liked it and then I took another one maybe a year later. And that was . . . so it was kind of through experience, and I made my own decision. I was like, "I really like psychology and I do analyze a lot, just everything around me." So I thought that was maybe a better choice

As in the case for Aaron Head, Samantha Gill felt that she was able to transfer her educational experience in biology and chemistry into psychology. She described this integration as follows: "Whereas biology . . . or I mean . . . sciences, it was good to just have that little background about it because a lot of psychology students don't know like, totally about your body inside." Samantha also stated that she wanted to maintain her science courses as well as a means of keeping open an option apply for dentistry open. She hopes to maintain a minor in sciences.

Several of the other students also switched from programs with major science components into others that included at least one psychology course in their revised programs. Their first experiences with the subject of psychology seemed to act as a catalyst to general changes in direction. Hayden Polowski described his experience: "Then I took a psych class, and I found it—just an intro psych class—and I found it really, really interesting. I was engaged. I was reading at home. I was looking into things more, looking at research." Following this initial experience Hayden took courses in criminology and began to seriously consider applying for law school. However, he still retained some connections with sciences through psychology. "But my favourite subjects have been neuropsych, drugs, and behaviour. . . . So it's like a neuropsych class that just focuses on the different classes of drugs and what's going on neurophysiologically" (Hayden Polowski).

Some of the students who switched directions clearly lost their interest in sciences, at least the science courses that they were experiencing. Hayden Polowski clearly described this loss of engagement: "Then I was taking the sciences, I was. . . . I didn't find them interesting; I was bored in class. I mean, I wasn't motivated to do extra reading outside of school. . . . It was just . . . it bored me."

Alas, Hayden's experience was not unique in students' perspectives of lower division science courses. In her study titled "Reaching Students: What Research Says About Effective Instruction in Undergraduate Science and Engineering" Kober (2014) noted,

> A single course with poorly designed instruction or curriculum can stop a student who was considering a science or engineering major in her tracks. More than half of the students who start out in science or engineering switch to other majors or do not finish college at all. Maybe they failed a crucial prerequisite course, or found little to engage their interest in their introductory courses, or failed to see the relevance of what they were being taught. (p. xi)

Kober continued,

> Evidence from research on learning and teaching in science and engineering suggests that a large part of the problem lies in the way these courses are traditionally taught—through lectures and reading assignments, note-taking and memorization, and laboratories with specific instructions and a predetermined result. (p. xi)

Student persistence and decisions to change directions can be affected not only by the intellectual engagement reflected in newfound interest and excitement in a field of study or performance but also by the influence of peers or role models—an effect termed social engagement (Cardwell, 2012) or social integration (Tinto, 1993). In the current study, social engagement was seen in the experiences of the group of students who joined the university's student newspaper and subsequently switched their majors to English because of the positive experience of writing for the paper and the encouragement resulting from working with a group of peers in a community of practice. Social integration also appeared to be fostered by the faculty in the BCRU Psychology Department. Aaron Head made particular note of the social environment that he found in the psychology program:

I guess another aspect is, a lot of them are really about getting students involved. So there's research meetings every couple of weeks that two of our teachers put on just to get students involved doing research on, you know, "If you have an idea you want to do," just kind of not for credits or anything, just voluntarily, you can just go for it and they're there to support you and help you kind of achieve that, . . . and they're doing their own research too, and they want students involved in their own research as well, so that's really neat.

Aaron continued by describing his experience with the Psychology Association: "Yeah, they put on social events every semester and we go into the 101 and 102 classes and do announcements . . . say, 'This event's . . . these events coming up. Come on out,' and that kind of thing."

Aaron's comments about the kind of community that he found in the psychology department were in clear contrast to comments that he made about the social experience he found in other classes:

I guess nobody really talks to each other in classes, I find, unless you know people beforehand. It's not particular to the university, but it's just kind of maybe a social thing . . . that plenty of the classes I sit in and you just don't know who you're sitting next to, right. . . . You can spend the whole semester, yeah, not talking to the person next to you, right.

Heather Hinchcliffe described finding a similar community of practice in the Global Development program. What is significant about the descriptions of the student–faculty interactions in Psychology and Global Development is that the faculty appears to actively share their research projects and interests with the students and may even invite the students to join them in various projects. BCRU is not a research-intensive university, so faculty may not have extensive research programs or dedicated labs and project groups as might be found in larger research institutions. Clearly, students seem to appreciate the opportunity to see their areas of study being actively applied in field settings and actual work situations and to become directly involved in fieldwork. Heather described the opportunities provided in the Global Development program.

Yeah, there's a lot of opportunities as far as internships and study tours go, so that's really nice, and just a lot of flexibility there, right. Like, I'm going on a Mexican study tour at the end of this semester to go to Mexico and learn, you know . . . and then hopefully, next January, I'm going to go to India and work on a public health internship, so there's a lot of opportunities.

It is significant that Heather Hinchcliffe is able to bring her background in nursing into play in her Global Development program even though she has not completed her BSN. She feels that she may now be able to use her health sciences background to pursue a Master in Public Health degree, which she sees as real asset to potential international work.

