CONSIDERING THE STUDENT PERSPECTIVE: FACTORS THAT UNDERGRADUATES PERCEIVE AS INFLUENTIAL TO THEIR ACADEMIC PERFORMANCE IN SCIENCE

by

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Abstract

The Association of Universities and Colleges of Canada, AUCC, (2007) and the Global Science Forum (OECD, 2008) indicated that in the next decade or so, the wave of baby boomer retirements and the increasing demand for a knowledge-based population would fuel a greater demand for individuals with science, technology, engineering and mathematics (STEM) degrees. With this increasing demand for individuals with STEM degrees in Canada, it is more important than ever for universities to focus on enhancing students' academic experiences (AUCC, 2007). Administrators within the Faculty of Science at the University of British Columbia (UBC) were concerned with improving the success of their students and were eager to understand what factors students perceived as influential to their academic performance. This concern fostered the orchestration of this mixed method study with data being collected via a survey (roughly 500 respondents), 24 one-on-one interviews and a four-person focus group discussion. The quantitative and qualitative data were analyzed to determine the factors that students perceived as most important to influencing their performance in science and why these factors were perceived as important. The data was also analyzed for gender differences. Students identified several academic, social and personal factors as influential but the most important factors were related to: the role of the instructor, assessment methods, study skills and habits, community, and the involvement of others. In comparison to males, females placed more emphasis on the approachability of their instructors, assessment methods, study skills and habits, the involvement of others and commuting. Based on the results of this study, recommendations were provided for administrators, faculty, and

students on how they could positively affect the academic performance of undergraduates in science programs at UBC.

Preface

This thesis is based on work I conducted as a Research Assistant with the Carl Wieman Science Education Initiative (CWSEI). I was the primary researcher for this study and developed, administered, and analyzed the survey, one-on-one interviews and focus group discussion.

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Dedication

To those who have supported me – my colleagues, friends and most importantly, my family.

1 Introduction

In 2007, the Canadian government introduced a strategic plan for science and technology entitled "*Mobilizing Science and Technology to Canada's Advantage"* (Industry Canada, 2007), to enhance the success of businesses, universities and other scientific organizations. Within the strategy, government officials state that they will help support the higher-education community in order to "sustain [their] commitment to train the next generation of researchers and innovators upon whom Canada's future success depends". The Association of Universities and Colleges of Canada, AUCC, (2007) indicated that in the next decade or so, the wave of baby boomer retirements and the increasing demand for a knowledge-based population would fuel a greater demand for individuals with science, technology, engineering and mathematics (STEM) degrees. With this increasing demand, it is important for institutions of higher education to address and improve the persistence and performance of students pursuing degrees in STEM fields.

In addition, it is important to consider how males and females differ in their perceptions of the factors that influence their academic performance and retention in science. In North America, within their first year of study close to half of the female and minority students enrolled in undergraduate STEM programs leave the sciences to pursue a non-science degree or in the most severe cases, dropout of university altogether (Seymour & Hewitt, 1997). Research suggests that elementary, secondary and tertiary science pedagogy and curricula follows epistemological methods ingrained within a white male-oriented science curriculum; a traditional way of teaching and learning that is identified

as being arguably unwelcoming to female students (Schiebinger, 1999; Sonnert & Holton, 1995; Wyer, Barbercheck, Geisman, & Ozturk, 2001). In the past few decades however, considerable research has been conducted to address the curriculum, teaching and underrepresentation of females in STEM fields, but the population of females in these fields of study within Canada has barely increased. In 2009, females in physical, life, mathematical, computer and informational sciences made up only 10% of all female undergraduates in Canadian universities and from 2005 to 2009, the number of females remained roughly the same (Statistics Canada, 2010).

If we hope to improve the success of all students in undergraduate STEM programs, it is important to understand the factors that students perceive as influential to their academic performance. The sheer amount of course material to learn, developing appropriate study skills and habits, coping with a new learning environment, developing new relationships, and balancing school, work and family responsibilities are just a few of the factors that might influence whether a student chooses to remain in or leave the sciences (Moore et al., 2007; Seymour & Hewitt, 1997). D'Andrea & Gosling (2005) comment that:

> Student learning cannot be understood in isolation. Students are never simply 'learners', and 'learning' is not simply a psychological process… Gender, ethnicity, nationality, class, personal and value commitments, these have been given less attention in much of the recent literature on teaching and learning which has tended to focus on purely psychological processes, such as deep and surface approaches to learning and taxonomies of understanding… Student learning is a process that is also intimately influenced by the wider cultural environment and of the institution (D'Andrea & Gosling, 2005, p. 2)

The factors that students perceive as influential to their academic performance and retention can vary from one institution to the next. Consequently it is important to

consider these factors in a specific university context, such as the University of British Columbia, which is the goal of the current study.

1.1 Research questions and an overview of the methodology

The Faculty of Science at the University of British Columbia attracts high-achieving students who, based on their high school grades are predicted to succeed in their first year of university (UBC Admissions Committee, 2007). Despite the fact that these students excel in high school, a noticeable number of undergraduates within the Faculty of Science fail or do poorly in some of their science courses. Administrators within the Faculty of Science, concerned with the performance of students pursuing degrees within the Faculty, prompted the development of this research. The following research questions guide this study:

1. What academic, social and personal factors do undergraduates within the Faculty of Science perceive as most influential to impeding or enhancing their academic performance?
2. How do male and female undergraduates differ in what they perceive as being most influential to their academic performance?

A mixed method design combining quantitative (survey) and qualitative (interviews and focus group discussion) data collection methods was used to answer the research questions. Overall, 492 students filled out a survey, 24 students completed one-on-one interviews and four students took part in a focus group discussion. Statistical analysis of the survey data assisted in pinpointing the factors students perceived as influencing their academic performance (Question 1) and in detecting whether differences existed among

males' and females' perceptions (Question 2). One-on-one interviews and a focus group discussion were also incorporated to provide a more candid and personalized look into the educational experiences of the students to understand why males and females perceived particular factors as important.

1.2 Significance of this research

The information collected throughout this study was used to provide recommendations for how administrators, faculty and students could improve students' academic performance in undergraduate science. The recommendations might not only improve students' academics, but also positively influence their confidence in their academic abilities and improve their overall university experience. Hopefully, this study will serve as an impetus for researchers at institutions of higher education to examine and address the topic of student performance more explicitly. Different universities, Faculties and departments might identify more strongly with certain factors thus encouraging the need for more directed studies, such as this research. Pinpointing the factors that students perceive as most important might help educators to create programs or improve teaching and curriculum to enhance undergraduates' success.

1.3 Definition of terms

This study explores what academic, social and personal factors undergraduates within the Faculty of Science at UBC perceive as influencing their academic performance. The following section will clarify some of the prominent terms that will be investigated and

discussed throughout this research. These terms include: student perceptions; academic, social and personal factors; academic performance; and a degree in science.

For this research I have chosen to concentrate on the factors that students *perceive* as important to their academic performance. It is important to note that students' perceptions may or may not reflect reality.

The term *academic factors* refers to issues relating to the influence that instructors, curriculum, coursework, assessment, high school preparation, study habits and group work have on a students' performance (Astin, 1993; Kuh et al., 2005; Smoot-Hyde & Gess-Newsome, 2000). *Social factors* pertain to how societal issues outside of one's academic life might shape a students' academic performance (Astin, 1993) such as commuting, living arrangements, language spoken at home, extracurricular/work activities, and parental influences. Finally, *personal factors* pertain to how students' individual characteristics, such as coping mechanisms and intrinsic interest, might govern their academic performance (Terenzini, Rendon, Upcraft, Millar, Allison, Gregg, & Jalomo, 1994).

The term *academic performance* in this thesis refers to the Grade Point Average (GPA) of the student. Performance carries with it a more neutral perspective whereas the terms success and failure carry with them a more positive and negative connotation respectively. Students perceive success and failure differently and in the case of female students, they typically underrate their academic abilities and have difficulty identifying

with success (Schiebinger, 1999; Smoot-Hyde & Gess-Newsome, 2000). Thus, the term performance was used to encourage students to discuss what issues might impede and/or enhance their grades in undergraduate science courses.

Students within the Faculty of Science are the population of interest for this study. The Faculty of Science is made up of several disciplines including Biochemistry, Biology, Chemistry, Computer Science, Environmental Science, Earth and Ocean Science, General Science, Geographical Biogeoscience, Integrated Science, Mathematics, Microbiology, Pharmacology, Physics and Astronomy, Physiology, Psychology, and Statistics. Throughout this thesis, I refer to the students as pursuing a degree in the sciences. When I use the term science, I am referring to all of the majors offered within the Faculty of Science.

1.4 Limitations

One of the major limitations of this study is the lack of generalizability of the results to the entire student population at the University of British Columbia or at other institutions. This study focuses on students within the Faculty of Science at UBC. Their concerns or needs might be different from those in other Faculties. Some of the results might be transferable to other Faculties or institutions but I would encourage them to conduct similar analysis to fully understand the factors that students perceive as influencing their academic performance.

I have been attentive to the sources that might foster or impede the validity of the results. Although it is impossible to eliminate researcher bias (Bogdan & Biklen, 1998), I have attempted to minimize it by being aware of how my own perceptions and experiences might influence my interpretation of the students' responses. This research will remain focused on presenting the factors students perceive as influential to their academic performance.

2 Literature Review

2.1 Overview

Major public universities have been criticized for focusing too much of their attention on faculty research and not nearly enough on improving teaching and programs to enhance student learning (Astin, 1993; Kuh, Kinzie, Schuh & Whitt, 2005; Moore, Walsh, & Risquez, 2007). With the increasing demand for individuals with STEM degrees in Canada, it is more important than ever for universities to focus on enhancing students' success and preparing students' for their future careers (AUCC, 2007). A myriad of academic, social, and personal factors have been identified as influencing students' performance and persistence in higher education but different universities, Faculties and departments might identify more strongly with particular factors (Astin, 1993; Kuh et al., 2005; Seymour & Hewitt, 1997). This notion that the factors students perceive as influencing their performance are context-dependent suggests the need for more focused studies.

The research I present in this thesis examined the factors that students pursuing degrees within the Faculty of Science at UBC perceived as most influential to their academic performance. In this chapter I will examine some of the more salient literature on student success in higher education and review the empirical results of previous studies that identify factors that students attribute to influencing their performance in undergraduate science programs. Finally, I will summarize the literature findings to identify which factors apply to the context of this research.

2.2 Exploring student performance in institutions of higher education

Several large- and small-scale studies have been conducted to explore and improve undergraduates' persistence, development and performance in higher education (Astin, 1984, 1993; Kuh et al., 2005; Seymour & Hewitt, 1997; Smoot-Hyde & Gess-Newsome, 2000). Crede and Kuncel (2008) commented that in order to protect the failing or attrition of students from higher education, "researchers have focused on understanding the academic success and failure of students and have examined a wide array of student characteristics as determinants of academic performance" (p.425). Kuh, Kinzie and Buckley (2006) discussed the complexity of factors that have been linked to affecting student success in university. These factors include students' behaviours, institutional conditions, pre-college experiences, and demographics.

In their book, *Student Success in College: Creating Conditions That Matter*, Kuh et al. (2005) provided a thorough description of previous literature in student performance and presented five facets describing effective educational practice that can be used by faculty and administrators to enhance student success. They included (Kuh et al., 2005, p. 10):

- Fostering an appropriate level of academic challenge by
    - Choosing feasible amounts of assigned academic work
    - Presenting stimulating and relevant cognitive task to students
    - Making the standards faculty use to assess students transparent
- Incorporating active and collaborative learning across the curriculum to
    - Involve and engage students in their own learning
    - Provide students with the opportunity to apply their skills in everyday situations
- Encouraging student interactions with faculty members to
    - Provide students real-life role models, mentors, and guides for continuous lifelong learning
    - Improve their sense of belonging and make them more open to seeking academic help

- Enriching educational experiences to
    - Provide students with learning opportunities inside and outside the classroom
- Creating a supportive campus environment by
    - Cultivating positive working and social relations among different groups on campus to improve their satisfaction with and commitment to the university

Amidst the empirical research, scholars also developed several theories to describe how different internal and external factors might influence students' experiences in university. Astin's (1984) *theory of student involvement* was one of the first focusing on student development. Astin theorized that a student's involvement in the university experience was integral to their learning and development. He defined involvement as "the amount of physical and psychological energy a student devotes to the academic experience" (p. 518). This theory guided a number of studies and was adapted by several scholars over the past 25 years. In addition to students' involvement in the academic experience, the time and energy they spent engaging in other aspects of university life such as clubs, extracurricular activities or organizations were also found to be important (Watson and Stage, 1999).

Based on Astin's *theory of student involvement*, Watson & Stage (1999) suggested a framework that could be used by student affairs professionals to plan and discuss the complexities and factors that influenced students' learning, involvement and educational outcomes. The authors suggested that research take on a holistic approach due to the sheer number of factors that seem to influence students' performance. Watson & Stage's (1999) framework consists of three components: input, process, and output. Input describes the characteristics and previous experiences that students bring with them to

college such as their academic preparation, home and community environments, age, and gender. The process component considers how students choose to be academically (i.e. time and effort put into academics), socially (i.e. volunteering, work, extracurricular activities) and personally (i.e. interest) involved on- and off-campus. The output component describes the educational gains students experience as a result of completing their program within higher education. This framework takes into consideration how students' experiences before, during and after their completion of a course or a degree might influence their learning. It has served as an impetus for me to adopt a holistic approach when considering what factors might influence students' academic performance in science at UBC.

With respect to students pursuing degrees in science, a piece of research that has provided a thorough and insightful glimpse into the experiences of science undergraduates was *Talking About Leaving: Why Undergraduates Leave the Sciences,* a book by Seymour and Hewitt (1997). Within this body of work, the authors present their findings from a 3-year longitudinal study aiming to understand the importance of how particular factors might have influenced undergraduate students' decisions to persist in or leave STEM degrees. Seymour and Hewitt's (1997) book has been cited by over 900 studies investigating topics related to attrition and participation of women in science, the intersection of gender, career and degree choice processes, and the transformation of curriculum and pedagogy (Google Scholar, 2010). This research was one of the first studies to explore the lived experience of undergraduate students in STEM degrees and its empirical findings and theoretical mechanisms remain salient contributors to present

research on undergraduate students' performance and experience. When discussing students' experiences in science, Seymour and Hewitt (1997) indicate that:

> Students were learning that the challenge facing them was not only intellectual; it was also physical and moral. To survive the constant round of assignments, problem sets, tests, lab work and reports required by several courses simultaneously, class work had to take precedence over all other educational interests, personal relationships, athletic commitments, social life, paid employment, leisure and sleep. (p. 92)

The heavy time commitment on academics at the expense of other aspects of life was an important factor influencing students, especially women to switch to a non-science major (Seymour & Hewitt, 1997). This suggests we should view undergraduates' experience in science as a holistic experience influenced by several academic, social and personal factors.

2.3 Factors influencing undergraduates' academic performance and persistence

The difficulty with conducting research in the realm of undergraduate performance is that multiple factors have been identified as influences on their academic achievement. For example, Terenzini et. al (1994) uncovered an array of factors that influenced undergraduates' transition from high school to university. These factors included students' social, family, and educational background, personality, educational and career aspirations, and the kinds of interactions students encountered with their peers, faculty, and staff members. To simplify the examination of these factors, researchers commonly classify them into three categories, namely school-related, socialization and individual processes (Astin, 1984; Kuh et al., 2005; Smoot-Hyde & Gess-Newsome, 2000); or as I will refer to them, academic, social and personal factors. In what follows, I describe

what research tells us about how various academic, social and personal factors influence students' persistence and performance in university.

2.3.1 Academic factors

Seymour and Hewitt (1997) conducted a 3-year longitudinal, ethnographic study with 335 undergraduate students to understand what factors students claimed as important to enhancing or deterring their persistence in STEM fields. The authors conducted one-on-one interviews and focus group discussions with students who remained in (45.4%) or left (54.6%) a STEM degree. Seymour and Hewitt (1997) used the metaphor of an iceberg and described students who switch out as the tip of a much larger problem. The authors presented tables depicting the 23 most common concerns of switchers and non-switchers with respect to the practices and attitudes that existed in the structure and culture of STEM. Faculty, teaching, advising, assessment techniques and curriculum design were identified in all but seven of the factors in the iceberg tables (Seymour & Hewitt, 1997). According to Seymour and Hewitt (1997), the most prominent concerns mentioned by all students (n=335) were poor teaching by faculty (74%), inadequate advising or help with academic problems (61%), and inadequate high school preparation/study skills (41%).

2.3.1.1 Faculty teaching and advising

Previous research indicates that the instructor is one of the most important influences on student performance (D'Andrea & Gosling, 2005; Wigfield, Eccles, & Printrich, 1996). In their book addressing ways to improve teaching and learning D'Andrea & Gosling

(2005) present Chickering and Gamson's Seven Principles of Good Practice which include:

1 Encouraging contact between faculty and students

2 Increasing interaction among students to develop cooperation on learning tasks

3 Using active learning techniques to engage students

4 Giving prompt feedback as per students' progress in the course

5 Emphasizing time on task (providing materials that attract students to spend more time on their studies)

6 Communicating high expectations of student work

7 Respecting the diverse talents and ways of learning for different students

The first principle discusses the need for institutions and departments to increase interactions between faculty and students both inside and outside the classroom. The way in which an instructor communicates with their students is important for helping students learn (Moore, et al., 2007). Instructor clarity, organization, and expressiveness can attract student attention and positively influence students' cognitive engagement and involvement in class (Moore et al., 2007; Wigfield et al., 1996). Researchers also indicate the important role that instructors played in addressing students' conceptual difficulties or poor course performance. Moore et al. (2007) advise professors to:

> Help underperforming students to reflect upon the root cause of their poor performance and how they might take their own steps to address it. Try to allocate particular time slots to students who have failed or underperformed on your assignments/projects/exams. Going through students' work with them and explaining clearly the main reasons why they have underperformed can be a very simple way of transforming student approaches to the challenges you set for them. (p. 80)

In a study by Deslauriers, Lane, Harris and Wieman (2010), instructors of an undergraduate physics course and a general science course designed interventions for students who did not perform well on their first midterm exam. These students were contacted by the course professor and asked to meet to discuss how they prepared and studied for the midterm. Significant improvements on the second midterm were observed for the students who received feedback from the professor on how to improve their study habits (Deslauriers et al., 2010). Some of the students even outperformed their high-achieving peers. This study exemplifies the potential impact that faculty-student interactions can have on students' performance in science.

Receiving timely feedback and engaging students in their learning are reported as being beneficial to students' performance in a course (Handelsman, Miller, & Pfund, 2007; Khan, 2005; Moore et al., 2007; Wigfield et al., 1996). Recent research has stressed the importance for instructors to include assessment techniques throughout the course (formative evaluation) and not to rely solely on largely weighted finals (summative evaluation) (D'Andrea & Gosling, 2005: Handelsman et al., 2007; Moore et al., 2009). Ongoing assessment techniques allow students to determine what they do and do not understand in a course and might prompt changes in their study habits or encourage them to seek out help to improve their comprehension (Handelsman et al., 2007).