According to information participants shared in their interviews, the Global Development program, which is relatively new to BCRU, is employing an educational approach that more closely integrates theory with practice, enabling students and faculty to work together on real-world projects and also offering students internship experiences. This approach has been referred to as work-integrated learning (Peters, Sattler, & Kelland, 2014). Institutions and employers have found work-integrated learning programs to be an important part of student experiences, as they prepare students to enter the workforce or labour market with relevant, transferable, and marketable skills. Peters et al. (2014) also reported that half of students surveyed indicated that they would pursue a work-integrated learning option if they could start their post-secondary education over again.

In research-intensive universities some students may have opportunities to work in laboratories and on research projects as assistants and gain direct experience of a discipline. Hayden Polowski also mentioned working as a research assistant in the Criminology program at BCRU; as a result of this experience Hayden is now considering graduate work in Criminology and Social Psychology as options should he not enter law school.

Madison Taylor made mention of activities provided by the English department, such as a Writer in Residence program, and noted that the program linked experienced and published writers with students in a mentorship model. She described the English Department as working to establish a "campus community" and noted, "What I like about that is, some of the professors are very thorough and some of them are very passionate about what they're teaching. So, by association, you also get excited by what you're learning, so I enjoy that."

In this study I found it notable that there were few comments from the science majors to indicate extracurricular activities similarly intended to foster greater socialization

and informal contact between students and faculty. Madison Taylor, who is undertaking a minor in mathematics in addition to her English major, remarked about the lack of a similar community-building orientation in the Mathematics department: "I can't really say the same for the Math Department because we have a math club that does one event a year."

However, Jessica Haven described experiences within the BCRU Agriculture program that were similar in format to the work-integrated learning approaches Peters et al. (2014) had studied.

> I like doing the labs and the hands-on portion. That's why I really enjoy the Agriculture program, because you've got the background information, the thought behind what you do. But then you would also go out to the greenhouse and you'd put it into practice, so it makes what you're learning very applicable to real life, and just makes it worthwhile. (Jessica Haven)

At the time of this research BCRU had not finally approved a BSc program in Agriculture, so although Jessica had already obtained a Diploma in Agricultural Technology with a specialization in Horticulture and she was taking additional biology and chemistry courses in order to meet the requirements that are expected for the Agricultural Sciences degree when it is eventually implemented. She described some personal frustration with this process.

> I get tired . . . because I've been here four and a half years now, and I still don't have a degree, but I know that I'm working towards something. But just that it's dragging on a bit and that gets tiresome sometimes and just . . . and then the courses that you have to take, but you don't necessarily enjoy and you wonder why you're taking it. (Jessica Haven)

Jessica's comments are interesting when considered in light of a recent report to the President at the Massachusetts Institute of Technology (2014) on the future of MIT education, in which students surveyed listed "commitment to hands-on experience" (p. 70) as a first priority for the institute and also selected "focus the curriculum on applying skills and knowledge, hands-on experience" (p. 70) as the highest ranking in response to the following question: "If you could change up to three things about the way MIT [Massachusetts Institute of Technology] educates its students, what would you change?" (p. 70).

If social integration and engagement can contribute significantly to student persistence in a field of study or course, then departments and faculty might be wise to

create activities and experiences that will foster greater contact and communication between their faculty and students. In particular, it would be beneficial to offer activities directed at giving students greater understanding of the actual work of practicing academics and scholars.

6.4.2. The Effect of Barrier Courses

As discussed in Chapter 2, a challenging (i.e., barrier) course can influence a student to choose a different major. In the case of science programs, students often appear to view calculus as a barrier course. In this study, as in Seymour and Hewitt's (1997) work, some participants chose to leave the sciences to pursue other disciplines due to a negative experience with math, and in particular with calculus. The influence of a barrier course is clearly evident in Margaret Peters' experience with calculus. She commented, "I think it was calculus that kind of broke [laughs] . . . broke my dreams of doing a degree in science" (Margaret Peters). Her comment illustrated how frustrating and critically influential a barrier course can be. Hayden Polowski expressed similar frustration with calculus, stating that his experience with calculus had "pushed him" out of the sciences. Other participants, including some who reported succeeding in math courses, still described calculus as being particularly difficult, especially for students who lacked adequate mathematics instruction in the upper grades of high school. Jennifer Rouleau, who completed part of her high school education in Russia, noted that because of the focus of Russian schools on mathematics and sciences, she found her university-level math courses to be relatively easy, but she found that many of her classmates struggled because of a lack of good preparation in high school math. While some BC high schools offer calculus courses, these courses are optional and are not offered by all schools.

Lower-level undergraduate mathematics courses, and calculus in particular, are often key prerequisites for further studies in a number of fields. Thus, poor performance in such courses, and subsequent loss of confidence, can greatly influence students' decisions to switch away from studies in STEM fields. Hayden Polowski noted that he believed that BCRU was implementing changes to the lower division math program by introducing calculus courses directed specifically to biology students in an effort to reduce the dropout and failure rates seen in the typical generalist calculus courses often offered for math majors or students in physics.

A major study conducted across 123 universities and colleges in the United States involving more than 3,000 students tracked changes in students' attitudes toward mathematics as a result of their experiences with college calculus (Sonnert et al., 2014). While Sonnert et al.'s (2014) research focussed on instructional methods, it also measured students' attitudes towards mathematics (confidence, enjoyment, and persistence) at the beginning and end of their calculus courses. Sonnert et al. (2014) reported, "All the changes were in the negative direction" (p. 380). The authors did note that there was a positive influence on attitudes for students who had taken more rigorous high school math courses; however, having taken either a college precalculus or college calculus course had no significant effect on the attitudes of the university-level students (Sonnert et al., 2014). Sonnert et al. (2014) also found students' initial attitudes to be a powerful predictor of their attitudes at the end of the semester (pp. 385–386). The authors made the following strong closing statement:

> Nonetheless, attitudes towards mathematics are also crucial because they may influence future career choices. In addition, if more students emerge from their college mathematics education with a sense of confidence and enjoyment, and fewer with a sense of dread, this will help make the general societal outlook on mathematics more favorable—itself a necessary condition of success for a society grounded in high-tech and science. (Sonnert et al., 2014, p. 22)

While math courses, particularly calculus, are often singled out as barriers to persistence in sciences, courses in other fields, including those in the arts, especially at the lower undergraduate levels, can also discourage students and lead not just to switching majors or program directions, or even to dropping out entirely. Research in the United States has focussed on this issue and has found that, particularly in the case of students with lower socioeconomic statuses or visible minorities, an encounter with a difficult course that leads to low grades or failure on an exam can have powerful effects on student persistence and retention. Some universities have begun to implement strategic interventions to help students overcome their loss of confidence and poor self-esteem. These interventions involve programs designed to change students' understanding of the nature of intelligence and the learning process and can operate with mentoring support from more senior students to those who are struggling (Yeager & Dweck, 2012; Yeager & Walton, 2011; Yeager, Walton, & Cohen, 2013). Yeager and Walton (2011) suggested universities often respond to retention issues by introducing programs to help faculty change or expand their teaching methods. While this approach

can be desirable and productive, Yeager and Walton (2011) claimed that there must also be a clear focus on changing students' perspectives about the causes of their problems, with an emphasis on altering how students perceive their intelligence and intellectual abilities. The students who participated in this study generally appreciated that the faculty at BCRU were accessible, perhaps as a function of smaller class sizes. Few comments were directly critical of the quality of teaching, but some of the participants had shared thoughts about university teaching in general. For example, Jessica Haven made the following observation about how she perceived university teaching compared to her high school experience, where she reported having some excellent teachers who "really stimulated interest" who seemed to be "excited and passionate about each class."

> But the difference would be, professors have done their doctorate or their master's on a very specific subject and they don't necessarily . . . they're not taught how to teach, and I find that's a problem. They need to at least take a couple courses on how to teach, because they're very intelligent; they know what they're talking about. But getting the message across to the students and stimulating interest in them is hard to do sometimes, and I think that's where you lose the students. (Jessica Haven)

Kober's (2014) report on undergraduate science and engineering, cited earlier, clearly proposed that the impact of barrier courses can be serious for students.

6.4.3. The Effects of Prerequisite Requirements and Career Goals on Persistence in Major Choice

Where success in a course or program is a prerequisite to further studies or for entry to a particular professional or vocational school, such as medicine or law, students may pursue and persist in a course or program in order to meet the required performance standard or in order to achieve long-term goals, such as completion of a degree. Wang's (2013) study of the factors that can affect entry to a STEM program in university concluded that aspiration to earn a graduate degree could affect high school students' commitment to enrol in STEM programs. Such a pattern of engagement is described as academic because it is shaped by external standards or requirements, although attitudes toward math, self-efficacy beliefs in regard to math, and intent to pursue STEM studies all play roles as well (Wang, 2013). Cardwell (2012) found that the commitment of high school students to a particular career goal or academic goal could have an impact on students' commitment to their education. This type of commitment was clearly seen in the interviews

with students who had well-defined goals for careers or further education. For example, in Marshal Tizzard's case, his commitment to entering medical school was driving his approach to his current science program: "Personally, I've just always found science interesting, and I don't really see myself doing anything other than it." Marshal went on to state, "You can get into medical school without a bachelor's degree as long as you just have all the requirements. I could . . . I might leave [BCRU] without actually getting a bachelor's." Charles Wong also described a very clear goal to enter a pharmacy school, and while he has liked chemistry and has been successful in it, he has no intention to enter graduate school or study chemistry beyond what is required for pharmacy. Charles' practical orientation towards chemistry can be seen in his statement about his preferences for learning experiences: "Weirdly, I still like lectures. Yeah, labs, not as much, maybe because I'm not really investigative myself, so I don't see myself in research. And I guess labs are closer to research than lectures would be."