Handelsman et al. (2007) coined the term EnGauge to describe assessment methods, which both *engage* students in their learning and allow them to *gauge* their learning in a course. Previous research indicates that interactive engagement techniques such as Peer

Instruction, electronic classroom response systems (i.e. clickers), and interactive demonstrations improve students' conceptual and problem-solving skills in science courses (Crouch, Fagan, Callan & Mazur, 2004; Fies & Marshall, 2008; Rosenberg, Lorenzo & Mazur, 2007). These studies illustrate that the use of such engagement techniques may be useful in encouraging students to be more invested in their own learning in ways that might improve their performance in courses. In addition, researchers have found that in order to enhance student learning and interaction in lecture, it is important for engagement techniques to be introduced and facilitated well by instructors.

2.3.1.2 High school preparation and study skills

A pre-college factor that might influence a students' likelihood to switch to a non-science major was their preparedness for the 'hardness' of science. High school preparation and students' study habits are two common factors that might predict whether a student will succeed in an STEM degree (Seymour & Hewitt, 1997). Students having completed AP (Advanced Placement) or IB (International Baccalaureate) classes in high school tend to be better academically prepared for the demands of undergraduate STEM courses and have more effective study habits in comparison to their peers who did not complete high school honours courses (Seymour & Hewitt, 1997). Regardless of their pre-college preparation, the majority of students entering STEM degrees experience a grave drop in their grades in comparison to high school (Moore et al., 2005; Seymour & Hewitt, 1997). Research suggests that for students beginning their undergraduate degree, the sheer amount of course material and the pace at which it is presented can be quite

overwhelming particularly for students experiencing conceptual difficulties (D'Andrea & Gosling, 2005; Moore et al., 2007; Kuh et al., 2005; Seymour & Hewitt, 1997).

Seymour and Hewitt (1997) go further to suggest that when students experience a dip in their grades or feel as though their grade does not reflect their effort or understanding, they become discouraged and undermine their academic ability. Although just a number or letter, "grades are not objective, neutral facts about people; they are labels to which people react emotionally, and in terms of behavioral and identity adjustments" (Seymour & Hewitt, 1997, p. 107). To cope with their low grades, researchers advise students to put less emphasis on their grades and more on their actual understanding of the course material. Re-focusing one's learning objectives, being more accepting of an average grade, trusting whether or not they understood the material and focusing on their interests in their program might help alleviate some of the burden students' experience with low grades (Crede & Kuncel, 2008; Dougan & Dougan, 1998; Seymour & Hewitt, 1997). This suggests the need for research to examine the emphasis that students place on their grades and to identify how this emphasis affects their interest and performance in science.

A study by Khan (2005) depicts how teaching strategies can be developed to not only improve students' understanding but also alleviate their anxiety and enhance their self-confidence. In this study, the instructor of a third year organic chemistry course developed a student-teacher contract that enabled students to stay on top of their coursework, rewrite assignments or labs they might have struggled with, attend additional learning sessions, and seek tutoring from volunteer tutors if they received a grade less

than C (Khan, 2005). The contract's emphasis on learning opportunities and homework rewrites eased students' conceptual difficulties and helped to build their confidence thus reducing their anxiety. Such activities encouraged students to attend lectures and to seek help when it was needed (Khan, 2005). Identifying techniques to increase students' investment in their learning may reduce the challenges that students face during their undergraduate education, and improve their experiences and persistence in science.

2.3.2 Social factors

Social factors such as a student's choice of major, the influence of others, and living arrangements, have been attributed to influencing students' academic performance in undergraduate science (Dougan & Dougan, 1998; Kuh et al., 2005; Seymour & Hewitt, 1997). In relation to students choice of major, the Organization for Economic Co-operation and Development (2008) commented that students' "choice of study is determined by a range of factors combining objective and subjective, conscious and unconscious influences ranging from family background... to happy or unhappy experiences at school" (p. 10). Students tend to seek advice or suggestions from high school teachers, advisors, family and/or friends to help them weigh the many options of study (Kuh et al., 2005; OECD, 2008; Seymour & Hewitt, 1997). In particular, students' familial socialization could influence their choice of major and ultimately their academic performance (OECD, 2008). This socialization includes parents' beliefs, attitudes and expectations of their child, and the interactions that occur between parent and child (Eisenberg, Martin, & Fabes, 1996). Unfortunately, Seymour and Hewitt (1997) found that 51% of the students they spoke to felt their reasons for choosing an STEM degree

were inappropriate. If students rely on the suggestions of others for a choice of major they are a greater risk of lacking the motivation to complete coursework, having diminished confidence in themselves and their academic abilities, and being uncertain of their identity in the world of science (OECD, 2008; Seymour & Hewitt, 1997). Thus, it is important to examine how students perceive the reasons behind their choice of a science degree and their family's involvement as influencing their academic performance.

Students' living arrangements have also been documented as influencing their academic performance and overall university experience (Astin, 1984, 1993; Dougan & Dougan, 1998; Kuh et al., 2005). Astin (1984) indicated that compared to the commuter students, students who live on-campus are much more likely to express satisfaction with their undergraduate experience, particularly in the areas of their relationships with their peers and instructors, and their involvement on-campus. This is a discouraging result for many Canadian universities, including UBC, that have high numbers of commuter students. This prompts us to wonder what commuter institutions might do to improve off-campus students' experience and performance.

2.3.3 Personal factors

Finally, one might also consider how personal factors might influence students' academic performance. Interest, frustration and anxiety are complex issues that one should consider when examining student persistence in university (Eisenberg et al., 1996). Studies indicate the need for more microanalytic research to examine the diversity amongst the student population at different institutions, and in particular, how individual

students vary in their coping strategies and their success (Kuh et al., 2005; D'Andrea & Gosling, 2005; Seymour and Hewitt, 1997; Wigfield et al., 1996). Psychological issues of this nature are both sensitive and complex and are sometimes more difficult to address than academic and social factors. D'Andrea & Gosling (2005) comment that "students' personal circumstances can, and do, become a barrier to their successful inclusion in study" (p.101-102). This suggests the need for advising and counseling services to help students address their personal concerns.

Researchers also indicate that students' interest plays an important role in their choice of and persistence in a STEM degree (OECD, 2008). Students express that throughout their undergraduate degree, their level of interest in courses fluctuates due to factors such as the course curriculum, teaching, work experiences and their level of engagement (OECD, 2008; Seymour & Hewitt, 1997). Understanding what affects students' interest in science would help me to provide suggestions to administrators and faculty as to how they might work to enhance student interest and success.

2.4 Women in science

The abundance of the literature examining student performance in university discusses the underrepresentation and experience of females in STEM degrees. Seymour & Hewitt (1997) found that within their first year of study, close to half of the female students enrolled in undergraduate STEM majors leave the sciences to pursue a non-science degree or in the most severe cases, dropout of university altogether (Seymour & Hewitt, 1997). Research suggests that elementary, secondary and tertiary science pedagogy and

curricula follows epistemological methods ingrained within a white male-oriented science curriculum; a traditional way of teaching and learning that is frequently noted as being arguably unwelcoming to female students (Schiebinger, 1999; Sonnert & Holton, 1995; Wyer et al., 2001). Studies of women in science have analyzed and critiqued how the male-dominated world of STEM has neglected the needs, desires and experiences of female participants. Through this, feminist perspectives in science have emerged. The literature related to feminism in science offers two models to explain why women are less likely to succeed in the sciences. These are referred to as the deficit model and the difference model (Barbercheck, 2001; Sonnert & Holton, 1995; Wyer et al., 2001).

The deficit model suggests that women are being treated differently in science and are presented with barriers in the social system of science that might deter them from pursuing degrees or careers in STEM fields. In this sense, the term deficit does not refer to females being deficient in the intellectual sense but considers women to be at a disadvantage in comparison to their male peers as women have more difficulty advancing in STEM fields (Sonnert & Holton, 1995). Several barriers that restrict the prominence of women in STEM careers have been identified. They include a lack of funding for female scientists, gender discrimination and a lack of sufficient role models (Wyer et al., 2001). These barriers tend to push women away from a career in the sciences, as the costs of persisting in a science career tend to outweigh the benefits. Policy changes and outreach programs have been introduced to promote inclusive science practices and to counteract the unwelcoming conditions for women.

The second model discussed in feminist science literature is that of the difference model. For years, females have been viewed as less capable compared to males in subjects related to math, science and technology (Sonnert & Holton, 1995). The difference model, however, does not view females in this light. It presents the idea that women act differently in science than males, and as a result, women are less likely to succeed (Barbercheck, 2001; Sonnert & Holton, 1995). The male-oriented attitudes that are often associated with STEM fields, such as aggression, competitiveness, and resilience, could present barriers for women who from a young age have been encouraged to socialize in a style de-emphasizing these male-like behaviours. Several interventions have been administered over the past few years to address the difference model to recruit and retain women in STEM. They are typically based on changing the norm of traditional science to be more inclusive and to improve the environment by introducing a wider range of acceptable behaviours and communication styles. The two aforementioned models present several factors that might deter women from pursuing or succeeding in STEM fields. This has served as an impetus to examine the literature in more detail to understand how females perceive different factors as influencing their persistence and academic success.

2.4.1 Factors influencing females' academic performance and persistence

In this section I will examine in more detail some of the factors that have been attributed to females' performance and persistence in undergraduate STEM degrees. Seymour & Hewitt (1997) indicated that the females they spoke to placed a stronger emphasis on the poor teaching by STEM faculty (85%), the inadequate advising or help with academic

problems (66%), and their inappropriate choice of an STEM major (66%) in comparison to the males. In their examination of the day-to-day interactions of undergraduate females in STEM programs, Smoot-Hyde and Gess-Newsome (2000) identified several academic, social and personal factors that females described as influential to their academic performance. The academic factors included the importance for females to have positive relationships with faculty, study with their peers, proper high school preparation, and interactive and engaging instruction. The social factors consisted of positive family support and relationships with female friends and the personal factors included the importance for females to feel confident and determined. From the interviews and focus group discussions, female students perceived three factors as being the most important in influencing their persistence in STEM fields. These include: their personal associations with peers and faculty, practical and active pedagogy, and related work experience (Smoot-Hyde & Gess-Newsome, 2000).

A main factor that has been known to influence females' persistence and performance in undergraduate science is the presence of female faculty role models. Kissinger et. al (2009) examined the role that gender and a sense of community played in undergraduates' persistence and performance in engineering and computer science majors. Females expressed a need to have a sense of belonging and community in comparison to their male peers (Kissinger et al., 2009). This study discussed that in disciplines where female students were present in higher numbers, their sense of belonging and connection to the class and departmental community was higher. Females who were able to build a community with their peers and instructors were more likely to

persist in their degree and expressed satisfaction with their program. In addition, Sonnert et al. (2007) determined that the percentage of women in undergraduate science and engineering programs and their completion of these degrees were associated with the percentage of women faculty in these fields. The presence of women faculty was shown to have a positive influence on females' performance and persistence in undergraduate science and engineering (Sonnert et al., 2007). This study suggests for departments with a low representation of female students and faculty (i.e. computer science, physics) to consider hiring more female faculty role models to improve the persistence and performance of females in these underrepresented degrees.

According to Seymour and Hewitt (1997) and the OECD (2008), females are twice as likely as males to choose a major in STEM based on the influence, pressure or suggestions from other people including their parents, high school teachers, counselors, and peers. As stated previously, relying on the suggestions of others when choosing a major may lead to a lack of motivation and contribute to diminished confidence in oneself and their academic abilities, and an uncertainty of one's identity in the world of science (Seymour & Hewitt, 1997). If they are not satisfied with their choice of major, females are more likely than males to switch from a STEM degree.

Research also suggests that women view their grades as 'not good enough' even when they receive grades that are judged as good from an outsider's perspective (Seymour & Hewitt, 1997). Schiebinger (1999) points out that "women often underestimate and men overestimate their abilities and probability of success" (p. 58). Seymour and Hewitt

(1997) indicate that the shock of receiving these low grades might entice a female student to switch to a non-science major, while males tend not to put as much emphasis on their number or letter grade. Seymour and Hewitt (1997) illustrate how low grades can affect a female's self-confidence and discuss the experience of a female student who received a D in one of her courses. Despite the fact that she had A's in the rest of her courses, she questioned whether or not she 'belonged' in the sciences. Females appear to place a lot of emphasis on their grades and use them as a form of comparison amongst their peers. This relates back to Seymour and Hewitt's (1997) advice for students to put less emphasis on their grades and to refocus their attentions on their learning and comprehension.

In comparison to their male peers, females are more concerned with interactive and engaging teaching strategies, building meaningful relationships with their peers and faculty, suggestions from family and advisors to pursue science, their grades, and work related experiences. These factors may be useful to consider for faculty and administrators who wish to adapt their teaching and programs to improve the persistence and performance of all students.

2.5 Summary

This review of the literature demonstrates the complexity of factors related to students' performance in undergraduate science. The factors discussed in this review are summarized in Table 2.1.

Table 2.1: A summary of the academic, social and personal factors discussed in the literature review

Category	Factors to be investigated in my proposed research	Importance
Academic	Faculty teaching, assessment techniques and curriculum design Advising or help with academic problems • Integral for females High school preparation Study skills and habits Student and institutional emphasis on grades Grade drop from high school to university Work related experiences • Important for females	• Importance of teaching strategies and assessment methods to improve conceptual difficulties, the likelihood for students to attend class, and to place less emphasis on their grades • Seeking academic support to help with conceptual difficulties • Lack of appropriate study skills and habits could negatively influence students' performance • Need to reflect on learning objectives to improve conceptual difficulties • Need for students to be more accepting of their grade and place more emphasis on comprehension • Increase students' interest and confidence in their academic abilities
Social	Reasons for choice of science major • Influence of others on females' choices Living arrangements	• Choosing a major in science for the wrong reasons could negatively affect students' experience • Commuter students have more difficulty creating relationships with their peers and with faculty. They also are less likely to be involved on-campus.
Personal	Interest Frustration, anxiety, confidence	• Interactions with faculty and advisors, teaching strategies, assessment and curriculum that help to alleviate students' anxiety and heighten their confidence • Need for high grades might increase student anxiety. Low grades might influence students to lose confidence.

In terms of the academic factors, it appears that students place considerable importance on their relationships with instructors and advisors, teaching, assessment techniques, curriculum design, and their preparedness for the 'hardness' of the sciences. Research suggests that an intervention by an instructor or an advisor may help address a student's

conceptual difficulty or improve their attendance and interest in a particular course. Providing inclusive, interactive teaching techniques or a student contract such as that described by Khan (2005), could increase students' sense of responsibility and provide a sense of control over their own performance. These actions may also improve student confidence and lessen their anxiety.

Research suggests that the social and academic factors seem to influence students' interest or emotional response. For example teaching strategies, assessment techniques, curriculum design, and advising may influence students' conceptual understanding and levels of anxiety and frsutration (Khan, 2005; Moore et al., 2007; Seymour & Hewitt, 1997). In addition, if students are under pressure to attain high grades, they might feel overwhelmed while losing confidence in their abilities (Seymour & Hewitt, 1997). When exploring what academic, social and personal factors students perceive as most influential to their academic performance it is also important to consider how different factors might interact with one another.

A factor that benefited undergraduates, but more specifically female undergraduates, was their involvement with work related experiences. Studies by Seymour and Hewitt (1997) and Smoot-Hyde and Gess-Newsome's (2000) indicated that female students perceived this work experience as integral to their persistence in the sciences as it provided hands-on experience that helped them to 'feel' like a scientist. This finding was supported by Khan's (2005) study of an undergraduate chemistry professor who encouraged females to seek out science internships and apply the skills they learned in their courses. Thus it

appears that provision of work-related experiences may improve students' academic understanding, their career objectives, and confidence thus enhancing their persistence in the sciences.

This review of the literature demonstrates how different academic, social and personal factors might intersect to influence students' academic performance in STEM. Past research indicates the need for more analytic research to examine the diversity among undergraduates at different institutions, and in particular, how males and females vary in their coping strategies and success (D'Andrea & Gosling, 2005; Moore et al., 2007; OECD, 2008; Seymour and Hewitt, 1997). Gender differences in science are a complex issue and are important to consider. Hopefully the research described in this thesis will add to what is already known and help identify the factors that students within the Faculty of Science at UBC perceive as most influential to their academic performance. Identifying these factors and listening to the experiences of students will provide useful insights for administration, faculty and students who seek to improve and enhance students' academic performance.

3 Methodology

3.1 Research questions

As demonstrated by the literature review in the previous chapter, student success is a complex subject. Teaching and assessment methods, work related experiences, study habits, courseload, family influence, and living arrangements are just some of the factors that could limit or enhance student success in university (Kuh et al., 2005; Moore et al., 2005; Seymour & Hewitt, 1997). This study extends research conducted to date by exploring what academic, social and personal factors undergraduates within the Faculty of Science at the University of British Columbia perceived as influential to their academic performance. The following research questions were addressed in this study:

1 What academic, social and personal factors do male and female undergraduates within the Faculty of Science perceive as most influential to impeding or enhancing their academic performance?

2 How do male and female undergraduates differ in what they perceive as being most influential to their academic performance?

A mixed method design was chosen for this research. The research questions were answered by the analysis of quantitative and qualitative data collected through use of a survey, one-on-one interviews and a focus group discussion. Overall, 492 students filled out the survey, 24 students completed one-on-one interviews and four students took part in a focus group discussion. Statistical analysis of the survey data assisted in pinpointing the factors students perceived as influencing their academic performance and in detecting

whether differences existed among males' and females' perceptions. The incorporation of one-on-one interviews and a focus group discussion provided a more candid and personalized look into the educational experiences of the students to understand why they perceived particular factors as important. Based on findings from the analysis of the data, I provide recommendations for administration, faculty and students who seek to improve the academic performance and overall experience of undergraduates within the Faculty of Science. These recommendations are presented in the final chapter of this dissertation.

3.2 Background to the study

In February 2009, I was asked by the Carl Wieman Science Education Initiative (CWSEI) and the Faculty of Science Dean's Office to partake in a study to examine the factors influencing student failure within science courses at UBC. Administrators were concerned with the performance of students in particular courses within the Faculty and were eager to understand what factors students perceived as affecting their success or failure. Before I could start researching this topic, I felt it necessary to understand more about the student population and the environment within the Faculty of Science at UBC. As a result I held meetings with administration (Associate Dean of Science, Vice-President of Student Affairs, Director of Medical Services, Director of Counseling Services, Science Academic Advisors, Director of International Student Affairs, Director of Recreational Programming), 10 faculty, and 10 male and 14 female undergraduates pursuing a variety of degrees (i.e. physics, mathematics, biology, general science, chemistry) to inquire as to what factors they perceived as impeding or enhancing students' academic performance. In addition to my conversations with the

administrators, faculty, and students, I consulted the literature on student performance to enhance my awareness regarding the researchers' findings (Astin, 1984; 1993; Kuh et al., 2005; Seymour & Hewitt, 1997; Smoot-Hyde & Gess-Newsome, 2000).