Of the 15 participants in this study, approximately 50% described fairly clear future goals, and the courses they were currently taking were necessary steps toward achieving those goals. In some cases their programs were viewed as practical requirements, rather than something chosen out of clear interest in the particular field. A number of participants believed that math or science courses included in a Bachelor of Arts degree would maximize their options and perhaps increase their chances at employment. It is interesting to note that although math courses often seemed to play an important role in some participants' decisions to change directions away from sciences, they often retained math courses in their programs, even when the major was in arts fields such as English. This approach could be seen as keeping options open.

A question that emerged from the interview data in this study concerns the degree to which having a clear understanding of the career options available to those who complete STEM programs at the bachelor's level might promote persistence in STEM studies. The students in this study who persisted with STEM programs seemed to have relatively clear goals post graduation, as in the cases of (a) Marshal Tizzard, who planned to apply for medical school; (b) Charles Wong, who saw a career in pharmacy; or (c) Jessica Haven, who already had acquired Certification in Horticulture and planned to work in the industry. Ted Hough was less clear about his career goals, but thought that teaching high school physics and chemistry would be a suitable destination. However, other than

professional careers in fields like health care or teaching, the other major post-graduate path seems to lead to graduate school, a path that would typically entail 6 or more years of study after a bachelor's degree. For students, especially for those who delayed entry to university after completing high school, the idea of many years of further study (and associated costs) is likely not to be very attractive. Madison Taylor, who switched from sciences into English, remarked that when she sought advice about possible careers available to someone with a Bachelor of Arts in History degree, she was presented with vague options.

> "What can you do with a history major?" And all they said was, "Okay, well, you can continue to get your Doctorate or . . . and become a researcher of some kind, or you can be . . . like, it's a path to a lawyer." So there was no like, "Get your bachelor and get a job." It was like, "Get your Bachelor and continue to something else." And that's something I didn't want to do. (Madison Taylor)

A question worth considering in the context of STEM undergraduate programs is whether students have good information about possible options other than continuing to graduate study. Students enrolled in engineering and technology-related programs are more likely to have a number of ideas about possible postgraduate employment, but students in general BSc programs, especially in chemistry and physics, may not see any options other than continuing to a master's degree and even further to a doctorate or applying to Teacher Education programs. Hence, once strategy for improving retention of students in STEM programs could be to ensure much better information about science careers available to people with a BSc qualification.

6.4.4.   Administrative Challenges

Both the students who switched from science majors and those who did not encountered some administrative challenges as they pursued their programs at BCRU. First, while BC has a very well developed province-wide policy of transfer credit that enables students to move across institutions and carry course credits with them, and regional universities like BCRU have progressive open-access admissions policies, students still face certain obstacles when they actually plan and try to schedule their courses and complete degree and program requirements. In some cases students who were accepted into BCRU with transferred credit discovered that the courses they needed to complete their programs were already fully enrolled. This may be because students

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who begin their programs at BCRU directly after high school are given higher priority for courses with limited enrolments than those who transfer from other institutions. Second, some students encountered scheduling problems, especially when trying to juggle part-time work and studies. Heather Hinchcliffe made a particularly strong comment in this regard:

> You know what, these timetables suck! It's just . . . like, it's a bad timetable, especially the summer one, right! . . . Like, last semester, I had the worst semester ever. . . . I had Behavioural Psychology in the morning and then I was still taking . . . I wanted to take math for economics], which had a 4-hour lab. So it was . . . like, my days were ridiculously long, right? I was spending 7 hours in lecture back-to-back . . . and it just sucks. . . . You can't pay attention that long, right?

Third, some courses are not offered every semester, so in order to take a particular course a student may have to enrol in a semester when they have an opportunity for full-time work or other commitments and had planned to step out for a term. BCRU has a strong commitment to small classes so enrolments are capped. This creates problems for students who need key courses that are in high demand.

Most of the students in this study did not mention finances as an issue, but they did note that the longer they took to complete their degrees the more likely this was to become an issue. Here again, the student who works part-time to meet financial requirements cannot also carry a full course load and, therefore, takes longer to complete. Many of the part-time jobs described by the students in this study are at minimal-wage levels, but the income was still necessary for the students to attend university. Finally, some types of financial assistance, such as scholarships that are based on academic performance, may be restricted to students who carry at least 15 credit hours per semester, so part-time students may not qualify for assistance from those sources. Adamuti-Trache (2005) made reference to the effects of some of these barriers, in particular on women who are single parents. She noted that many laboratory science courses operate on restrictive schedules, thereby presenting real barriers to the enrolment of these women in STEM-related courses (Adamuti-Trache, 2005).

6.5. Study Limitations

This thesis has provided an account of a collection of conversations with a small group of students who enrolled at a provincial regional university, designated BCRU for this study, and who were recruited and selected for the study so that the group would include those who planned to continue with sciences and others who had changed directions away from sciences. In conducting this study, it was not my intention to create a statistically valid sample of undergraduates in the university and to generate major generalizations about university policies or curricula. The 15 participants were all unique individuals with diverse histories prior to entering university and various current situations. This diversity among the participants offered a broader range of academic journeys and provided a unique perspective and a snapshot of the types of students who choose to attend BCRU.