Based on the previous research and my discussions with individuals at UBC, I decided to investigate the influence of the following factors on students' academic performance: pedagogy and instruction, assessment methods and feedback, study habits, academic support and advising, personal interest, the influence of parents/guardians/peers, living arrangements, and commuting. To examine these factors I decided to use a mixed method approach consisting of a student survey, one-on-one interviews and focus group discussions.

3.3 Institutional context and population of interest

3.3.1 Institutional context

The University of British Columbia (UBC) is a large, selective, public Canadian institution of higher learning. A minimum high school average of 67% is required to be admitted to a UBC program, however for most degrees, this admittance average is significantly higher (UBC Admissions Committee, 2007). In 2005, the minimum admission average for students hoping to study within the Faculty of Science at UBC was 87.1% and is steadily increasing (UBC Admissions Committee, 2007). Based on the admission average and discussions I have had with the UBC Associate Director of Enrolment Services, students entering science degrees are defined as high-achievers.

3.3.2 Population of interest

The participants in this study were undergraduates who were pursuing a degree in the Faculty of Science at the University of British Columbia. Students in second year or higher were targeted for this research under the assumption that they have had more experience in the Faculty of Science in comparison to their first-year peers. In 2009 there were 4,951 second, third and fourth year students enrolled in majors within the Faculty of Science.

This research also examined the differences between male and female students' perceptions of how particular factors influenced their academic performance. Within the Faculty of Science at UBC, the number of male and female students is quite similar however the proportion of males to females varies significantly with respect to their program of study. Table 3.1 provides a summary, by specialization, of the number of male and female students enrolled in their second, third or fourth year of study within the Faculty of Science in 2009.

Table 3.1: A summary of the number of female and male undergraduates in their second, third, and fourth year of a degree within the Faculty of Science at UBC

	2009	
Specialization	**Female**	**Male**
Biochemistry	165	212
Biology	577	326
Chemistry	144	147
Computer Science	126	452
Environmental Science	61	21
Earth and Ocean Science	50	73
General Science	824	554
Geographical Biogeoscience	13	14
Integrated Science	65	42
Mathematics	84	93
Microbiology	173	141
Other	3	8
Pharmacology	33	42
Physics and Astronomy	47	176
Physiology	28	29
Psychology	100	56
Statistics	40	32
Total	**2533**	**2418**

In 2009, within the Faculty of Science at UBC, more females than males pursued degrees in biology, environmental science, general science and psychology. In that year the majority of the students in computer science and physics and astronomy were males. The remaining degree specialization did not show significant differences with regards to the number of male and female students enrolled.

3.4 Mixed method research

A mixed method approach incorporating quantitative and qualitative methods in the design, data collection, and analysis was chosen to answer the research questions for this study. Mixed method research has been considered to fit the *pragmatic* paradigm in the sense that:

> The research questions in and of themselves are not inherently important and methods are not automatically appropriate. Rather, the researcher makes a choice about what is important and what is appropriate, based on a general consensus in the community that serves as the researcher's reference group.
>
> Mertens, 2010, p. 38

Under the *pragmatic* paradigm, the researcher influences what will be studied (Mertens, 2010). Consequently, as a researcher I must be aware that my choice of research design was influenced by my perception of what I felt should be investigated in this study. My decision was based on my conversations with administrators, faculty and students in the Faculty of Science at UBC and the literature on student performance.

The *transformative* paradigm has also been linked to mixed method research but in comparison to the *pragmatic* paradigm it emphasizes the "inclusion of values and viewpoints, especially of marginalized groups, as the driving force for all aspects of the research" (Mertens, 2010, p. 297) and "directly addresses the politics in research by confronting social oppression at whatever level it occurs" (Mertens, 2010, p. 21). Researchers favoring the *transformative* paradigm have criticized the *pragmatic* paradigm because it is based on the choice and values of the researcher. As a result it might negate the values of the individuals being studied and only serve whatever ends the researcher endorses (Mertens, 2010). Incorporating the qualities of both *pragmatic* and *transformative* paradigms has helped me to address this criticism. When analyzing the data I attempted to provide results and conclusions that were not imposed by my views, that benefited the various stakeholders involved in this study (i.e. administration, faculty and students) and that were "premised on higher social goals than being useful to those in power" (Mertens, 2010, p. 297). I feel that this research had qualities emanating from

both the *pragmatic* and *transformative* paradigms and have situated myself in both for this mixed method research.

Researchers have used a mixed method approach because "it seemed intuitively obvious to them that this would enrich their ability to draw conclusions about the problem under study" (Mertens, 2010, p. 294). When I was initially deciding what data collection methods to use in this study, I was drawn to conducting a survey and one-on-one interviews. The survey would allow me to collect the perceptions of a large subset of students and to determine the statistical significance of the responses while the one-on-one interviews would provide a more personalized voice to the student experience. Roughly 80 students expressed interest in speaking with me about their academic experience and as a result I decided to add focus group discussions as a means of data collection. Focus group discussions would help to provide depth and range of the research topic in a condensed period of time in comparison to the interviews alone (Bogdan & Biklen, 1998).

I classify this mixed method research under what Mertens (2010) calls a *pragmatic* and *transformative parallel* design. This design collects both qualitative and quantitative data simultaneously with a small timeframe to answer the research questions and to promote social change (Mertens, 2010). Each data set is analyzed according to the appropriate analytic techniques and then brought together to draw conclusions for implications. For this study, the survey data was analyzed using statistical methods whereas the interview and focus group discussion data were analyzed using the constant comparative method

(Bogdan and Biklen, 1998). Once data analysis was complete, the results from both the quantitative and qualitative methods were brought together to provide a more thorough understanding as to the factors that males and females perceived as influencing their academic performance in science and why they perceived these factors as important.

The following subsections will review in more detail the design, data collection and data analysis of the survey, and interviews and focus group discussion. These sections will further justify the methods chosen for this study and will describe how the results of the analysis were used to answer the research questions outlined earlier.

3.4.1 Survey

Before I discuss how the survey data was collected and analyzed, I will present the process of developing the survey. This was the first large-scale survey I had conducted as a researcher and its creation, administration, and analysis was an excellent learning experience.

3.4.1.1 Survey development

The creation of the survey for this study was a long process and opened my eyes as an amateur researcher to the complexity of survey design and analysis. My discussions with administration, faculty, student development and students along with previous research on student development provided a good base from which to create survey questions. The survey questions were designed to explore the following factors: pedagogy and instruction, assessment methods and feedback, study habits, academic support and

advising, personal academic motivations, parental/guardian/peer support and influence, living arrangements, and commuting. When creating the survey questions I attempted to keep them as clear and concise as possible. Questions were written and re-written multiple times until I felt they were articulated appropriately.

The survey (Appendix A) consisted of 41 questions. Twenty-eight of these were based on academic, social or personal factors and 13 provided demographic information. Spaces for students to provide additional comments regarding any of the factors were interspersed throughout the survey. The start of the survey had brief instructions for the students and thanked them for their participation. The first 19 questions inquired as to the importance that particular academic/personal factors played on students' academic performance. The scale was a 5-point Likert scale ranging from Unimportant to Very Important and the justification for its use is explained in the data analysis section. In the next portion of the survey students indicated their level of agreement with the importance of nine social/personal based survey questions. The scale was a 5-point Likert scale ranging from Strongly Disagree to Strongly Agree. Next was the demographic questions related to students' academic, social and personal life. At the end of the interview students were asked to provide their e-mail address if they were interested in participating in a one-on-one interview to discuss their experience as a student in the sciences.

Once I had completed a coherent draft of the survey, I needed to validate it with undergraduate students in science programs. I e-mailed biology, chemistry, physics and mathematics professors teaching second, third and fourth year courses to ask if I could

come to their class to recruit students to validate my survey. For those professors who agreed, I gave a 2-minute review to the students informing them of the study and asking for their participation with the validation of the survey. I provided the students with my contact information and also gave a written description to the professor.

Visiting the classes resulted in the recruitment of 14 students for the survey validations. The students varied in their gender, major and year of study. When students first arrived to my office I briefly went over the purpose of the research and asked them to fill out the survey. Once completed, I asked them to paraphrase each question to help me understand whether or not the question was being interpreted as it was written.

As a result of the validations some changes were made to the survey. For example, one of the questions asked students to indicate how important "adapting study habits for university courses" was to influencing their academic performance. Two students indicated that although they thought study habits were extremely important to their academic performance in university, they rated this question as only slightly important because they felt that they didn't adapt their habits. They didn't adapt their study habits because they were not aware of the study habits they had. One of the students suggested that I change the question to "*developing and* adapting study habits for university courses". Students' overall comments and suggestions were extremely insightful and during our conversations they enlightened me as to what factors I wanted to probe more thoroughly within the interviews and focus group discussion.

At the end of the survey validation I asked students what would entice them to fill out the survey. I had mentioned that it was going to be sent as a blanket e-mail by the Faculty of Science, but most students indicated that they tended not to read generic e-mails and deleted them. They did mention however that if the e-mail came from one of their course instructors they would read it in full. As a result, I decided to contact various instructors within the Faculty of Science to ask if they would provide the survey link to their students. I sent an e-mail to instructors teaching various grade levels in the winter term of 2010 in the botany, chemistry, computer science, earth and ocean sciences, mathematics, physics and astronomy, statistics and zoology departments. Within the e-mail I explained the purpose of this research and asked them to forward a survey description and the corresponding survey link to their students. Twenty-three of the 34 instructors I contacted said they would inform their students on my behalf. Three instructors were quite adamant about not sending my e-mail to their students because they did not agree with what I was researching. Although this might not have been the easiest or most direct method for recruiting students to complete the survey, it resulted in almost 500 responses from students pursuing degrees within the Faculty of Science.

3.4.1.2 Data collection

I used the Vivoci EFM Continuum survey tool to create a web-based survey and to collect the survey data. Creating the online survey was extremely straightforward and allowed me to organize the survey in a clear, attractive and well laid out fashion. Some of the advantages of a web-based survey were that it provided fast responses, quick troubleshooting, automated data collection, access to larger samples and was convenient

for those filling it out (Mertens, 2010). The main disadvantage with the survey was that it did not restrict students from completing it out more than once. Fortunately however the EFM survey tool recorded the IP addresses for the respondents and based on this I was able to see if anyone had submitted or completed the survey twice. Only one student had done this so I deleted their duplicate response. I am aware that some students might have filled out the survey on alternate computers, which might not have allowed me to catch the submission of more than one survey per student.

3.4.1.3 Data analysis

The data collected via the EFM survey tool was exported to SPSS (IBM, 2009) and Excel (Microsoft, 2004) for analysis. SPSS was used for the more rigorous statistical analysis with Excel being used primarily for graphing purposes. From the survey data I was interested in extracting what factors undergraduates perceived as most influential to their academic performance and to detect what differences existed amongst the responses of males and females.

Examining the demographic survey data allowed me to understand the academic and social backgrounds of the students who completed the survey. Students' provided information regarding their gender, citizenship, ethnicity, living arrangements, home language, commute time, academic year of study, discipline, average course and average grades. To determine whether or not the results could be generalized to the overall student population within the Faculty of Science at UBC, I compared the students by

discipline and gender based on the breakdown I received from the Faculty of Science Dean's office and that collected from the survey sample.

Before I was able to analyze the differences between students' gender and their discipline, I first had to consider how the data was collected and then justify what statistical tests to use for analysis. In the following section I discuss the issues that a researcher should consider when incorporating a Likert-scale for data collection. I also present how the overall distribution of the data results influenced whether parametric or non-parametric statistical tests were used for comparative analysis among male and female students' responses.

3.4.1.3.1 Determining the most important factors

Likert-scale surveys are typically nominal or ordinal in nature and as a result, researchers who interpret the responses as continuous and non-discrete have been criticized (Gravetter & Wallnau, 2008). With an ordinal scale it is difficult to justify that the intervals between the categories are equal, and so representing the data as a mean can be quite misleading for the reader (Gravetter & Wallnau, 2008). For example, if for a 5-point Likert-scale two respondents were at the low end of the scale with an assigned value of 1, and two others were at the high end with a value of 5, the mean for this group of individuals would be 3. Comparatively, if 4 respondents indicated a satisfaction in the middle of the scale (a value of 3) the mean would also be 3. Both of these groups would be considered the same based on their overall mean despite the fact that in one group, the respondents had values at either extreme of the scale. Thus, the most accepted way to

present the data for Likert-scale results is to display the descriptive frequencies and the mode for each survey question (Motulsky, 2010).

For this study, two 5-point ordinal scales consisting of Unimportant to Very Important, and Strongly Disagree to Strongly Agree were used in the student survey. To begin the analysis, I computed the descriptive frequencies for each survey question for the overall student population, and then for male and female students. To ease the analysis of the frequencies, the survey responses were condensed into three categories; Unimportant, Somewhat Important and Important. The Slightly Important and Very Important responses were grouped with the Unimportant and Important categories respectively. The frequency data was arranged in descending order to determine what factors students' perceived as most important to influencing their academic performance in science.

3.4.1.3.2 Determining gender differences

To evaluate whether or not observable differences existed amongst the responses of males and females, I first had to consider whether parametric or non-parametric statistical tests best suited the data. For parametric methods comparing more than one set of independent groups (i.e. gender), the data must abide by the following assumptions: the observations are independent, the populations follow a normal distribution and the populations have equal variance (Gravetter & Wallnau, 2008). Non-parametric tests on the other hand do not make assumptions about the distribution of the population and can thus be used if the collected data does not follow a normal distribution.

To determine whether or not the data followed a Gaussian (normal) distribution I used the Kolmogorov-Smirnov test for normality in SPSS. For the Kolmogorov-Smirnov test, a *p*-value greater than 0.05 accepts the null hypothesis and states that the data follows a normal distribution. A *p*-value less than 0.05 is considered statistically significant and rejects the null hypothesis; indicating that the data does not follow a normal distribution (Bryman & Cramer, 2009). For this research, the Kolmogorov-Smirnov test indicated that the overall data, as well as that distinguished by gender was not normally distributed (Appendix B). As a result, I opted to use non-parametric tests for my analysis.

Although non-parametric statistics are considered to be "less sensitive than their parametric cousins" (Gravetter & Wallnau, 2008), they are only slightly less powerful than parametric tests when analyzing large samples (Motulsky, 2010). When calculating if there are any differences between males' and females' responses I used the Mann-Whitney *U* Test. The Mann-Whitney *U* Test, although not as sensitive as its parametric counterpart the Independent t-test, is considered a viable alternative for analyzing data that is not normally distributed but has a large number of responses (Bryman & Cramer, 2009). This statistical test compares the number of times a response from one sample is ranked higher than the score from the other sample. If the two groups are similar then the number of times this happens should be the same. With a *p*-value greater than 0.05, the null hypothesis states that there is no difference between the two groups. If the *p*-value is less than 0.05 we can reject the null hypothesis and assume that there is a difference between the samples.

3.4.2 Interviews and focus group discussion

In their study investigating the factors influencing student persistence in science Seymour and Hewitt (1997) describe students as "expert informants who are well-placed to describe the strengths and limitations of their educational experiences" (p. 23). In this body of work, the authors provided a critical analysis of the undergraduate experience in science, mathematics and engineering by conducting in-depth interviews and focus group discussions with students. To support their written findings, Seymour and Hewitt (1997) presented a variety of student quotes that offered a glimpse into the lives, perceptions and experiences of the students. In light of Seymour and Hewitt's (1997) work, interviews and focus group discussion were chosen as the qualitative methods for data collection for my research.

There are many advantages to completing interviews, but one should also consider the disadvantages and the role they might play in the research process. Although they provide a plethora of valuable information and insight into the lives of individuals, the collection and analysis of the data can take a lot of time and contain biases and subjectivity through the researcher's interpretations (Mertens, 2010). Researcher biases are inevitable in interpretive research that uses qualitative data sources. Thus, researchers must be aware of their own subjectivity as this will influence the judgments they make throughout the research process (Bogdan & Biklen, 1998). For the qualitative analysis of this research, I was attentive to presenting the viewpoint of the participant and not my own. Being aware of and reflecting on my own subjectivities helped me to attend to possible researcher biases.

In-depth interviewing and focus group discussions provide a set of rich data which can be used to generate detailed and intimate descriptions of participants' reflections. This data can be presented through verbatim quotations that capture the participants' perspectives on a particular topic (Best & Kahn, 1998). The use of these qualitative techniques provided a picture of why students perceived particular factors as influencing their academic performance. In the next sections I will describe how the data was collected and analyzed.

3.4.2.1 Data collection

Interview and focus group discussion data were gathered from undergraduate students pursuing a degree within the Faculty of Science at UBC. Professors forwarded an e-mail message to their students regarding the survey. In that message students were encouraged to contact me if they were interested in completing a one-on-one interview to discuss their experiences in science. In addition, within the survey itself, there was a space at the end for students to fill in their e-mail address if they were interested in completing an interview. Eighty-five students signed up to complete one-on-one interviews. Since there were too many students to interview individually, I decided to incorporate focus group discussions into the study. This way, I was able to speak to more students in the time available for this research.

Before I contacted the students who had volunteered, I organized a list of these students by their year of study, gender and major in order to select students from various

backgrounds. To seek participation for the interviews I randomly selected 50 students and contacted them via e-mail. This e-mail provided students with a review of the purpose of the study, a numerical identifier to use to sign up for an interview date/time, and the interview consent form for their perusal (Appendix C). An e-mail was sent a week later to remind students to sign up for an interview date/time if they had not already done so. Once students had signed up for a timeslot they received a confirmation e-mail with the location of the interview. The day before the interview I sent the students an e-mail to remind them of the date, time and location. In total, 22 students took part in one-on-one interviews.

For the focus group discussion, an e-mail message was sent to 35 students asking for their participation but also indicating that if they preferred to complete a one-on-one interview this was also possible. Similar to the e-mail message describing the interview, an e-mail message about the focus group discussion provided students with a review of the purpose of the study, a numerical identifier to use to sign up for an focus group discussion timeslot, and the focus group discussion consent form for their perusal (Appendix D). Eight students signed up for one of the focus group discussion timeslots, and two others completed a one-on-one interview. Once students had signed up for a timeslot they received a confirmation e-mail regarding where the focus group discussion would take place. The day before the focus group discussion I sent an e-mail to remind the students of the date, time and location. On the day of the focus group discussion, two students had to cancel due to their work schedules with another canceling because of a family

emergency. At the time of the focus group, one student did not show up and as a result, there were only four students who took part.