I did not structure the interviews to probe directly into participants' personal situations outside BCRU, nor did I collect their complete academic records or transcripts as part of this research. The participant group volunteered for participation based on an invitation letter sent out by two advising centres, and students self-selected whether they met the study criteria or not. I did not cluster participants according to years of age or semesters completed, so the group included (a) relatively recent entrants and those who were closer to completion of their studies, (b) men and women, (c) individuals spanning a broad age range, and (d) people with diverse cultural backgrounds. As a result, I did not enter into conversations with a set of expectations formed in advance about those who chose to persist with their science programs or those who changed directions, nor did I hold preconceived notions about the individuals themselves. As I listened to the conversations, topics emerged that were quite unexpected. I did not attempt to frame the conversations around existing concepts of student engagement, because I did not want to try to fit the participants into theoretical categories as the conversations proceeded. At times, I found bracketing my expectations to be a challenge.

Qualitative data such as those from this set of interviews are often analyzed by a process that seeks to discover the patterns that may be present in it (Saldaña, 2013). In reviewing the transcripts from the interviews I found that I was drawn more and more by how unique they were and how much the personalities of the participants began to emerge

from them. However, the unique nature of the individuals and their contexts made it difficult to discover recurrent patterns, and I found myself being cautious to avoid imposing membership in particular themes on them as I proceeded. I was informed by Van Manen's (1997) advice to pay intense attention to how participants interpreted their experiences and to avoid imposing a connecting structure across them, except in the broadest sense.

The interviews were conducted as private and personal conversations, one on one, with each participant. Most of the participants chose not to see the transcripts, and those who did never provided feedback. Grouping participants into a focus group to compare experiences might have been useful. However, since the participants did not share membership in a common cohort or program and were very diverse in their level of progress through university programs, I felt that a group interview would not have been productive. While the results of the research generated interesting questions and suggests implications for the curriculum and policies of the university, the highly qualitative and individualistic nature of the data suggest caution in making any action proposals.

6.6. Directions for Further Research

The focus of this research was on a group of students who responded to experiences with math and science courses and curriculum in various ways. It would certainly be interesting to invite faculty from science and math programs to discuss their own beliefs about student engagement and their interpretations of the reasons for student persistence or non-persistence. The question asked by Marshal Tizzard (cited at the end of Section 6.7 Concluding Comments) could also suggest a line of research in which faculty from different departments and programs across the university were to compare their concepts on the topic of student engagement and explore their relative strengths and weaknesses. Large universities have a tendency to become siloed, sometimes even within faculties and departments, and it could be productive to bring faculty representing diverse curriculum structures and orientations together around the topic of student engagement.

A faculty institute on student engagement would be extremely interesting, particularly for seeing the difference in perspectives within the same disciplines. For example, the issue of the barrier course and the varying perspectives in math alone in

regard to calculus would be both interesting and controversial, as even within the discipline of mathematics itself, there is no clear answer about how to deliver the required calculus material.

Another area of interest that I believe is linked with student engagement and persistence is the concept of grit. Angela Duckworth and colleagues explored why some individuals with equal or lesser intellectual ability to their peers actual accomplish more (Duckworth, Peterson, Mathews, & Kelly, 2007). Through their studies, Duckworth et al. (2007) learned that the one characteristic shared by most successful individuals is grit. They defined grit as "perseverance and passion for [the accomplishment of] long-term goals" (Duckworth et al., 2007, p. 1087). Duckworth et al. (2007) have found that individuals with the most amount of grit manage adversity and failure better than most and are better able to overcome the challenges encountered to continue on towards their long-term goal.

Duckworth et al.'s (2007) research is directly related to post-secondary education and degree persistence, as, in almost all cases, students entering post-secondary, are faced with a variety of challenges that must be overcome, such as the transition to a new learning environment and trying to connect with a new peer group. Grit is of particular importance when discussing barrier courses and the need to overcome poor grades and in some cases poor instruction in order to learn the material and persist in both the course itself and the program in the long term. Therefore, I believe future studies exploring the concept of engagement, persistence, and retention should also include the role of grit in trying to determine why students choose to persist to degree completion while other do not.

6.7. Concluding Comments

I was drawn to conduct this research due to my personal experiences as an advisor to students within a Faculty of Science at a teaching-intensive university. My experience as an advisor led me to be curious about why some students who had entered the university with goals to pursue science majors decided to change directions and leave sciences entirely. Furthermore, what I found even more interesting was that there was no

consistency in their academic preparation that ensured success. Some students would enter with straight As and flourish in the sciences and others would flounder and choose to switch to another non-science major. As an advisor, I listened to stories told in my office by the students seeking information about their possible options. I wanted to learn more about why some students persisted in the sciences and why others left, and I wanted to go beyond the anecdotal stories I heard about in my office.