In total, 24 one-on-one interviews and one four-person focus group discussion were conducted with undergraduates to explore their perceptions regarding what academic, social and personal factors were viewed as important for impeding or enhancing their academic performance in science. The interviews and focus group discussion questions are provided in Appendices E and F, respectively. The interviews lasted anywhere from 45 – 85 minutes and the focus group discussion lasted about 75 minutes. The interviews and focus group discussion were semi-structured and examined how students perceived factors related to pedagogy and instruction, assessment methods and feedback, study habits, grades, choice of major, parental/guardian/peer support and influence, living arrangements, and commuting as influencing their academic performance. During the interviews and focus group discussion, I attempted to avoid "real" conversation and refrained from providing personal opinions that might have influenced students' responses (Fontana & Fray, 2005). In addition to audio recording, I took notes during the discussion, however this was kept to a minimum to ensure that I was able to maintain eye contact with the student.

Even though prepared questions served as the starting point for developing dialogue, the students determined the specific direction of any individual conversation (Bogdan & Biklen, 1998). The students were encouraged to speak openly and to reflect upon the details of their academic, social and personal undergraduate experience. The flexibility

of this semi-structured approach allowed me, as the interviewer, to pick up on and probe particular topics initiated by the respondents and encourage their elaboration (Bogdan & Biklen, 1998). To explore students' answers further, yet not lead them to a desired answer, the following probing questions were used: How does that work for you? What has your experience been like? Could you elaborate a little more on what you just talked about?

The interviews followed a format suggested by Bogdan & Biklen (1998). The interviews began with small talk so I could build a comfortable, positive rapport with the students. I then reviewed the purpose of the study and had the students fill out the consent form. The beginning interview questions served to ease the student into the interview with some straightforward demographic information (major, academic year, ethnicity, living arrangements, etc.). The discussion then moved to asking questions related to topics of pedagogy and instructors, course curriculum and assessment, study habits, grades, choice of major, parental/guardian/peer influence, living arrangements and commuting. At the end of the interview, I asked the students a few questions to summarize their thoughts such as: Thinking back on your experience, what do you perceive as the top three factors that have enhanced or impeded your academic performance? What advice would you give to students to be successful in the sciences? When our conversation was complete, I thanked the students for their participation and encouraged them to contact me if they have any comments, questions and/or concerns with regards to the study.

For the focus group discussion I followed a format similar, but not identical, to the one-on-one interviews. At the beginning of the focus group discussion I reviewed the purpose of the study and had the students complete the consent form. I then asked them to share with the rest of the group their name, year of study, major and whether they lived on- or off-campus. Before I began with the focus group discussion questions I passed a piece of paper to each student and asked them to write down the top 5 factors they perceived as most influential to their academic performance. Once they were done writing, I instructed the students to fold the paper in half and to leave them until the end of the discussion. After this activity I resorted to the prepared focus group discussion questions. I began by asking students about their experience in science and based on their responses asked the prepared questions or used probing questions. Near the end of the discussion the students were instructed to open their paper on which they had written their top 5 factors. The students were then asked to share their responses with the group. My reason for doing so was to see how their perceptions might have changed or stayed the same after speaking with their peers. At the end of the discussion, I thanked the students for their time and encouraged them to contact me if they had any further comments or concerns.

As I completed more interviews I started to become more comfortable with the semi-structured questions and with probing so as not to lead the students' responses. One practice I found quite useful was that at the end of the interview and the focus group discussion I informed the students as to how I was going to analyze the data and to whom it would be presented (about a 1 or 2 minute summary). My explanation seemed to

trigger students' memory and as a result they would add additional information that we did not discuss previously in the interview or focus group discussion. In about half of the interviews, students would talk for another 3-5 minutes about a particular topic. In the focus group discussion, students talked for an additional 10 minutes about the use of active learning techniques in lecture, especially the use of clickers. It seemed that having a bit of informal conversation at the end of the interview helped students to think about any additional factors that they might not have mentioned earlier on. In each case, students were interested in knowing how the data was going to be used and offered more information regarding the factors they felt influenced their academic performance.

3.4.2.2 Data analysis

The analysis of qualitative data can be extremely tedious and time consuming, however effective transcription and coding techniques helps to ease the process (Bogdan & Biklen, 1998). In their book, *Qualitative Research in Education: An Introduction to Theory and Methods*, Bogdan and Biklen (1998) review Glaser and Strauss's constant comparative method (CCM) – a method for analyzing data. For the CCM, analysis begins early on in the study, is carried out throughout the study and almost complete by the end of data collection. Bogdan and Biklen (1998) described Glaser's outline of the steps involved in the constant comparative method which include (p.67):

1. Begin collecting data
2. Look for key issues, recurrent events, or activities in the data that become categories of focus.

3. Collect data that provide many incidents of the categories of focus, with an eye to seeing the diversity of the dimensions under categories.
4. Write about the categories you are exploring, attempting to describe and account for all the incidents you have in your data while continually searching for new incidents.
5. Work with the data and emerging model to discover basic social processes and relationships.
6. Engage in sampling, coding, and writing as the analysis focuses on the core categories.

Although complex, adopting this analytic method assisted in keeping me up to date with my analysis of the interviews and focus group discussion and helped me to detect any common themes emerging from the data. For this study, the interviews and focus group discussions were audiotaped and documented by brief written notes. To begin my analysis, the interviews and focus group discussion were transcribed into a word document. Once I had written and re-read the transcription I created a summary for each interview and the focus group by parsing out prominent themes and supporting student comments. With these summaries I was able to prepare a coding scheme (Appendix G) with 17 coding categories: Qualities of the Instructor, Lecturing Methods & Note-taking, Expectations, Assessment Methods, Grades, Conceptual Difficulties, Coursework/Courseload, Study Habits, Choice of Major, Influence of Others, Effects of Living Arrangements, Additional Responsibilities, Work experience & Application, Community, Personal Qualities & Language, Advising and Advice/Change.

Once I had completed the coding scheme, I went back and began coding the interview and the focus group discussion summaries. While doing this, I also narrowed the student quotes down to those I felt would enrich the study and provide more insight than my words alone. After that, I went back through the interviews and focus group discussion summaries to determine how often particular factors/themes were discussed by students. I also considered why particular factors seemed to be more important for males or females.

3.5 Summary

The findings from the analysis of the interview and focus group discussion were combined with the survey results to answer the research questions. These findings are presented and discussed in Chapter 5. In addition, the quantitative and qualitative data findings were used to generate recommendations for administrators, faculty and students about how they can positively affect the academic performance of undergraduate students in science programs (Chapter 6).

3.6 Ethics

This research follows the ethics for the Carl Wieman Science Education Students' Academic Performance Investigation which was approved by the UBC Behavioural Research Ethics Board on June 26th, 2009 (Appendix H). Annual renewal with amendments was accepted on June 8th, 2010 (Appendix I).

4 Data Analysis

In this chapter I present my analysis of the data collected from the student survey, the 24 one-on-one interviews and the 4-person focus group discussion. First, I present the survey data to establish which factors students perceive as most influential to their academic performance. Then, I consider how males and females differ in their emphasis regarding the influence of particular factors. Finally, I will present the findings from my analysis of the one-on-one interviews and focus group discussion data to provide a more in-depth look at the experiences of students within the Faculty of Science. The quantitative and qualitative findings are examined together and discussed in more detail in Chapter 5.

4.1 Student survey

The survey data was collected using the Vivoci EFM Continuum survey tool. This tool organized the data into bar and pie charts which allowed me to visualize the data before I began more rigorous statistical analysis. After having familiarized myself with the overall data, I exported it into SPSS (IBM, 2009) and Excel (Microsoft, 2004) files for analysis. SPSS was used for the majority of the statistical tests and Excel was used primarily for the construction of graphs and charts.

4.1.1 Demographic information

When I first began analyzing the survey data I was immediately overwhelmed by the sheer amount of information that I had collected and the endless possibilities for analysis.

To ease myself into the analysis process, I first decided to focus on students' demographic information. I was curious to understand who the students were and what their respective academic and social backgrounds were. 492 students pursuing degrees within the Faculty of Science completed the survey. Their demographics are summarized in Table 4.1.

Table 4.1: A summary of the demographics for students who completed the survey

Demographic	Number of students (n)	Percentage of students (%)
What is your sex?		
Male	205	41.7
Female	287	58.3
What is your citizenship?		
Canadian	421	86.1
Permanent Resident	35	7.2
International Student	33	6.7
What is your race/ethnicity?		
Aboriginal	3	0.6
Arab	3	0.6
Black	1	0.2
Chinese	170	34.6
Filipino	10	2
Japanese	4	0.8
Korean	13	2.6
Latin America	8	1.6
South Asian (i.e. East Indian, Pakistani, Sri Lankan)	19	3.9
Southeast Asian (i.e. Vietnamese, Cambodian, Malaysian, Laotian)	15	3
West Asian (i.e. Iranian, Afghan)	9	1.8
White	189	38.4
Multiracial	24	4.9
Other	9	1.8
I prefer not to respond	15	3
What is your current academic year of study?		
1st	10	2
2nd	142	28.9
3rd	181	36.8
4th	115	23.4
5th	38	7.7
greater than 5th	5	1

Demographic	Number of students (n)	Percentage of students (%)
What is your average grade for courses taken at UBC?		
80-100%	172	35
70-80%	216	43.9
60-70%	91	18.5
below 60%	9	1.8
What is your department?		
Biochemistry	5	1
Biology	163	33.4
Chemistry	35	7.2
Computer Science	36	7.4
Earth and Ocean Sciences	36	7.4
General Science	58	11.9
Geographical biogeoscience	3	0.6
Integrated Science	11	2.3
Mathematics	23	4.7
Microbiology and Immunology	27	5.5
Physics and Astronomy	43	8.8
Physiology	5	1
Psychology	3	0.6
Statistics	5	1
Not yet decided	9	1.8
Other	26	5.3
Where do you live?		
Home of parents/relatives/guardians	220	44.8
Off-campus rental house/apartment	135	27.5
On campus in university apartment or residence hall	123	25.1
Other	13	2.6
How long is your one-way commute from where you live to UBC?		
less than 15 minutes	137	28
15-30 minutes	92	18.8
30-45 minutes	58	11.9
45-60 minutes	101	20.7
greater than 60 minutes	101	20.7
How often is English spoken where you currently live?		
Never	10	2
Infrequently	27	5.5
Sometimes	34	6.9
Half of the Time	50	10.2
Most of the Time	103	20.9
Always	266	54.1

The demographic data indicate that students of White (n=189) and Chinese (n=170) descent are the ethnic majority and make up 38.4% and 34.6% of the survey respondents respectively. The remaining 27% (n=133) of students are Aboriginal, Arab, Black, Filipino, Japanese, Korean, Latin American, South Asian, Southeast Asian, West Asian, those who identified as other and those that were not inclined to identify their ethnicity. I consider these students collectively to be representing an "ethnic minority group" because none of these ethnicities comprise more than 5% of the survey respondents. Students of differing ethnicity might have different academic and cultural dispositions (Lee, 1994; Li, 2005), which might influence how they rank the importance of various factors on their academic performance. If this is the case, the results in this survey might be more heavily weighted towards the perceptions of White and Chinese students.

This study was intended for students in their second academic year of study or higher, and this is reflected in the demographic results with second (n=142), third (n=181) and fourth (n=115) year students comprising of 29%, 37% and 23% of the overall survey responses respectively. Only 2% of the responses came from first (n=12) year students and these responses can most likely be attributed to the fact that they came from students who were taking an upper year course in their first year. In relation to academic standing, students with an overall average between 80-100% (n=172), 70-80% (n=216) and 60-70% (n=91) make up 35%, 44%, and 19% of the survey respondents respectively. Students with averages below 60% comprise the smallest percentage and make up only 2% of the overall respondents.

Biology students make up the largest fraction of survey responses with the rest of the students pursuing degrees in a variety of departments within the Faculty of Science. About 33% of the survey respondents (n=163) are pursuing degrees in biology. Students in general science (n=58) represent the second highest percentage and consist of 12% of the respondents. The remainder of the responses (n=271, 55%) is comprised of students from 13 other disciplines and from those who have not yet decided their major.

The questions considering students' living arrangements, confirmed my assumption that the majority of students completing this survey would be living off-campus with the highest percentage living with their parents. Only 25% (n=123) of the students live on campus whereas 45% (n=220) live with their parents/guardians and 28% (n=135) live off-campus in rental apartments or housing. This observation demonstrates that UBC has a significant percentage of the student body living off-campus (72%) rather than on-campus. In addition to living off-campus, 41% (n=202) of the respondents travel more than two hours to and from school each day. With so many commuter students on campus, it is important to understand their perceptions (through the survey and interviews) as to how the commute influences their academic performance.

To understand a little more about students' language background, respondents were asked to indicate how often English is spoken in their home with 54% (n=266) and 21% (n=103) indicating that English was spoken always or most of the time respectively. About 25% of the students however claimed that English was spoken half of the time or

less within their household. This demonstrates that just under half of the survey respondents are at least bilingual and that English might not be their primary language.

4.1.2 Comparison of the survey sample to the overall population

After analyzing the demographic information collected in the survey I compared it to the overall student population within the Faculty of Science. This helped me determine if my sample was representative of the larger population of students and thus whether or not the survey results could be generalized. The Dean's office in the Faculty of Science provided information representing the number of students enrolled in second year and higher within the Faculty of Science at UBC. This information was parsed out by both gender and discipline and is compared to the survey sample data in Table 4.2.

Table 4.2: A summary of the number of students in second year or higher by gender and specialization in the Faculty of Science at UBC

Specialization	Faculty of Science Population		Survey Respondents	
	Female	**Male**	**Female**	**Male**
Biochemistry	165	212	1	4
Biology	577	326	119	44
Chemistry	144	147	17	18
Computer Science	126	452	9	27
Environmental Science	61	21	-	-
Earth and Ocean Science	50	73	24	12
General Science	824	554	43	15
Geographical Biogeoscience	13	14	3	0
Integrated Science	65	42	6	5
Mathematics	84	93	11	12
Microbiology	173	141	18	9
Other	3	8	21	14
Pharmacology	33	42	0	0
Physics and Astronomy	47	176	7	36
Physiology	28	29	3	2
Psychology	100	56	1	2
Statistics	40	32	2	3
Total	**2533**	**2418**	**285**	**203**

The gender split for the larger population is almost equal with female and males making up 51% and 49% of the students in second year or higher pursuing degrees in science, respectively. For the survey sample, 58% were females and 42% were males. When comparing the gender distribution of the survey sample to that of the entire population, the proportion of females in the survey sample (58%) is higher than that of the female population (51%). Thus, the survey findings are in favour of female students' responses and might not be representative of the general population within the Faculty of Science.

To simplify my comparison of the survey sample and the student population within the Faculty of Science at UBC, I clustered the majors to create three categories: Physical

Sciences & Technology, Life Sciences and Other Sciences. The Physical Sciences and Technology category consists of chemistry, computer science, mathematics, physics and astronomy and statistics. I have combined biochemistry, biology, biotechnology, microbiology, pharmacology, and physiology into the Life Sciences category. The Other Sciences category included earth and ocean science, environmental science, geographical biogeoscience, general and integrated science, psychology, cognitive science or those who have yet to choose a degree. Table 4.3 provides a comparison of the survey sample and entire population by gender (within and between) and discipline.

Table 4.3: A comparison of the survey respondents with the overall population by gender and discipline

Discipline	BETWEEN GENDER				WITHIN GENDER			
	Population		Sample		Female		Male	
	Females (%)	Males (%)	Females (%)	Males (%)	Population (%)	Sample (%)	Population (%)	Sample (%)
Physical Science & Technology	32.9	67.1	31.6	68.4	17.4	16.8	37.2	51.0
Life Sciences	57.4	42.6	70.8	29.2	36.1	48.2	28.1	27.9
Other Sciences	58.4	41.6	69.9	30.1	46.5	35.0	34.7	21.1

When determining if the survey results findings can be generalized to the overall population I needed to take into consideration the differences existing between distributions of the survey sample and the entire population. Between gender differences were apparent amongst males and females with the females being more heavily populated in the Life Sciences and Other Sciences in comparison to the entire population of students in the Faculty of Science. When considering within gender differences, females and males pursuing degrees in the Life Sciences and Physical Sciences and Technology,

respectively, were a greater part of the survey sample distribution relative to the entire population. Comparatively, females and males pursuing degrees in Other Sciences and the Life Sciences respectively, had a lower survey sample distribution than expected. Thus, the survey sample may not be fully representative of the entire population of the students pursuing degrees within the Faculty of Science because a greater proportion of females completed the survey. This difference is important to consider for the interpretation of the results and influenced my decision to explore how gender might affect what students' perceive as most influential to their academic performance.

4.1.3 Data analysis

As described in Chapter 3, the analysis of the survey data would help in answering the research questions. In the following section I present the results of my analysis of the survey data to determine the factors that undergraduates within the Faculty of Science perceive as most important to influencing their academic performance (Question 1). I will also consider differences in males' and females' survey responses using the Mann-Whitney *U* test (Question 2).

4.1.3.1 Determining the most important factors

Two 5-point ordinal scales consisting of Unimportant to Very Important, and Strongly Disagree to Strongly Agree were used in the student survey. To begin the analysis, I computed the descriptive frequencies for each survey question for the overall student population, and for male and female students. To simplify the analysis of the frequencies, the survey responses were condensed into three categories: Unimportant,

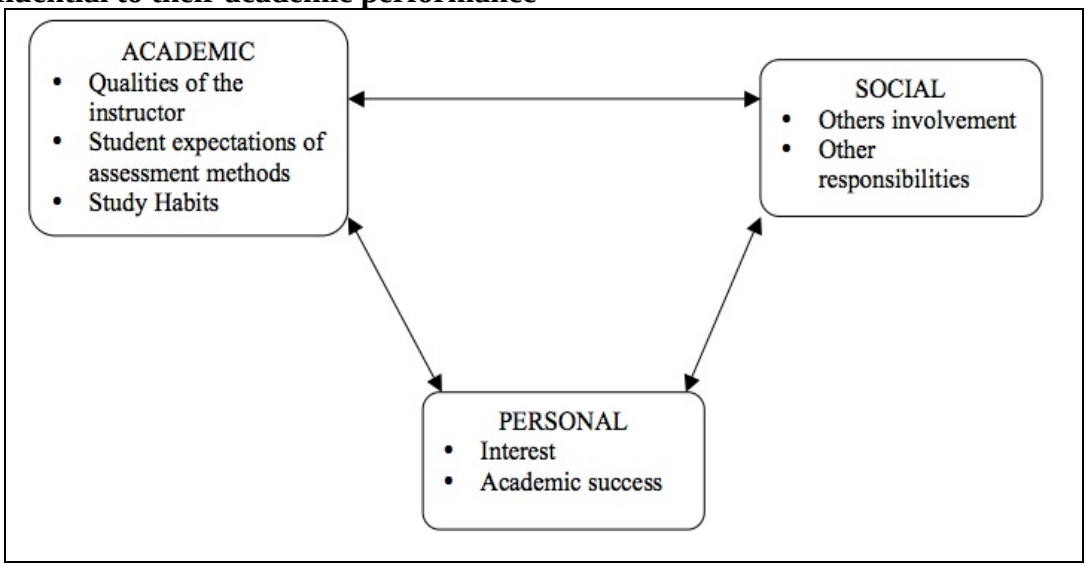
Somewhat Important and Important. The Slightly Important and Very Important responses were grouped with the responses in the Unimportant and Important categories respectively. The frequency charts for these groups of students are found in Appendix J. The frequency data was arranged in descending order to determine what factors students' perceived as most important to influencing their academic performance. There were nine survey questions that over 70% of students perceived as either important or very important and these are summarized in Table 4.4. This table also presents the percentage of males and females who perceived these questions as important and whether or not the survey questions were identified as an academic, social or personal factor.

Table 4.4: A summary of the factors that undergraduates found most important to influencing their academic performance

Rank Value	Survey Question	Category	Percentage of students perceiving the question as important or very important (%)		
			Overall	Males	Females
1	It is important for me to succeed academically	Personal	98.2	96.1	99.7
2	Ability for the instructor to make the course interesting	Academic	89.4	84.2	93
3	Developing and adapting study habits for university courses	Academic	84.7	79.1	88.7
4	The instructor's ability to speak English clearly	Academic	83.7	81.4	85.3
5	The lack of relevant practice problems to complete before an exam was a/an _____ factor influencing how well I performed on exams	Academic	83.1	75.6	88.5
6	My interest in a subject is a/an _____ factor in motivating me to complete the suggested homework/assignments	Personal	77.5	76.6	78.2
7	Receiving encouragement from my parents/family/guardians assists my academic performance	Social	76.2	71.4	79.6
8	My uncertainty in knowing what types and difficulties of problems will be asked on a midterm or final exam is a/an _____ factor limiting my academic performance	Academic	72.2	68.8	74.6
9	Volunteering or working during the school year limits the amount of time I spend studying	Social	70	68.8	70.9

To ease the analysis of the survey questions that students perceive as most influential to their academic performance, I have grouped the questions into academic, social and personal categories. Their placement in these categories is represented in Figure 4.1.

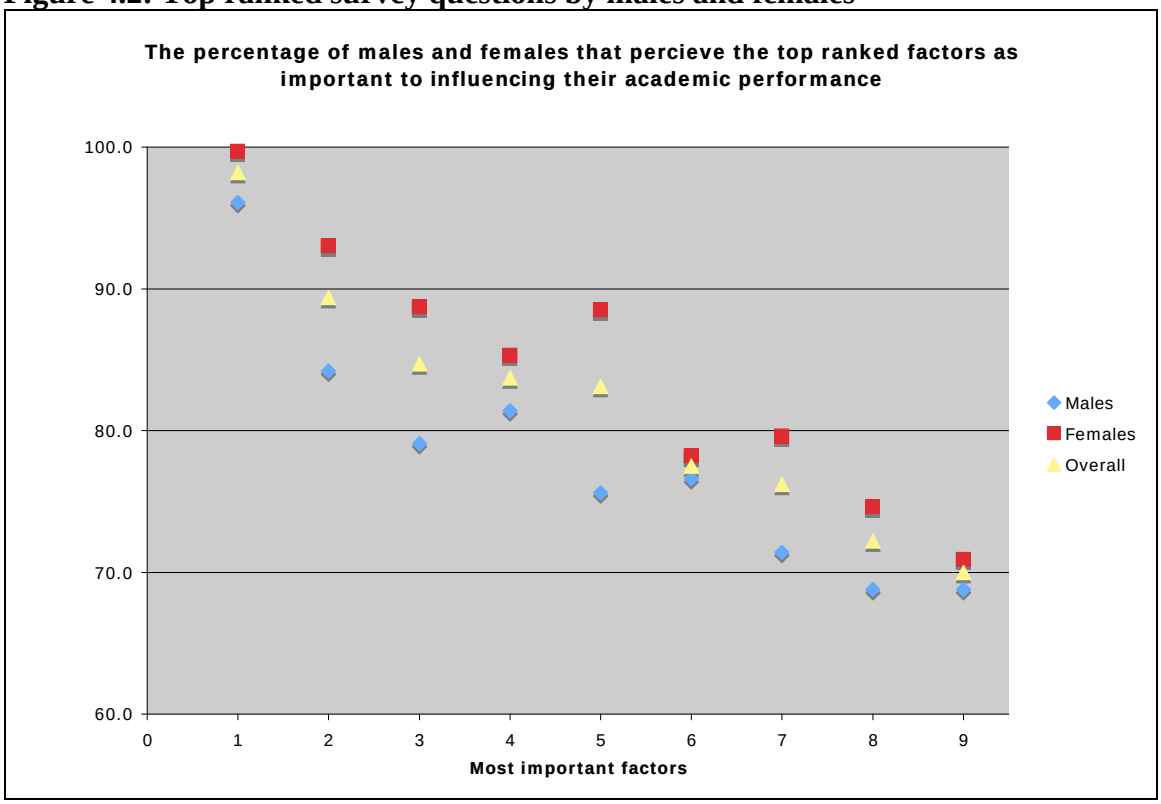
Figure 4.1: The academic, social and personal factors that students perceive as most influential to their academic performance



I have assigned the second, third, fourth, fifth, and eighth ranked questions to the academic category for they reflect the qualities of an instructor, student expectations of assessment methods, and study habits. I have distinguished the seventh and ninth ranked survey questions as social factors for they depict the importance that students place on the involvement of others and additional responsibilities in influencing their academics. Finally, I have placed the first and sixth ranked survey questions into the personal category because they reflect students' personal qualities such as interest and motivation.

The graph shown in Figure 4.2 compares how male and female students' responses varied in terms of the importance they placed on the nine survey questions (Figure 4.2).

Figure 4.2: Top ranked survey questions by males and females



In comparison to males, females perceived the majority of factors as more important to influencing their academic performance. The correlation between the female and male data for this graph was 0.91. Although more females perceived these factors as important, the data for males and females follows a similar trend. These observations served as an impetus to investigate in more detail the differences in students' responses based on gender.

4.1.3.2 Determining gender differences

As described in Chapter 3, the Mann-Whitney *U* test was used to compute any significant differences between the survey responses for males and females. If the tests returned a *p*-value less than the fixed 0.05 level of significance, significant differences existed

between the two groups. Using the Mann-Whitney *U* test in SPSS, I detected significant differences for 10 of the survey questions. The questions are presented in Table 4.5 in order of highest to lowest level of significance.

Table 4.5: Factors that display significant differences between the response levels of male and female students

Survey Question	**Mann-Whitney *U* Value**	***p*-value**
The lack of relevant practice problems to complete before an exam was a/an _____ factor influencing how well I performed on exams	22544	0.000
The approachability of your instructor	24205	0.001
Receiving encouragement from my parents/family/guardians assists my academic performance	23322.5	0.001
The use of in-class learning techniques (i.e. clickers, group activities)	24241.5	0.002
Developing and adapting study habits for university courses	24762.5	0.01
The number of students in the class	25172	0.011
Suggestions from parents, teachers and/or advisors influenced my decision to major in math and/or science	24147.5	0.014
My uncertainty in knowing what types and difficulties of problems will be asked on a midterm or final exam is a/an _____ factor limiting my academic performance.	25336	0.021
Ability for the instructor to make the course interesting	26046	0.026
My commute to campus limits the amount of time I spend studying	16049	0.048

To determine whether male or female students expressed higher emphasis on the factors listed in Table 4.5, I created bar graphs displaying the frequency of responses for male and female students for each factor. These bar graphs are represented in Appendix K. In each graph, it was apparent that female students placed greater emphasis on all of the

factors depicted in Table 4.5. For instance, Figures 4.3 and 4.4 respectively, are bar graphs comparing the percentage of males' and females' responses to the survey questions: "The lack of relevant practice problems to complete before an exam was a/an _____ factors influencing how well I performed on exams" and "Receiving encouragement from my parents/family/guardians assists my academic performance".

Figure 4.3: A comparison of the responses for male and female students for the survey question: The lack of relevant practice problems to complete before an exam is a/an _____ factor influencing how well I perform on exams.

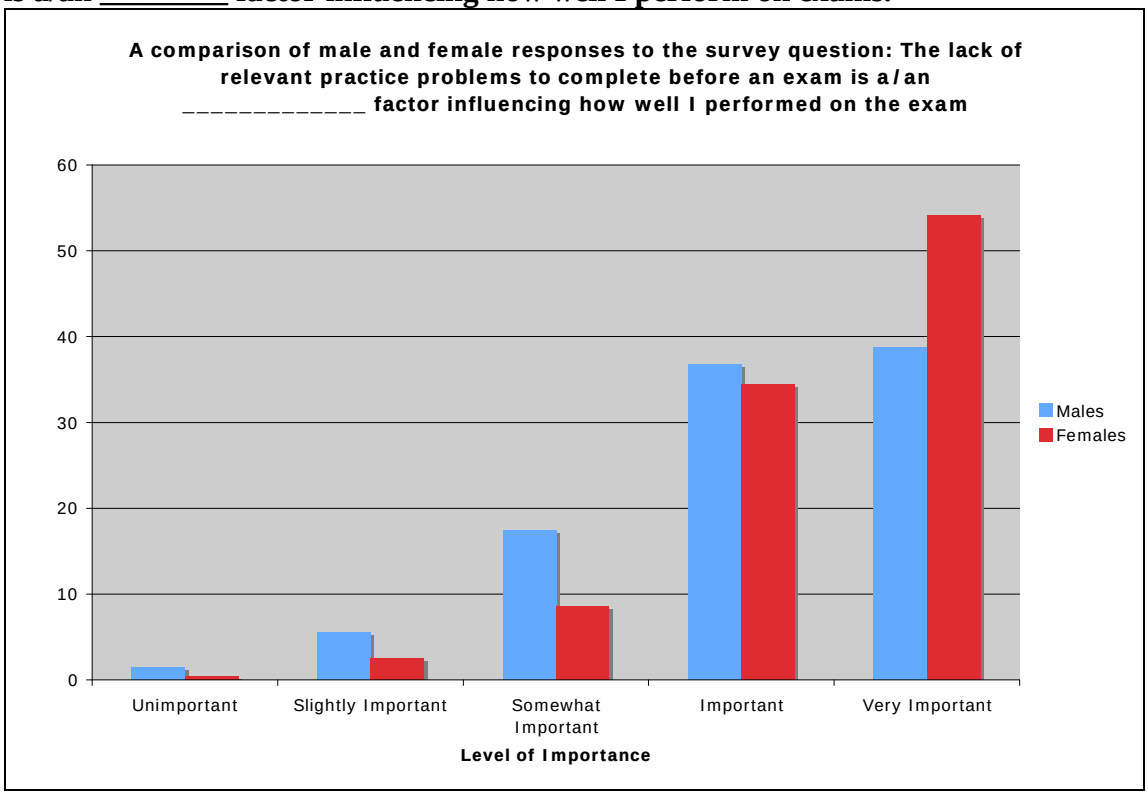
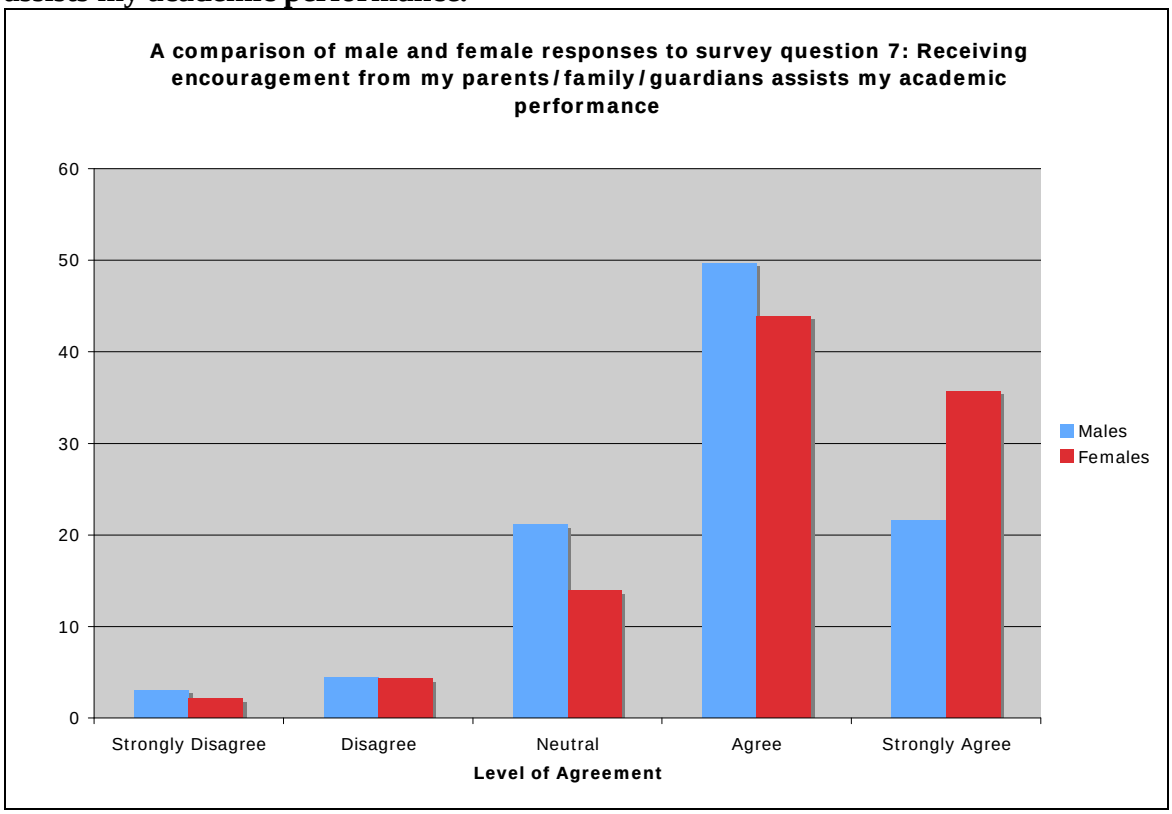


Figure 4.4: A comparison of the responses for male and female students for the survey question: Receiving encouragement from my parents/family/guardians assists my academic performance.



In figure 4.3, 54.1% of females in comparison to 38.8% of males perceived the lack of practice problems to complete before an exam as very important to influencing their academic performance. For figure 4.4, 36.2% of females in comparison to 21.6% of males perceived familial encouragement as being very important to influencing their academic performance. Overall, females were more likely to choose the Strongly Agree or Very Important categories in comparison to the male respondents.

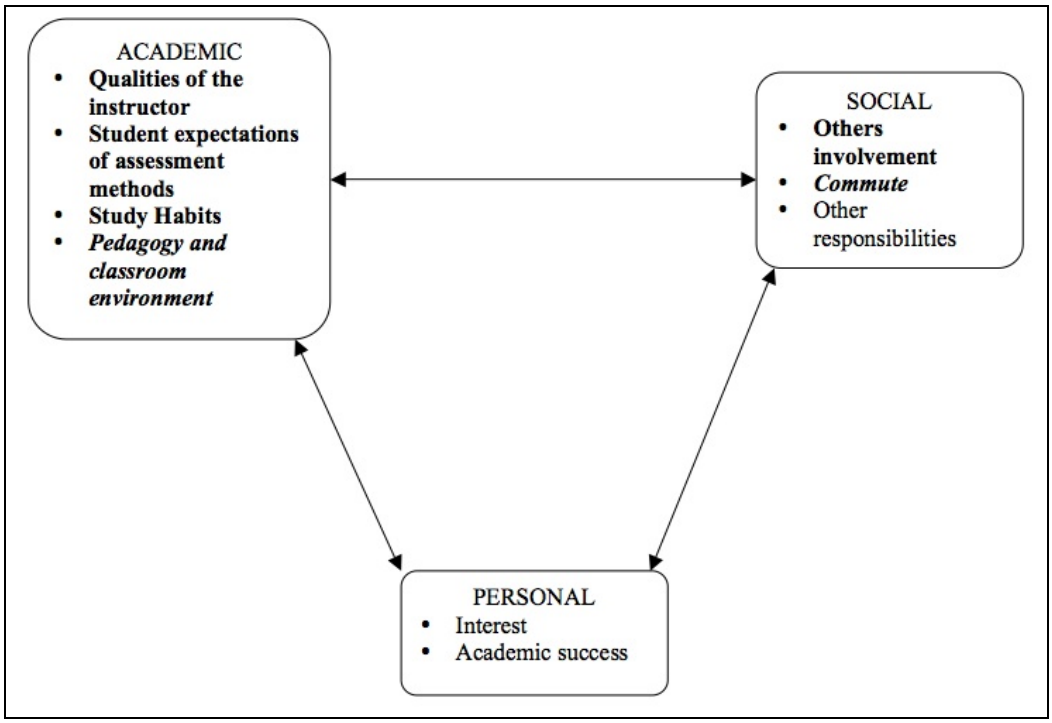
The Mann-Whitney *U* results indicated a significant difference exists between male and female students' views regarding the influence that their study habits, the lack of knowing what to expect on tests/finals, and receiving encouragement from their family

have on their academic performance. In addition, female students perceived factors related to the instructor and his/her teaching (their approachability, ability to convey interest, teaching techniques), the classroom environment (number of students in the class), suggestions from their family/advisors to pursuing a degree in the sciences and their commute to school as influential to their academic performance.

4.1.4 Summary

Based on the analysis of the survey data, it appears that males and females perceived a variety of academic, social and personal factors as important to influencing their academic performance with females placing more emphasis on particular factors. Figure 4.5 is adapted from Figure 4.1, which organized the survey questions into academic, social and personal factors.

Figure 4.5: A summary of the academic and social factors that male and female students perceive differently as influencing their academic performance



In Figure 4.5, the boldface represents those factors where gender differences were detected. The italicized and boldface factors were factors where gender differences were observed but these factors were not considered among the most important to students. These factors and their relationship to the interview and focus group discussion data will be more thoroughly discussed in Chapter 5.

4.2 One-on-one interviews and focus group discussion

To provide a more in-depth look into the factors students perceive as influencing their academic performance, I conducted 24 one-on-one interviews and one four-person focus group discussion with students pursuing degrees within the Faculty of Science at UBC. The interviews and focus group discussion provided extensive data that was analyzed to

extend the survey findings. My analysis of these data is discussed in the following section. I have organized my presentation of data under the headings of: academic, social and personal factors.

4.2.1 Academic factors

At the beginning of the one-on-one interviews and the focus group discussion, I asked students to describe their overall experience in the sciences. In most cases, students' responses reflected academic factors. Students talked about their struggle in keeping up with the coursework, their drop in grades in comparison to high school, trying to adapt to the academic demands of UBC science, and in general – they talked about being overwhelmed with their academic experience in the first couple of years. In this section I examine some of the academic factors students identified as influential. I specifically consider: the quality of the instructor, lecturing and note-taking methods, expectations, assessment methods, grades, conceptual difficulties, coursework/courseload, and study habits and high school preparation. I present these academic factors in three subsections: pedagogy and assessment, grades and study habits.