What emerged from listening to and transcribing the conversations was as much a series of possibilities and questions as a set of consistent themes. The individuals in this study all reflected on their university experiences, not just as a way of collecting a catalogue of the courses needed to move on to a future goal or target, although some had definite post-graduation goals. I found that almost all the participants interpreted their experiences and goals in the context of how they understood their own personalities and preferences. If they saw a need for opportunities to exercise personal creativity, then they assessed their university program and courses against the standard of whether or not the program allowed their creative side to flourish. If they sought a clear linkage between their studies and their current goals and directions, then they preferred courses and programs that could be seen as having practical value. In some cases participants appreciated university experiences that were simply cool that had explanatory power for understanding the world around them and common everyday happenings and social interactions. Some participants had long-term goals that involved addressing real-world problems in disadvantaged settings. Many of the participants expressed a desire to have lives that were satisfying and enjoyable, regardless of whether their expected degree or credential would clearly lead to employment and financial rewards. It seemed as if the conversations reflected at times a kind of tension between practical requirements and personal ideals. The participants often described trying to navigate or manage their academic programs to balance or resolve those tensions. Madison Taylor's comment reflected this line of thinking:

> I'll switch back to the Bachelor of Arts, because I decided, instead of going with an education that will hopefully provide me with a solid career in the future, I'm going to go and follow something that I'm passionate about, and eventually I will find a career out of it.

My conversations with those participants who had elected to switch from sciences to non-science fields often seemed to imply a view of the sciences, or at least undergraduate curricula in STEM fields, as being less connected to real-world experiences, less relevant, and less inclusive. The excitement conveyed in the comments of the participants who switched to programs in psychology, global development, or creative writing was not often found in the comments about the science programs of those who persisted in science and math studies, even in highly relevant and practical fields such as nursing. Participants described programs such as global development or psychology as inviting them to join a community of practice where they could have personal contacts with faculty and students who were engaged in action projects and research or who were active writers who invited the students to join directly into the process of creative writing. These programs were not simply seen as necessary preparation, or learning the basics, but as offering an opportunity to learn through action. Those who continued with their science studies seemed to be less excited and passionate about their experiences. Perhaps this attitude reflects Kober's (2014) comment about undergraduate STEM programs.

> Evidence from research on learning and teaching in science and engineering suggests that a large part of the problem lies in the way these courses are traditionally taught—through lectures and reading assignments, note-taking and memorization, and laboratories with specific instructions and a predetermined result. (Kober, 2014, p. xi)

However, some of the participants, even those who switched away from sciences, found keen interest and passion in sciences as a general field, a way of looking at the world and providing explanation and insights into everyday happenings and things. Ted Hough, who was the oldest member of this group and had returned to university 10 years after leaving high school, was clearly excited by his program and the whole experience of returning to university. He expressed his view of the importance of science in the following remark.

> Science is one of the things that I will learn that isn't going to go away. One of the things that always kind of sticks around in my head is, "If the society as we know it just completely blows up and there's nothing left, but science will still be there." (Ted Hough)

When reviewing the literature, I found the results of this study connect to research on retention, persistence, and engagement. As Andres and Finlay (2005) noted, retention

is located more at the level of institutional policies and practices designed to reduce rates of drop out of schools or universities. None of the study participants indicated that they were considering leaving the university, and, as of the time of writing this thesis, none had left, although some may move to other institutions if they succeed in being accepted to programs not offered at BCRU. This study was focussed on the question of why some students persist in science programs while other switch directions, and the results suggested that persistence and engagement are closely coupled. Students who are not engaged with a course or program are less likely to persist unless the program or course is a formal requirement necessary for the attainment of a desired future goal. Cardwell (2012) would consider this aspect of engagement to be academic, as it is enforced by policies and curricular structures rather than necessarily through the genuine personal interest and enthusiasm of the student. Introductory mathematics courses often fall into the category of entry requirements, and students engage with them as such. Of course, students may discover a passion and genuine interest for a course or field of study in a required course—a positive outcome from an imposed requirement. The interviews in this study do not suggest a high probability of this result, at least among this group of students.

The Handbook of Research on Student Engagement (Christenson, Reschly, & Wylie, 2012) described engagement as a "multidimensional construct" (p. v) in which the role of context "cannot be ignored" (p. v). Engagement incorporates academic, social, and emotional learning outcomes. Considering the relationship between learning and engagement, the description of learning offered by Brown and Duguid (2000) as meaning driven, identity forming, and socially situated certainly seems to apply to the experiences described and interpreted by the participants in this study. The choices and decisions that they described reflected the various contexts in which they live and the ways in which they interpret their experiences, situations, and project their futures. The programs and courses that they find to be intellectually engaging (Cardwell, 2012) are ones that they see to be meaningful, connected to their personal senses of identity, and to offer participation in communities of practice.

I am reluctant to make proposals about the curriculum or academic policies of BCRU based on this very small, highly qualitative study. However, based both on what the interview conversations offer and research on engagement combined with studies of student attitudes towards STEM subjects, it would seem reasonable to suggest that faculty

who intend to engage students will need to address not merely the content of courses, or focus on skill development, but also consider the development of a community among students and faculty while offering experiences that reveal the applications of the content and skills to actual projects and problems.