4.2.1.1 Pedagogy and assessment

When students were discussing their academic experience several of them mentioned the importance of having a 'good' instructor. When I asked them to define what they meant by 'good', students typically reiterated the need for an instructor to be approachable, interesting, organized and clear. Approachable in the sense that the student was not intimidated to seek out academic help from the instructor in or outside of the classroom.

Throughout the interviews and focus group discussion, 19 of the 28 students I talked to indicated that they would have sought help from their instructors earlier on in their degree, however they were too shy, intimidated or unaware of the benefits of seeking support. For example, a second year female student expressed that "when a student asked a question the professor stared at the student like he should know the answer and I don't want to feel like that if I go to office hours". As a result of this experience, this student still has difficulty seeking academic help or guidance from her course instructors.

When I probed as per what the students meant by interesting, they typically said they expected the professor to present the material in an intriguing, interactive and enthusiastic way. A third year male commented that for some students, "just lecturing might be more difficult to adapt to for people in general actually because you have to grasp how a professor puts emphasis on this point rather than another point". Students preferred lectures to be more interactive and organized. When discussing the term interactive the majority of students brought up the use of clickers in lecture. Students' reviews of clickers were mixed but most commented that in order for clickers to be facilitated effectively they needed to be used in a timely manner to tests students' understanding. Clickers allowed students to gauge their understanding of the course content by providing immediate feedback of particular important concepts or problems related to the course. Group discussions were usually used in conjunction with clicker questions and six students commented that this combination was effective if the question was challenging enough that they had no choice but to work with their peers. A second year female commented that in her computer science courses:

> Putting us in groups and having us struggle through a problem that's when you learn the most about something and make all the connections to the problem... and we get to discuss why we're making certain decisions to come to a solution.

Students also suggested the need for the professor to review the solutions regardless if 90% of the class answered the question correctly. A couple even admitted that sometimes they would guess an answer if they were unsure. If they guessed right and the professor did not review the answer then they were still at a loss.

Throughout my conversations I was surprised at the number of students who mentioned the importance for the professor to be 'caring' or considerate. With regards to a considerate professor, a graduating female stated that "the professor would say – a lot of students asked me this question so I'm going to go over it more because it seems a few of you don't understand it." Although a small gesture on the part of the instructor, this student continually reiterated how aware this professor was with regards to the class' level of understanding. If the students were expressing difficulties, the professor would attempt to address their misunderstandings.

The majority of students reflected on the need for the professor to be clear in both the oral and written presentation of the course material. Most of the students I spoke to expressed that professors tended to vary in their lecturing and assessment styles. When I probed further most indicated that Power Point presentations were the most common means for presenting the lecture material. Over half of the students criticized this method because in most cases, the professor would move too quickly through the slides and did not allow time for the students to personalize their notes or fully grasp the material. A

fourth year male who took part in the focus group discussion commented that "by the end [of the lecture] half the people are not paying attention and the other people are scrambling to write down what was on the power point and not listening to what the professor is saying". Twelve students mentioned at one point or another that they preferred when the professor wrote the notes on an overhead or used skeleton notes. These techniques reduced the pace of the lecture and gave students sufficient time to digest what was being taught. Twenty students commented that if a professor used power point presentations, they'd appreciate if the notes were posted online ahead of the lecture. This would allow them to review them before class so they have an idea as to what it going to be covered in lecture.

Lecturing techniques or assessment methods that allowed students to test their understanding in a course was important to most the students. A fourth year female in general science indicated that with regards to teaching and assessment:

> There are many different ways and each style depends on size and what you're doing. I have some favourite classes and they all had different styles but the key component is that they all had plenty of space to practice what you were doing.

Twenty-three out of 28 of the students commented that receiving timely and regular feedback throughout the term was integral to helping them gauge their progress in the course and in ensuring they do not just "cram at exam time". Small, weekly or bi-weekly assignments worth marks were popular among the students because they allowed them to stay on top of the material.

Many students commented on assessment and on the weighting of midterms and finals. Nineteen students indicated that they preferred courses with two midterms primarily for three reasons. First, having two midterms allowed them to keep up with the material. Second, the first midterm prepared them for how the instructor would assess them in future tests/exams. Third, having two midterms put less weight on grades and reduced students' feelings of stress and anxiety. Eleven of the 28 students described feeling scared, overwhelmed and stressed by heavily weighted finals (those over 50% of the students' overall grade). Nine students indicated that heavily weighted finals might not be representative of the work they had done during the term and 11 commented that their performance on exams may be more representative of whether they were having a good or bad day. A third year male admitted that although a heavily weighted final worth 70% of his overall grade worked in his favour, he was upset that he didn't learn anything and stated:

> It wasn't very effective at assessing how well you know the material because I crammed a day before and I ended up with a 78% in the course. I probably can't recall anything I learned in that course. What I'm getting at is huge finals are redundant as to how well you understand the material because you can just cram right before and if you luck out and do well – I guess the big thing is in most cases you won't luck out and you might fail. In some courses I study well before a final worth that much but... basically it's whether or not you have a good or bad exam day.

Students also comment that some of their anxiety came from their uncertainty regarding what would be tested on the midterm or final. If they had little feedback throughout the semester and were unfamiliar with the instructor's expectations they felt lost when reviewing the material. Eighteen of the 28 students brought up the importance for professors to have relevant practice problems or clicker question that paralleled the types

of questions being asked of them on a midterm of final. Only two of the 28 students actually talked about the importance for professors to have learning goals that reflected what topics students needed to understand so they felt prepared.

In relation to pedagogy and assessment it appears that students really placed the most emphasis on instructors using interactive and organized techniques, providing small weekly or bi-weekly assignments to help gauge their progress in the course, moving away from heavily weighted finals, and providing clear expectations as to what will be tested. Only two students mentioned the role of learning goals, but they both commented on how essential the goals were to helping them prepare for their midterms and finals. Although students do not ask to be told the exact questions on the midterm or final, they indicated it would be helpful if instructors could provide them with a bit of guidance as to how they might be able to focus their attentions.

4.2.1.2 Grades

One topic that was not probed in the survey was how students' perceived their grades and what emphasis they placed on their importance. When asked what they considered a 'good' grade, students' answers were quite varied. Some gave a percentage range (75-80% or 80+%), some a letter grade (B, B+, A+) and some indicated they strived to be above the class average. The majority of students admitted experiencing a grave drop from their high school to university grades which contributed to feelings of doubt, stress and panic. For example, two females commented that in their first couple of years:

> I got like 62 and the average was 68 so I was in serious panic. Oh my gosh – I don't understand anything!... For me, failing means being below the average. My standards for grades are getting lower and lower and I'm aiming to pass my subjects – so getting the average.
>
> Second year female in biology

> I was probably doing fine but then you get to university and the standards change. When you're grouped together with the other top students and compared to the other top students your own evaluation as to how you're doing is really affected whereas in high school you were the bright students at the top of the class.
>
> Third year female in computer science and physics

Just over half of the students I spoke with attributed this drop in grades to the vast amount of material they were expected to learn, their lack of effective study habits, and the fact that they were held responsible for their education. I was intrigued by a second year female's comment that "in high school they told us to expect our marks to go down in university but they didn't say that if you try, you can keep them up!"

Although students tried not to place too much emphasis on their grades, for those hoping to apply to medical, pharmacy or graduate school, or who were hoping to retain scholarships, attaining high grades was quite important. Seven students discussed that they perceived their understanding of the material as the most important thing to take from a course however they admitted to still being quite concerned with the grade letter or number.

> In second year I didn't care so much about my grades. Third year has been a bit different because I've been feeling the pressure that grades matter for graduate school. There's a battle between wanting to learn things and 'grad school will look at this'. When it sinks in, I get depressed – then it becomes about the mark versus understanding the concept. I sort of oscillate between the two.
>
> Third year male in biochemistry

The difficulty with students placing so much emphasis on their grades is that they spend more time trying to figure out what is on the test or exam instead of learning the material.

> A lot of times it's how well you adapt to the instructor so honestly sometimes I think I didn't deserve such a high grade and other times I worked so hard and there's no way I could have done any better and it's frustrating.
>
> Third year male in physiology

Although the majority of the students talked about the importance of learning and understanding in university, the grades they achieved seemed to govern their behaviours and affect their confidence. One student somewhat jokingly, but earnestly commented that if she received a poor mark in one of her courses that was essential to what she hoped to do in the future than "it's the end of the world! My future is over". A couple of other students commented that grades could act as both positive and negative feedback. If they received a good grade, they experienced a confidence boost. On the other hand, if they were doing well in a course but did poorly on the midterm, their confidence "dive bombed". Over time, students found ways to cope with their low grades by accepting the grades they received, by focusing on understanding the material, and by developing and adapting appropriate study habits.

4.2.1.3 Study skills and habits

From my perspective, study skills and habits was discussed most frequently during the interviews and focus group discussions. When I asked students to provide some advice for incoming science students, 25 out of 28 of them stressed the importance for students to develop and adapt appropriate study skills and time management early on in their degree. Several students expressed feeling overwhelmed with the coursework demands in their first and second year and lacking the study skills to do well in their courses. Most

science students take five courses that on top of going to lecture typically have labs and tutorials associated with them. Half of the students I spoke to actually commented that during their first year experience they realized the importance of becoming more independent and taking on a new sense of academic responsibility. They no longer had a high school teacher reminding them to hand in their assignments or monitoring their class attendance. Students expressed however that they struggled with not knowing how to distribute attention to all of their courses throughout the term and especially during the exam period they would resort to 'cramming'.

> I would cram just before the exam and continued to do that because I didn't know how to change and I should have talked to some people and didn't seek guidance so I got bad marks in first semester.
>
> Third year male in biochemistry

> This term I was in panic because I had three exams in a row so after I was done the first I stayed up all night to study for the second one and then those two exams are affected very much… I guess I was scared.
>
> Second year female in biology

If a student had difficulty with understanding the course material or a particular concept they would become discouraged and start neglecting the material. For a third year male:

> If there's something I can't understand like when I'm reading a lecture slide that I thought I understood and then I go to the questions and can't do a single one. Right then and there I think I'm going to fail the course. When I put 1 or 2 hours into it and still don't understand anything then it affects my confidence and I just dive bomb.

The majority of the students felt that it wasn't that they didn't understand the material, but that they didn't have sufficient time in a semester to fully comprehend all of the concepts they were expected to know. Students also expressed that in their first couple of years in university they rarely sought out help from professors and tended to consult the

textbook or course notes to improve with their understanding. They claimed being too shy or intimidated to ask for help.

Four students mentioned going to study workshops to improve their study habits although they did not find them very helpful. The information was too general and didn't reflect the fact that they would need to use different study techniques for different courses. Students were aware that they would need to adapt their study skills and habits according to a particular course but found it difficult to do so.

> I actually felt lost sometimes. I don't know how to study for some courses and it would be nice it there was, I guess, support and advice in that because I don't think you can study for different courses in the same way.
>
> Second year female in general science

Interest was another factor affecting students study skills and habits. It was especially hard for students to focus their attentions on a course they did not enjoy it and as a result, they would focus their attention on the courses that peaked their interest.

> I find that I put the most emphasis on the subject I'm most interested in because if I have a homework assignment for two courses I would rather do the one I like and then the other one gets left off until the end.
>
> Third year male in computer science and biology

Eighteen students expressed that they did not like studying with their peers because they would become easily distracted. A few of the students did mention that in computer science, physics or biochemistry courses they would complete their assignments with their peers however most indicated that for conceptual courses such as biology, they would study individually. Only one student preferred studying with someone else rather than on her own:

> I like to study with someone else because if I'm by myself then I'm wondering, 'why do I have to do this?' But when I'm around others I see we're in the same boat. It kind of motivates me."
>
> Second year female in general science

Two males who lived in an on-campus fraternity house mentioned that they were academically motivated by their peers and would go to the library together to study their respective subjects. Just having someone else present while they were studying kept them focused.

Over time, students commented that their study habits improved. Twenty-two students mentioned that over the course of their degree they started reviewing the material on a more regular basis. They read their notes before and after class, completed suggested practice problems, and made summaries of their notes on a weekly or bi-weekly basis.

> I review much more early on and more frequently so before the final I have gone over the material at least once. Just knowing the material or the general concepts beforehand and filling in the details… just a couple of days before taking the exam.
>
> Third year male in physiology

> I try to know more of the lecture material before the exam time comes so I'm not completely panicked like when it's exam time and I can focus on remembering what I learned rather than just learning for the first time what was presented in class.
>
> Fourth year female in plant biology

> You have to make sure to study every section and course enough so by the time midterms roll around you don't get caught behind. If you keep up, then you can just review.
>
> First year male in computer science

The more senior students indicated that they became progressively more active at seeking out help with their conceptual difficulties right away instead of letting them fester until

just before an exam. By doing so they would not fall behind and come exam time they would be "reviewing, not learning" the material. Students emphasized the importance of seeking help from their professors with one student indicating that good professors would "break down my steps and find the flaw in my thinking and suggest more practical examples". Seeking help from friends and professors was regarded as one of the most important pieces of advice that students suggested for incoming science majors.

Thirteen of the 28 students decided to lighten their courseload and switched from taking five courses a semester to four. Most made this change after their first year and attributed it to their being overwhelmed with the sheer amount of material they had to learn and the work they had to complete. Six students also suggested the administration or advisors to encourage first year students to take four courses in their first semester instead of five to ease them into university. The students who opted to take less than five courses a semester, either made up the loss of credits in the summer or added a fifth year to their degree. Decreasing their courseload left students with more time and energy to focus on their courses and studying.

Although rare, a couple of the students were quite aware of how they learned and went out of their way to create their own problems to test their understanding or would research effective learning techniques.

> I've realized I need a quiet place to study, I need to go over the material everyday, using the learning goals to derive questions and make up my own problems. It's very useful.
>
> Fourth year female in general science

> I find that I have been developing a lot more self-awareness. I know when I work best. I also actively seek [study habits] out and read them on the internet all the time. I'm kind of unusual in that respect.
>
> Third year male in computer science and biology

Developing and adapting the appropriate study habits for university science courses seemed to be essential for student success. Almost all of the students I spoke to discussed feeling overwhelmed in their first couple of years of undergrad and believed they lacked the appropriate skills and habits to manage their courses. The senior students seemed to be more aware of what 'worked for them' with regards to studying and 'knew how to adapt to the professor's testing methods'. The students in second year however were still struggling with balancing their attentions to and keeping up with their courses. It appears that if students know what is expected of them on a midterm or final, they can focus their studying and are less likely to waste significant time learning irrelevant material. Students also claimed that they had never been taught how to study effectively and mentioned that they would appreciate if professors or study workshops reviewed how students might tailor their studying to different subjects.

4.2.2 Social factors

I now focus on the social factors that emerged from the one-on-one interviews and the focus group discussion. I discuss social factors under four subsections: students' choice of major, living arrangements, additional responsibilities, and community.

4.2.2.1 Choice of major

When asked why they chose to major in the sciences, the majority of students expressed that it was based on their interest in math and science. About half of the students also commented that in high school, math and science were the subjects they excelled in so it seemed only natural to pursue a degree in this field. Three ESL (English as a second language) females mentioned they disliked writing essays and reading novels (they related this to high school English and History) and as a result, chose a degree that placed less emphasis on writing. They also commented that in science, their poor writing skills did not affect their grades as significantly as they did in arts courses.

Twelve students I spoke with had changed their initial major or had added a major or minor to their current degree. Three female students who were initially in some form of biological science completed the introductory computer science course and as a result, switched to major in computer science or combined it with their initial choice of major. All three students commented that the professors teaching the course were extremely interesting and approachable and that the content itself was stimulating. For another student who had chosen a BA in English, her positive experience in a science elective course for arts students influenced her decision to switch from a BA to a BSc:

> I guess the teacher was really passionate about it and engaged with the class and it sparked my interest. It wasn't so cut and dry like memorize all these body parts – it was thinking deeper. Now that I'm in the sciences I'm looking at things way differently than I use to.

Similarly, a fourth year female opted to specialize in plant biology because of the involvement of one of her female professors:

> She's inspiring – the way she talks about plants and makes things interesting. I just wanted to learn more about it and she told me I could specialize in it – I didn't know I could… so when I found out there was that option I was pretty excited.

Students' experiences in particular courses or meaningful interactions with instructors seemed to have influenced students to reevaluate their major. Four of the students I spoke with discussed switching to the integrated science program because it allowed them more flexibility to pursue their varied interests in science. The general science program was also popular among students because it provided them the opportunity to take courses from various departments instead of being more narrowly focused in one subject realm.

Seven students discussed how their career goals were the main reason for their choosing to pursue a degree in the sciences. Students were striving to go to medical school to become a doctor and others were hoping to work outdoors as an environmentalist. This group of students saw their pursuit of a degree in the sciences as a natural fit to their career goals. When I asked students where they saw themselves after graduation, the reviews were mixed. About half of the students were fully aware as to where their degree would lead them, the other half seemed quite unsure. Those who were unsure would respond with rather vague responses such as "I guess I could be a researcher", "maybe I'll go to graduate school to help me decide". Most of the students with career direction had completed co-op work terms or work study placements in labs/industry. These experiences gave them a more concrete perspective of where their degree might lead them.

> Co-op is reasonable because if you graduate and you have no experience at all you can't get into the field directly. It also helps you to get to know the field and see if you actually like it.
>
> Graduating female in computer science & biology

> Reading papers and getting information out of there and having discussions about papers. Taking apart what has been done. It's helping me see what's out there and the graduate students help me gain a new perspective so it's been really informative, educational and fun.
>
> Third year female in general sciences

> Most people in biology are planning to enter research and the more hands on experience you get while you're in undergrad the more valuable an experience getting your degree would be.
>
> Third year female in integrated science

One criticism that 19 voiced about their courses was that there was not enough application of the material in a practical sense. Students longed to understand how what they were learning in their courses was relevant to situations they might experience in everyday life or in their career as a scientist. A fourth year female in hydrology expressed that "a lot of courses don't give you the applied side, which when you graduate it's kind of like, why – what am I doing and how is it going to be useful?" A couple students expressed their appreciation for professors who actually presented connections between the course material and practical applications. A third year male student talked about one of his professors who would put a medical symbol in the top right corner of the lecture slides to indicate that this particular slide dealt with course content related to the medical field. A fourth year female commented on an assignment in which the professor asked the students to design their own gene regulation experiment. She stated that "it was the first time I thought about something as a scientist – I think it was the first time that science made sense to me as a field and that was in third year!"

Ten students also expressed that they were interested in knowing more about their professor's research and even more about how it applied to the course they were teaching. Even if professors did not make the connection between their research and teaching, one of the interviewees commented on the need for students to seek out research experiences with professors.

> I would advise students to ask the professor for extra opportunities to learn material or to do anything extra. UBC as a research school has a lot of innovative professors and I don't think they get to share a lot of their ideas with us. If people are keen on doing school further they need to seek out other opportunities from professors.
>
> Fourth year female in general science

For a few students, their choice of major was influenced rather heavily by suggestions from their parents. For example, a second year female student majoring in biology expressed being pressured to become a doctor. "It's more like they told me so I started to accept it and then like it. I have adapted their choice to my own goal and have actually come to like it". A second year female student in the general sciences told me that her parents were extremely influential to her choice of courses. They would review the academic calendar and note what classes she should take. Although she was more inclined to take courses that would help with her goal of becoming a nurse, her parents would advise her to take pharmacy preparation courses because they did not think that nursing was a good enough job. As a result she would take the classes they advised her to take and expressed that "I feel a bit of pressure. Like I know they want me to do certain things but I want to find out for myself". This student longed for independence

from her family, however she still felt the need to please her parents and struggled with the balance.

Although the students sensing pressure from their family enjoyed their degree, they could also experience feelings of guilt and being overwhelmed.

> They don't say it or act it out but it's just like – I know I have to live up to their expectations. It makes you feel guilty. I want to let them know I can do it.
>
> Second year female in biology

> The pressure comes from that they're never happy enough. It's like they're just not happy with what I've chosen. Like I don't think they know how to be supportive.
>
> Third year female in plant biology

> Their involvement wasn't huge but their opinion and how worried they were affected me a lot… I didn't want to make them worry. But not knowing how to make someone not worry is very difficult.
>
> Fourth year female in general sciences

> I can't see any external pressure – maybe not so much pressure but expectations. You don't want to – I guess it's irrelevant but as the first child – it's a psychology thing but as the first child you're supposed to conform more to your parents expectations.
>
> Third year male in computer science and biology

> It was kind of hard when they realized I wanted to research [undergraduate] education. They are researchers so they were thinking that if you can't do research you teach. They were like – you're throwing things away – but I like education. It was foreign at the time the notion of someone who has research potential choosing not to be a researcher.
>
> Third year female in computer science and physics

Receiving encouragement from their parents, family and/or peers was identified as important to students. Students expressed that when they were struggling with their grades in first year they turned to their parents for support and advice. Students also commented that this support was not only emotional, but financial.

> I actually have a very strong social support structure – my parents are fully for me doing education and financially support me as well. I live at home so they're very big on education throughout my life.
>
> Third year male in computer science & biology

When discussing students' choice of major several factors emerged including the influence of professors as role models, work related experiences and family involvement. Female students seemed to place more emphasis on all three of theses subtopics and in particular, five out of the six of the students expressing pressure from their parents were female. Most female students who switched their degree did so because of their interaction with or inspiration from particular professors whereas males switching was more based on interest. Males did talk about the importance of receiving encouragement from their parents but placed less emphasis on making their family 'proud' in comparison to their female peers.

4.2.2.2 Commuting

The increased importance that students place on family involvement and commuting might be linked to the fact that 44.1% of the survey respondents lived off-campus with their parents. Students claimed that the main reasons they did not live on-campus were because there were not enough residence rooms available and it was too expensive. Some commuter students indicated that although they saved money by living at home or in cheaper rental accommodations, they thought the commute was tiring and a waste of their time. Students commuting from locations such as Surrey, Delta or White Rock, spent a minimum of three hours a day on the bus.

Eleven students indicated that commuting affected how they chose their courses and limited their involvement with on-campus extracurricular activities. To avoid rush hour traffic, students would arrange their timetable so their courses started at 8 am and ended at 1 or 2 pm. With this timetable they were better able to beat morning and afternoon rush hour. Due to their long commutes, students found it difficult to be part of an intramural team or to join a club. These activities usually took place in the evenings so if they stayed around to take part, it would take additional time to get home because transit did not run as frequently in the evenings. This was also the case for when a professor held office hours or a tutorial in the evenings.

Although commuter students expressed concerns with living off-campus, some have found ways to cope with it. For instance, one student who woke up at 5:30 am to arrive in time for her 8:00 am class would audio record the lecture and listen to it on the bus on her way home. She did this because at that time in the morning she was quite groggy and had difficulty paying attention to the lecture. Eight students used the bus as their downtime and would read for pleasure, sleep or chat with friends. This way, when they arrived home they were ready to get back to work. Nine students also commented that they would review their lecture notes or start writing outlines for projects or labs during their commute. Students typically did not read on the bus because they felt there were too many distractions and they would just have to re-read the information later on.

Students who lived at home with their families, typically expressed that they had to cope with many distractions. Their parents might ask them to fix the computer, their younger

siblings might need to be picked up from school, or they were responsible for helping with the family business.

> My family can be quite a hindrance to my… it's a little bit difficult – I have a very young brother so I have a pretty important role in his education. Helping him with his studies, and just there's a lot of responsibility with the family – helping around the house. Also trying to cope with my mother at times if you know what I mean. And then the dog – so everyone was helping to take care of that. It can add up living with my family.
>
> Graduate female in mathematical sciences

Although living with their family could be stressful at times, it helped to keep students grounded and provided them with both financial and emotional support.

Students who lived on-campus were all quite content with their experiences and felt it kept them academically focused. A third year male who lived in a fraternity on-campus explained that "if I'm not motivated [to study] there are people [in the fraternity] to help me and almost force me to study". The only thing that students who live on-campus were concerned with was that they became distracted by the noise in residence when trying to study. To cope with this, most on-campus students mentioned going to one of the on-campus libraries to study. Students who lived on-campus claimed that they had better access to academic resources (libraries, office hours), more involvement with extracurricular activities, and were able to sleep more in comparison to their peers who commuted on a daily basis. Throughout these activities students were more likely to develop new friendships whereas commuter students (especially those living with their parents) commented that they typically kept the same friends from high school.

In summary, the time and energy that students spend commuting seemed to really affect their academic performance, the organization of their timetable, course selection and involvement in on-campus activities. Some students did mention that their long commute was an incentive to move on-campus however to afford living in residence they had to get a job.

4.2.2.3 Additional responsibilities

The majority of students I spoke to had several commitments outside of their academic coursework. Over half of the students volunteered on- or off-campus, worked, or were involved with extracurricular activities (i.e. sports teams). The majority of students chose particular volunteer, work or extracurricular activities to enhance their degree and to gain career insight. For example, students interested in becoming a nurse or doctor volunteered at hospitals to expose themselves to the field. A third year female in the biotechnology program started a biotechnology club and organized events with various organizations in the industry. She claimed that:

> My involvement has been a great opportunity because I have got to meet all the leaders in the biotech industry in British Columbia and so I know it's opened doors because I'm in touch with people who are exposed to that. I don't get that from classes so I'm getting it from extracurriculars.

When I asked students if their additional responsibilities interfered with their academic performance, the majority of students claimed that academics were their priority but that having downtime from courses was important.

> I've been really careful in choosing my commitments outside of school so they enhance rather than having a negative effect
>
> Third year female in integrated science

> Academics come first but you don't want to be studying all the time. You need something to balance it out.
>
> Third year male in physiology

A small number of students placed more emphasis on their extracurricular activities in comparison to their academics.

> Extracurriculars might have influenced my academic performance a little bit but seriously though, I would be bored without them!
>
> Second year male in computer science

> It's a balance that leans less towards school and more towards volunteering… and getting to know myself and making sure I have the best experience.
>
> Second year female in general sciences

> I feel motivationally different about my extracurriculars and academics. My extracurriculars enrich my degree quite a bit and are more interesting so I might neglect my assignments or work.
>
> Third year female in computer science and physics

Over half of the students I spoke with indicated that their extracurricular activities provided them a much-needed outlet from school. In addition, it was an opportunity for them to meet new people with similar interests as their own. Feeling part of an academic or social community was a theme that emerged from the interviews and was viewed as extremely important for all students.

4.2.2.4 Community

In their interviews, students commented on the importance of having both an academic and social network. Nine students talked about their struggle to meet new friends or study partners in their first year and second years in science. This was also an issue for

students transferring from college to UBC in their third year of study. Students typically attributed this to the large, impersonal class sizes and being to shy about meeting people.

> But the classes are so big in first and second year that it's hard to find someone and want to meet them. Like talking to the person next to you. Having that initiative to introduce yourself and say – hey, do you want to study together? It was really difficult.
>
> Graduate female in mathematical science

> In large classes individual voices just seem to get lost.
>
> Third year female in integrated science (transfer student)

> What I was missing was a learning community. Lecture halls being so big… personally I was a bit shier so saying hi to someone, I didn't do that before.
>
> Graduating female student in general sciences

It was important for students to have either a group of their peers, a teaching assistant or a professor to go to if they were having academic difficulties or were looking for degree guidance.

> In first year I didn't seek out help and I should have. I was shy and didn't realize how nice most of the professors were.
>
> Second year female in computer science

> It's important to have a social network of people to go to if I'm having difficulties.
>
> Third year female in integrated science

> Talking to upper year students to get the feeling of where you're heading or you can ask them about their experiences.
>
> Fourth year female in cell biology and genetics

In addition to developing a community to improve their academics, students discussed the importance of seeking the appropriate advising to help with the planning of their degree (i.e. what courses should they take, how to add a minor to their degree). Students commented on having received both good and bad advising during their time at

university. Three students talked about their being 'footballed' around from person to person within advising or departments as per their transfer credits from previous institutions or assistance with changing their major.

> With science advising I was footballed around from person to person. People seemed frustrated and didn't want to talk to me and were trying to kick me out. I ended up taking courses I didn't need to.
>
> Fourth year female in geographical biogeoscience

Although few actually did, students expressed the importance for planning their degree and making appropriate changes when necessary. One student in particular was quite organized and had a degree plan upon arriving to UBC:

> I have had my degree planned since first year. I periodically review it and shift my courses. I'm pretty happy with what I have and I know where I want to go. In first year I didn't know what I wanted to do but now I know its computer science and biology.
>
> Third year male in computer science and biology

Thirteen students indicated that they wished they had sought out more help with planning their degree and courses. This might have saved them from taking courses they were not required to and to finish their degree in a timely manner.

> I wish I had a better idea of what to take in first and second year – floundered around less. Then I would have been able to space out my upper years and have more electives because I felt the need to retake some things I did in high school which I didn't need to.
>
> Third year female in integrated science

Several students talked about the importance of seeking out guidance from professors because their insight and experience was extremely enlightening and beneficially in helping students with their academics and career path.

> I have had great advising from two professors. They are two role models that have been close to me and quite the influence on how I view and act in the field.
>
> Third year female in computer science and physics

The community theme emerged from the interviews and focus group discussion and community was considered of great importance for most students. Having peers inside and outside of their program of study was integral to helping them cope with the stresses of academics while also enriching their overall undergraduate experience. Seeking guidance from professors and advisors was also important for ensuring the students received the appropriate academic and personal help they needed.

4.2.3 Personal factors

With regards to personal factors, several students expressed experiencing frustration, struggle, fear, stress and feeling overwhelmed with regards to the pedagogy and assessment, grades, their study habits, and with building a sense of community.

> Ambition is important but it is related to a fear of failure which is not a good thing to be motivated because it's better to be motivated by passion but in the past few years it has been largely fear of failure. There's a fear that no matter how much I study it's not going to be enough.
>
> Third year female in cognitive systems

Students also talked about how their personal health (i.e. depression, illness) had negatively affected their academic performance. Three female students talked about taking a year leave from school to regain their footing and to concentrate on their personal well-being. They commented on the need to take care of themselves before they could even fathom returning to university to continue their degree.

> [To one of her peers in the focus group discussion] All of those non-academic concerns you mentioned [outside commitments, health, finances, and coping with them] are a big factor because a lot of the academics have to take a backseat to health, finances and other commitments. That is definitely important.
>
> Fourth year female in cell biology and genetics

> It's more about what is going on in your personal life that really dictates how much you do at school.
>
> Fourth year female in hydrology

Six students (2 males and 4 females) also commented that relationships were another part of their personal life that appeared to influence how well they might have done academically. If they were experiencing difficulties in their relationship or if one had just ended, it was psychologically difficult for them to be fully invested in school. It was especially difficult for students whose partner was in the same course as them. Luckily all of the students who expressed these concerns sought out the appropriate counseling or advising to help them with their personal issues and they were able to once again focus on their undergraduate degree and experience.

The most prominent personal factor discussed during the interviews and focus group discussion was related to the influence that a student's interest in a course had on their academic performance. Twenty-five of the students discussed that as their courses became more specific to their major, they became more interested and invested in their academics and attributed their increase in grades to this. Interest seemed to be the biggest motivator for students to complete the work associated with a particular class and to attend class.

Overall, females seemed more open to discussing their feelings and candidly shared their family or personal difficulties with me. Two of the three females who took a year off stressed the importance for students to seek out the appropriate advising to help them with their emotional or academic problems. These students admitted to feeling lonely

and lost, but once they realized other people were going through it too, they felt more at ease. This illustrates the importance for students to find a social or academic community that can help them through the challenges of their undergraduate program.

4.2.4 Summary

At the end of each interview I asked students to provide advice for incoming science students. The most common pieces of advice were related to study habits, seeking guidance from professors, and developing a community of peers. Twenty-five of the students suggested for incoming students to adapt and develop good study skills and habits. They also expressed the need for students to try different techniques to find what works best for them and for particular courses. Nineteen students said it was essential to seek guidance from their professors early on in their degree. Several of them wished they had taken the initiative because the guidance they received from professors in their later years was integral to setting them on the right track for improving their grades and knowing what to expect on tests/exams. With respect to the importance of developing community, 12 students suggested for incoming students to break out of their shells and to make new friends. In particular, they stressed the need to have friends in your courses because you can then discuss the difficult concepts or complete assignments together. Five students also suggested the need for incoming students to have fun and enjoy their time in university. A graduating female stated it so intricately with "you have to give yourself the playground to be curious, to be a good student and to entertain some of the places you can go".

4.3 **Overall summary**

The analysis of the quantitative and qualitative data in this chapter explored the academic, social and personal factors that males and females pursuing degrees within the Faculty of Science at UBC perceived as influential to their academic performance. Some of the more important factors included: the quality of the instructor, students' expectations of assessment methods, study skills and habits, the involvement of others, additional responsibilities, personal interest, and community. In the following chapter, I will amalgamate the factors and themes that emerged from the analysis of the survey, one-on-one interviews and focus group discussion and will discuss how they relate to one another and the previous literature.

5 Discussion

In this chapter, I will discuss the results that emerged from my analyses of the quantitative and qualitative data in this study. First, I will combine and compare the survey, interview and focus group discussion results to help determine what factors undergraduates perceive as most influential to their academic performance. I will also consider why the undergraduates identified these factors as important. Second, I will further elaborate on the gender differences detected in the survey analysis by including supporting information from the qualitative data analysis. Third, I will discuss any additional factors that emerged from the interviews and focus group discussion. Finally, I will summarize the overall findings and propose which academic, social and personal factors were most important to consider for the implications of this study. In the next and final chapter of this thesis, I will provide recommendations for administrators, faculty, and students on how to improve the learning of undergraduate students in science and indicate areas for further research.

5.1 The most important factors

The factors that were perceived by over 70% of the respondents as being influential to their academic performance were considered as the most important. Factors that were defined in nine of the survey questions fit this description (Table 4.3, p. 60). To simplify the analysis of the survey questions, they were clustered into the following groupings: qualities of the instructor, student expectations of assessment methods, study skills and habits, the involvement of others, additional responsibilities, and interest and academic success.

5.1.1 Qualities of the instructor

In the survey, students perceived the instructor's ability to make the course interesting and to speak English clearly as important to influencing their academic performance. From the interviews and focus group discussion, students defined an instructor as interesting if the course material was presented in an interactive and enthusiastic manner. In relation to interactivity, students typically brought up the use of clickers in the classroom. Students appreciated clickers as a pedagogical tool for its quick feedback and stressed the need for the clicker questions to test and improve students' understanding. The use of active engagement techniques such as clickers, Peer Instruction or interactive demonstrations in lecture has been recognized as enhancing students' involvement and interaction with their instructor and peers in lecture (Fies & Marshall, 2008; Rosenberg et al., 2007). In addition, the facilitation of such techniques improves students' conceptual understanding in comparison to traditional means of teaching (Rosenberg et al. 2007; Fies & Marshall, 2008). A few students in this study also emphasized the importance for the instructor to review the answers to the clicker questions regardless of the number of students who answered correctly. Rosenberg et al. (2007) assumed that if over 70% of students answered the question correctly that this implied that the majority of students understood the concept and thus it was not necessary to review the correct answer. However, even if over 70% answer correctly, students may have answered the question right for the wrong reasons and still not understand the concept.

In the survey, 83.7% of the respondents perceived the professor's ability to speak English clearly as influential to their academic performance. In the interviews and focus group discussion, several students discussed the need for the instructor to be both clear and organized in their oral and visual presentation of the material. They did not however, specifically mention the importance for the instructor to speak English clearly. Students seemed to be more concerned with the need for instructor to deliver the course content in a clear manner versus the instructor's actual ability to speak English.

With respect to lecturing, PowerPoint presentations were described by students as the most common method for presenting the course material in lectures. Although this was the most popular method, several students were concerned with the fact that professors would speed through the slides making it hard for them to keep up with this fast pace lecturing. Students expressed difficulty with simultaneously listening to the professor, reading the slides, and copying their own notes. In their study examining how students effectively process information in lectures, de Winstanley & Bjork (2002) report this student concern and indicate that additional factors such as daydreaming might also compete for students' attentions in lecture. The use of presentation software such as PowerPoint appears to divide student's attention between what the professor is saying and what is written on the screen (de Winstanley & Bjork, 2002). On top of this, students also need to determine what information is most important to write in their notes. To improve students' attention in lecture and processing of information, the authors suggest that instructors to provide their students with an outline with headings and subheadings of the key terms that will be reviewed in the lecture. Instructors should also encourage

students to create their own outlines or study questions because those who did this learned more from lectures than students who used the prepared outline (de Winstanley & Bjork, 2002). Monitoring the pace of the lecture, minimizing divided-attention and providing lecture outlines are just a few pedagogical suggestions that might help to improve students' attention and focus in lecture.

5.1.2 Student expectations of assessment methods

From the survey, the lack of practice problems to complete before an exam and the students' uncertainty in knowing what types of problems to expect on exam were factors that negatively influenced their academic performance. Milner-Bolotin and Moll (2008) indicate that:

> The mismatch between what we intend to teach and what we effectively test in exams is of great concern to many science teachers … Exam content and style sends the clearest message to students about what skills and content are valued by instructors. (p. 494).

Almost 65% of the students I interviewed expressed the need for assignments and clickers to mimic the types of questions that would be asked on a midterm or final. One student mentioned her appreciation for a professor who allowed students to contribute to the examination process:

> For exam questions she'll ask everyone to think up potential exam questions and put them all together and choose from them so we actually have a say in what our – it gives us more power over what we're going to study and what we can expect.
>
> Fourth year female in plant biology

In the interviews and focus group discussion, students also stressed the need for frequent formative assessment and feedback such as bi-weekly assignments, clicker questions or

online quizzes to test their understanding. Assessment is often viewed as one of the most complex and difficult aspects of teaching, especially in university courses with hundreds of students (Handelsman et al., 2007; Moore et al., 2007). Despite this, it is considered one of the most effective means for instructors and students to gauge and improve student understanding. "Assessment tools that provide regular checkpoints and measures of achievement let the students determine whether they are on track and accordingly modify their approaches" (Handelsman et al., 2007, p. 48).