Of course, the achievement of a curriculum with these attributes entails not only the engagement of the students, but also that of the faculty. Research on the construct of engagement sometimes seems to neglect the element of the time required for it. The participants in this study live multiple lives—lives as students in university programs, as members of families and communities outside the university, and as workers and employees in various businesses and enterprises. Whether we can expect the level of engagement required for excellence in fields as rich and challenging as STEM from students whose lives are divided among multiple demands and contexts is an interesting question. In this study it has only been slightly surfaced.

Participants in research such as this current study sometimes pose provocative questions. Marshal Tizzard offered one such question.

> What's wrong with science, technology, engineering and mathematics that makes it unappealing to students? Because I don't think the Faculty of Business has a problem getting students. I don't think the Faculty of Arts has a problem getting students . . . maybe it does . . . or any of the other faculties. What's with the science? Why do people shy away from it?

His question is worthy of further conversation.

7. Epilogue – Where Are They Now?

It has been over 18 months since I first interviewed my participant group. I have since had the opportunity to reach out to the entire group and learn more about where they are in their studies and whether they are still following the same academic plan as when we first met.

Of the 15 participants I interviewed, seven responded to my email. Six of the seven students are continuing with BCRU and are on target to graduate. One participant, Jennifer Rouleau, has completed her BSc degree in Physics, as she intended, and is now in a Teacher Education program with BCRU, as she planned.

When asked how many credits students took on average per semester, the group of seven averaged approximately 12 credits per semester. In Marshal Tizzard's case, as his long-term goal is to enter medical school, he stated clearly that he has chosen to take 15 credits per semester as he wants to make sure he is eligible for the Dean's List each term. From his responses, it is clear that Marshal is still planning on applying to medical school post degree completion.

One student, Sohani Toor, switched her major from when we first met. Sohani has entered a BSN program. As a result of this change, Sohani pointed out she takes 15 credits per semester; she reported her new program is cohort based and requires her to take certain courses in certain terms.

Of the seven students who responded, Ted Hough is the only student who switched schools. He is now attending McGill University in Montréal. He is still pursuing a BSc in Chemistry, which was his goal at the time of our interview.

As for the eight students who never responded to my email, I cannot help but wonder what happened to them? Did they quit school? Did they simply choose not to respond to my email? Did they graduate and go on to another school?

Upon reflection of the last 3 years of my life, it is clear to me the question of "why" will always be with me. I have always been deeply curious about the "why" of student success; this journey began the moment I entered post-secondary education as an

academic advisor many years ago. However, my curiosity about this particular group of students will never stop now that I have learned so much about them.

As a post-secondary administrator, the next step in my desire to answer why some students are engaged and persist through to degree completion, while others do not, is to try and learn how I can take the knowledge I have learned in my dissertation and apply it in a workplace setting. My goal is to improve our systems and processes with the hope of assisting students with the transition to post-secondary and providing them with the opportunity to succeed.

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Appendices

Appendix A.

Darren Francis: Participant Invitation Letter

SFU

Simon Fraser University
Faculty of Education
250-13450 102 Avenue
Surrey, British Columbia
V3T 0A3

Dear (insert participant's name): (Note: the project information and recruitment letter will be personally addressed only if being sent to a specific person as an invitation to participate. Otherwise, this will be a general distribution invitation.

My name is Darren Francis. I am currently enrolled in the Ed.D. program in the Faculty of Education at Simon Fraser University. As part of the requirements for my doctoral thesis I am conducting research on the factors influence the program and course choices of students in college in regard to the inclusion of science and mathematics in their university studies The study is designed to focus on the experiences and perceptions of students who have either started the Bachelor of Science program within the last 3 years and are currently pursing a science major or who started in the Bachelor of Science program within the last 3 years but have switched to a different major. This letter is an invitation for you to participate in a study, and as a means of providing you with further detail about the purposes and approach of the research, and about your involvement should you decide to participate.

Study Description and Detail

Study Number: 0548018f

Title of Research Project: Factors influencing the program and course choices of students in regard to the inclusion of science and mathematics in their university studies.

Investigators:

Principal Researcher: Darren Francis   [telephone number]   [email address]

Senior Supervisor: Dr. Milton McClaren   [telephone number]   [email address]

Purpose of the Research

The proposed study seeks to understand why students choose to include science and mathematics courses in their university programs. The study will conduct a comparison of students who are pursuing science majors with those who started in university science programs but ultimately switched to a major outside of the Faculty of Science.

If you agree to participate you will be asked to discuss several topics in a semi-structured interview pertaining to your experience as a student who has either entered the Bachelor of Science program at the [BCRU] and continued on as a science major or have switched to another non-science major.

The interview will be in the form of a loosely structured conversation about the factors that led you to make your major choice.

Description of the Research

Several topics will be discussed during a private interview. The interview will be conducted at a time and place that fits your schedule and at your convenience. The interview will take approximately 45 minutes. Participation is entirely voluntary and can be retracted or withdrawn at any time, following which, any data collected will be removed from the study data set and will be destroyed.

Four main topics will be discussed during your interview:

1. How do you describe your experience with school from elementary school through to high school? Did you have a favourite subject as you moved through school? How did you feel about your experiences with school science and math?

2. What factors did you consider when choosing your choice of Major with [BCRU]?

3. Has your university experience so far been what you expected? Has it been different from high school?

4. Are you planning on continuing with your current choice of Major choice?

All Interviews will be recorded, transcribed, and numbered. Personal information will not be used to identify participants in the research data sets, and will not be recorded. In conformity with the research ethics policy of SFU and following the guidelines of the Social Science and Humanities sResearch Council of Canada, all data will be kept on an external hard drive with multiple levels of password-protected security. The hard drive will be kept in secure, locked cabinet when not in use. Shortly after the interviews are completed, a copy of the interview transcript will be sent to you in order to provide you with an opportunity to confirm the accuracy of the interview and to add, clarify, or delete any comments. Participation in the study is, of course, voluntary. As a participant in this research you may choose to decline to answer any of the interview questions or to discuss a topic or topics. Further, you may decide to withdraw from this study at any time. If you withdraw none of your data will be used in the study report. With your permission the interviews will be digitally recorded and later transcribed for analysis.

All information provided by you will be treated confidentially. No names will appear in the thesis or in any report resulting from this study; however, anonymous quotations may be presented in the final thesis. Any references to persons, programs, institutions, or departments that might identify you or your university will be edited, replaced by pseudonyms, or deleted in order to provide anonymity.

Your confidentiality will be respected and no information that discloses your identity will be released or published without your consent unless required by law. Data gathered will be retained throughout the study duration and for two years following. There is no known harm nor direct personal benefit associated with your participation in this study.

The ethics of this study has been reviewed and approved by the Office of Research Ethics at Simon Fraser University and with the [BCRU] Ethics Board. If you have any comments or concerns resulting from participation in this study, contact Professor Milton McClaren, the senior supervisor for this research, at [email address] or at [telephone number], or Associate Director, Dr. Dina Shafey, Office of Research Ethics, Phone: [telephone number], Email: [email address].

If you agree to participate in this study, you will be asked to sign a consent form.

Appendix B.

Informed Consent

What factors influence the program and course choices of students in the first two years of college in regard to the inclusion of science and mathematics in their university studies?

January 24th, 2012

Dear student:

I am currently undertaking a research project investigating students' attitudes towards science education as part of the requirements for completing a doctoral degree in Education at Simon Fraser University. I would like to 5 focus groups of approximately of 10 people per focus groups session. Each focus group session is expected to last between 45-60 minutes, over a one month period. During the focus groups it is my intent to explore and better understand what factors students consider in choosing their major, specially their thoughts and feelings towards science and mathematics. The data gathered from these focus groups will be analyzed to better understand the relationship between students and science education.

Participation in this research will be completely confidential. The identity of participants and the University they are attending will not be published.

The focus group sessions will be recorded and these recordings will be labeled with a code to protect your identity. Recordings will be kept for two years in a secure location on my password protected computer. After two years these recordings will be erased. In short, every effort will be taken to ensure that participation is kept completely confidential.

The University and myself subscribe to the ethical conduct of research and to the protection at all times of the interests, comfort, and safety of participants. This form and the information it contains are given to you for your own protection and to ensure your full understanding of the procedures and benefits of this research. Your signature on this form indicates that you understand the procedures and benefits of this research project, that you have received an adequate opportunity to consider the information in this document and that you voluntarily agree to participate in the project.

As your participation is completely voluntary you have the right to withdraw from the study at any time, and that any concerns with the study can be brought forward to Dr. Hal Weinberg, Director, Office of Research Ethics at [email address] or [telephone number]. If you agree to participate in the study, please complete the information on the attached permission form.

Thank you in advance for your valuable collaboration.

Yours truly,

Darren Francis

Interview Consent Form

I understand that:

1. My participation is completely voluntary and I may withdraw from the study at any time;

2. I can register any concerns or raise questions about the project at any time by contacting, Dr. Hal Weinberg, Director, Office of Research Ethics at [email address] or [telephone number].

3. Participation in this study involves being interviewed with recording audio equipment (digital voice recorder) these audio files will be stored on my password protected computer in a secure location;

4. I can obtain a summary of the results from Darren Francis, [email address], [telephone number];

5. I will receive an outline of the interview questions in advance of the interview, but am aware that the interviewer may seek clarification or ask clarifying questions;

6. My name and location will not appear in any reports or in the research itself. I consent to participate in this research.

PARTICIPANT'S NAME (Please print):_____

ADDRESS: _____

SIGNATURE OF PARTICIPANT: _____

DATE:_____

Principal Investigator: Darren Francis, Graduate Student

As required for the completion of a Doctorate of Education Degree, Faculty of Education, Simon Fraser University