In the interviews and focus group discussion, students perceived heavily weighted finals (over 50% of their final grade) as an ineffective means for testing their understanding and did not view them as representative of their work over the course of the semester. They also provoked students to feeling stressed, frustrated, and anxious. Instead of having such high stakes tests or finals, educators suggest that instructors to have more frequent, regular assessment throughout the school year (formative assessment).

> Ongoing assessment provides a mechanism for students to evaluate themselves and each other. As a result learning becomes a process of reflection and analysis with specific markers of achievement, rather than simply an end point and a grade. (Handelsman et al., 2007, p.49)

Developing appropriate assessment methods requires considerable time and energy on the part of the instructor. For this reason, programs such as the Tomlinson Project at McGill University (http://www.mcgill.ca/science/tpulse/) and the Carl Wieman Science Education Initiative at the University of British Columbia (http://www.cwsei.ubc.ca/) have been created to assist professors in developing assessment and teaching methods that can enhance student learning. Several books such as Angelo & Cross' (1993) *Classroom Assessment Techniques: A Handbook for College Teachers* and Handelsman

et al.'s (2007) *Scientific Teaching* have been written to provide practical suggestions or advice for faculty with regards to effective assessment practices that have been used in the undergraduate classroom. In addition to consulting professional support or literature, we must also consider how students' perceptions can help inform and improve our choice and development of assessment methods.

5.1.3 Study skills and habits

The qualitative and quantitative findings from this study suggest that male and female undergraduates' study skills and habits as one of the most important factors influencing their academic performance. Several students indicated that in their first year of study, they struggled with developing the appropriate study skills and habits to deal with the mass quantity of material they were expected to learn. They expressed feeling lost regarding how they should study for their classes and what skills and habits were best suited for different subjects. Cramming a few days before a midterm or exam was common for students in their first and second year; however, over time, most students realized what study techniques worked best for them. The senior students seemed to be more metacognitive and improved their "ability to adapt study behaviours to the demand characteristics of the particular learning tasks" (Crede & Kuncel, 2008, p. 428). Understanding how they learned and reflecting on the learning process not only improves students' study techniques, but their academic performance as well (Smale & Fowlie, 2009).

The data indicated there was a group of students who were troubled with their lack of effective study skills and habits. This finding indicates the need for administrators and faculty to provide guidance to students regarding the development of appropriate study skills for undergraduate science courses. D'Andrea and Gosling (2005) indicated the need for study specialists to work with instructors to address how students might focus their studying to various courses.

> A subject-embedded approach to supporting students' transition to higher education means that study skills cannot be devolved to a specialist department. The specialist needs to work alongside the subject teachers, so that students see the subject-specific relevance of what they are being taught. (p. 93)

The students I spoke to attributed their drop in grades from high school to university to their poor study skills and habits. One comment that deeply resonated with me was a second year female's comment that "in high school they told us to expect our marks to go down in university but they didn't say that if you try, you can keep them up." This reminded me of my first year undergraduate chemistry course when the professor said "look to your left, look to your right, one of the three of you won't pass this course." Not only is it important for students to understand how to study effectively, it is equally important for faculty and administrators to provide suggestions and support to students to improve their academic performance.

5.1.4 Involvement of others

The survey data indicated that 76.2% of the respondents perceived encouragement from their parents/family/guardians as assisting their academic performance. Half of the students who completed an interview or the focus group discussion also claimed that

receiving encouragement from their families was important to them. Students typically turned to their families when they were having difficulty with their grades or particular courses. For example, a third year male expressed that in his first semester of first year he failed four out of five of his midterms and turned to his parents for support, "I did really poorly right at the beginning. Throughout that time I was just not doing well and I talked with my parents and had to accept the fact that I'm going to get the mark I get." According to a fourth year female, her family support eased the stress of being a student and this was extremely important to her.

> They don't have to know about what you're doing and they don't have to know about the subject but they know it's important to you and if they know you're going through a stressful time they just try to make your life a little easier. Or give you a high five.

Support from parents, family and friends are an integral part of a student's life and are a strong influence on a student's performance and enjoyment in university (Kuh et al., 2005). The students I spoke with felt that their personal life governed whether or not they were able to focus on their academics and deemed it extremely important.

5.1.5 Additional responsibilities

70% of the survey respondents perceived volunteering or working during the school year as influencing their performance by limiting the time they were able to spend studying. Out of the 28 students who completed an interview or the focus group discussion, 15 volunteered and 16 worked throughout the school year. The students expressed the importance of finding a balance between their volunteering, work, extra-curricular activities and their academics, and some mentioned struggling to find that balance.

Finding this balance can improve the overall academic performance and university experience for students (D'Andrea & Gosling, 2005; Dougan & Dougan, 1998).

The majority of students in my study also commented that they chose their work or volunteering based on whether or not it would enhance their academic experience or provide them with the opportunity to apply their knowledge. Some completed undergraduate research opportunities with their professors to gain experience in their field of study. Undergraduate research opportunities have been shown to increase students' understanding, confidence and awareness (Moon, 2009). Such experiences expose students to the world of science that exists beyond the classroom. Attending conferences, mentoring other students, analyzing and critiquing journal articles, and authoring papers can entice students to pursue a degree in research or to continue on to graduate school (Moon, 2009). Like undergraduate research projects, co-op programs such as the one at UBC help students to connect themselves to the 'real world' (Moon, 2009).

> It's so valuable to go in there and figure out what you like and don't like and know that the term is going to end. The accreditation isn't important – it's the experience. It's the test drive.
>
> Third year male in computer science & biology

Students who completed undergraduate research opportunities or co-op work terms felt that their experiences not only allowed them to apply their knowledge in real world situations but also helped them to understand where their degree might lead them in their future career.

5.1.6 Interest and academic success

Although some students might not appear concerned with their grades or performance in university science, almost 100% of the survey respondents indicated that academic success was important. However, students tend to differ in their definition of success and as Kuh et al. (2005) states "there is no blueprint for success". In the interviews and focus group discussion, students typically referred to their grades when reflecting on whether or not they perceived themselves as successful. For some students, attaining a grade above the class average was considered successful while for others, attaining grades above 90% was important.

The survey, interview and focus group discussion data indicated that students perceived their interest in a course as influential to their academic performance. On the survey 77.5% of the respondents claimed that their interest in a subject was an important factor in motivating them to complete the suggested homework and assignments. In addition, students who took part in an interview or the focus group discussion expressed that their interest also affected their class attendance. If students did not particularly enjoy a course, they would opt to skip the lecture. This could impact performance because they would fall behind in their readings and coursework.

5.2 Gender differences

The use of the Mann-Whitney *U* Test detected ten factors (Table 4.5, p. 66) with significant differences for males' and females' responses. Females ranked these ten factors as more important to influencing their academic performance than their male

peers. The factors were organized into the following categories: Qualities of the instructor, pedagogy and classroom environment, student expectations of assessment methods, study skills and habits, the involvement of others, and commute to campus. In the following sections I will discuss these factors and consider whether or not the interviews and the focus group discussion data support the survey findings. I will also consider whether or not the differences I found are supported by the literature.

5.2.1 Qualities of the instructor

In comparison to their male peers, females placed more importance on the need for a professor to be approachable and the literature supports this finding. Female students are reported to seek relationships with faculty and are deterred if the professor is unfriendly (Smoot-Hyde & Gess-Newsome, 2000). A second year female in general sciences commented on the need for the professor to not "seem intimidating in class and that they're there to help you and not just instruct". A third year female in computer science thought it was important for professors to make a "conscious and clear effort to get to know the students at an informal level". One of the more confident male students I interviewed stated that the professor "doesn't need to be approachable as long as he teaches the material well".

Developing personal relationships with faculty and peers tends to be important for females in undergraduate science, especially in majors such as physics and computer science where females are underrepresented (Smoot-Hyde & Gess-Newsome, 2000). When reflecting on her experience as an undergraduate, a female in Smoot-Hyde & Gess-

Newsome's (2000) study said, "I think the biggest support for me came from the fact that there were professors and teachers that were interested in my success. That really impressed me and gave me confidence that I could do it" (p. 123). Comments such as this and those mentioned previously demonstrate that the approachability of the instructor can influence females both academically and emotionally.

5.2.2 Pedagogy and classroom environment

In relation to teaching techniques and the classroom environment, females place more emphasis on the use of in-class learning techniques (i.e. clickers, group activities) and the number of students in the class. From the interviews and focus group discussion, gender differences were not obvious when students discussed active learning techniques. My survey finding that females perceived the use of active learning techniques as more influential to their academic performance in comparison to males is supported by the work of Smoot-Hyde and Gess-Newsome (2000). The authors found that female undergraduates in science preferred practical and active learning experiences in the classroom in comparison to passive methods. Such interactive and collaborative approaches to teaching promoted learning and also enhanced females' enjoyment in lecture (Smoot-Hyde & Gess-Newsome, 2000).

With respect to the class size, more females than males talked about feeling alienated or lonely in the large classes they experience during their first and second year of university. These feelings were attributed to the impersonal classroom environment of large classes. Although the females interviewed in my study did not express a desire to leave the

sciences, Kissinger (2009) indicated that the isolation that students in engineering and science experience in large classrooms could entice them to leave their degree early in their programs. As class sizes grew larger, females' in-class interactions tended to decrease (McKimm Stevens, 2005). Fies and Marshall (2008) also discussed that several females commented that the intimidating classroom setting and their personal fear of being wrong deterred them from speaking in front of the whole class. Similarly, when I was discussing in-class group activities with students, two females admitted to being too shy to discuss the problems with their neighbours. In addition, several females I spoke with in the interviews and the focus group discussion expressed that if they could go back and change something about their experience, they would have been more active during lectures at the beginning of their degree. These results stress the need for teaching techniques that not only improve female students' engagement in lecture but also encourage them to interact with their peers more frequently.

5.2.3 Student expectations of assessment methods

The survey factor that showed the most significant difference between males' and females' responses was the one regarding the lack of practice problems to complete before an exam. Roughly 89% of females perceived this factor as impeding their academic performance in comparison to 76% of males. In addition, more females than males rated their uncertainty with knowing what to expect on a final exam as influential to their performance. Within the interviews and the focus group discussion, both males and females discussed feeling frustrated when they didn't feel properly prepared for a midterm or final exam. The females however, more openly admitted to feeling anxious,

stressed and nervous. Females are apt to feel discouraged and lost especially in their first few years of university because, "the support is almost completely withdrawn and expectations were raised which leads to anxiety, frustration and a severe drop in self-confidence" (Malicky, 2003, p. 14). Female students seem to invest more emotionally into their education and despite having higher grades than males, are more apt to switch out of the sciences (Seymour & Hewitt, 1997).

Females in science have also been pegged as perfectionists in comparison to male peers, which can contribute to their fear of academic failure (McKimm Stevens, 2005). During my discussion with a high-achieving female she indicated that "the fear that no matter how much I study it's not going to be enough" negatively affected her. Having some expectation of what they will be tested on and how they will be tested might relieve some of the anxiety and pressure that females experience in undergraduate science.

5.2.4 Study skills and habits

Although the survey responses of males and females regarding the importance of developing and adapting their study skills were found to be significantly different, I did not notice a marked difference in the interviews and the focus group discussion. Almost all of the students I interviewed mentioned they would advise incoming students to improve and adapt their study techniques. Students also commented that they believed their study habits strongly influenced their grades. Similar to what I discussed in the previous subsection, the females in the interviews and focus group discussion conveyed a lot more emotion regarding their performance in undergraduate science in comparison to

the males. Feeling scared, lost, frustrated, anxious, incompetent, and dumb were emotions that several of the females in my study admitted to experiencing.

> I actually feel that I'm lost sometimes. I don't know how to study for some courses and it would be nice if there was, I guess, support and advice in that because I don't think you can study for the different courses in the same way.
>
> Second year female in general science

Crede and Kuncel (2008) found that academic anxiety was an important negative predictor of students' performance. In the interviews and focus group discussion, males seemed to be more accepting of a poor grade whereas females typically held the mentality that "it's the end of the world!" A third year male commented that:

> After all those shortcomings and not doing well in that first semester I came to the conclusion that it's going to be hard and I have to put a lot of work in it. If I don't put a lot of work into it – I'll have to take what I get.

In particular for women, even if grades seem to be good from an outsider's perspective, they typically see the grade as 'not good enough' (Seymour & Hewitt, 1997) and underestimate their abilities (Schiebinger, 1999). As mentioned in the literature review, Seymour and Hewitt (1997) suggest actions students can undertake to put less emphasis on a number or letter grade and more on their actual attainment. These include re-focusing one's learning objectives, being more accepting of an average grade, trusting their own judgment as to whether or not they understand the material, and focusing on what interests them in their discipline. In addition, Seymour and Hewitt (1997) also discuss the importance for students to have supportive faculty who draw attention to the need for students to focus on their comprehension, and to provide advice as to how students could study. Women who are assertive and have learned to depend on themselves for evaluation tend to progress further in the fields of math, science and

engineering (Malicky, 2003). Thus, it is important for females to receive the appropriate guidance or advice to help them become more confident in their abilities and cope with some of the challenges they might encounter in undergraduate science.

5.2.5 Involvement of others

Although both females and males perceived encouragement from their family as important to influencing their academic performance, females place slightly more importance on this factor. Females also indicated that suggestions from parents, teachers and/or advisors influenced their decision to major in math and/or science. When analyzing the interview and the focus group discussion data, I became aware that the majority of students who elaborated on their reasons for switching their major were female. For example, three females talked about switching into computer science based on their positive experience in an introductory course, one female switched from the arts because of the enthusiasm of faculty member, and another female chose her specialization based on the influence of a female professor. All of these individuals talked about the positive role that a faculty member had on their choice to switch majors and, in each case, the faculty member was a female.

My findings are supported by the literature that indicates that female students benefit from the presence of and their relationships with female faculty (De Welde et al., 2007; Kissinger, 2009; McKimm Stevens, 2005; Sonnert et al., 2007). Having women role models in fields of science appears to have a positive influence on undergraduate females' participation and performance in science (McKimm Stevens, 2005; Sonnert et

al., 2007). It also allows females to develop a strong sense of community and belonging within their program (Kissinger et al. 2009). This finding suggests for administrators to consider hiring more female faculty in science departments, especially those where female undergraduates are underrepresented (i.e. physics, computer science). It is also important for faculty to be aware of the strong influence that their actions, teaching, and advice might have on students' performance and persistence.

Although not one of the most important factors identified by students, the pressure students receive from their family might influence their academic performance. Five students expressed that they experienced pressure from their family to pursue a particular degree within the sciences. Although in the survey the number of students perceiving pressure from their parents as discouraging was only 23.8%, it still indicates that almost a quarter of the respondents experienced this pressure. Within the interviews and the focus group discussions, four females and one male discussed feeling pressure from their parents to major in the sciences. In all but one case, the students were of Asian (Chinese, Vietnamese & Korean) descent.

Although more interviews would be needed to explore the correlation between students' ethnicity and familial pressure, the literature suggests this relationship may exist. In a study exploring the experiences of Asian females in undergraduate science, each participant spoke candidly about their parents' over-involvement in their education and the constant pressure to succeed (Chinn, 2002). This pressure and the way in which it affected their performance in science and engineering were viewed by students in both a

positive and negative light. Parents' high expectations pushed the students to do well, however if the pressure was too severe, students felt overwhelmed and discouraged because they were not performing at the level that was expected of them. Asian parents in North America are reported to place a lot of pressure on their children to succeed academically and to excel in science courses in order to attain successful careers in these fields (Chinn, 2002; Li, 2005; Lee, 1994). Students with stronger ties to their ethnic culture identify experiencing more parental pressure and language barriers within Canada than their white peers and indicate issues balancing Western and Asian cultures (Lee, 1994) - critical factors that might be strong influences of academic performance. This observation prompts further research to consider how students' ethnicity might play a role in affecting their academic performance and experience.

5.2.6 Commute to campus

The survey data indicates that females placed more importance on the fact that their commute to campus limited the amount of time they spent studying in comparison to males, however I did not notice much of a difference between their comments in the interviews and the focus group discussion. Whether they lived on- or off-campus, all of the students I spoke to talked about commuting. Students who commuted long distances had some interesting experiences such as the anecdote shared by one female student who commuted over two and half hours to campus each day:

> When I drove a lot last year – rush hour controlled my life. I would be on campus at 6am to avoid rush hour and to get free parking and I would bring my sleeping bag and sleep in the car for an hour and then go to class at 8 am. It was horrible!

Students who lived on-campus expressed having more opportunity to become involved with extracurricular activities, attend office hours, and have access to on-campus resources (i.e. library, gym). On-campus students that were more involved in these activities found it easier to develop new relationships with their peers and faculty in comparison to the commuter students. Earlier research by Astin (1984) reflects similar findings from a study regarding on- and off-campus living:

> Residents are more likely than commuters to achieve in extra-curricular areas as leadership and athletics and to express satisfactions with their undergraduate experience, particularly in the areas of student friendships, faculty-student relations, institutional reputation, and social life. (p. 525)

With such a high number of students commuting to UBC campus (74.9% of the survey respondents), it is important to examine and consider ways to better accommodate the needs of this group of students.

Student development has a commuter magazine that is published every fall for new commuter students that reviews topics related to student life, academic success, health and wellness, and campus culture (UBC Student Development and Services, 2009/2010). In addition, student development also organizes a Commuter Student Parent Orientation every September to educate parents regarding the resources, programs and student life at UBC. Although these resources are readily available online, none of the students I spoke with indicated having used either of these resources. This suggests that further communication between Student Development and the Faculty of Science may be needed to determine how the needs of commuter students might be more appropriately addressed.

5.3 Additional factors from the interviews and the focus group discussion

In this section I review and discuss particular factors that were not explored in the survey but emerged from the interviews and the focus group discussion. These factors include the importance of the courseload for science students, building an academic and social community, and seeking advising and academic support.

5.3.1 Courseload for science students

One of the most important findings that emerged from the interviews and focus group discussion was the number of students who switched from taking five courses in a semester to taking four. Almost half of the students I spoke to had lightened their courseload and a number specifically recommended that first year students be advised to only take four courses in their first year. With fewer courses, students were better able to manage their time and could focus more on their academics. In their book, *College Smarts: The Survival and Success Guide for Canadian Students*, Dougan and Dougan (1998) actually suggest that students take fewer courses in their first semester or first year of university. They discuss that if students' have underdeveloped study skills and habits, or other responsibilities such as volunteering or work, taking five courses might be too overwhelming (Dougan and Dougan, 1998). Similarly, Smoot-Hyde and Gess-Newsome (2000) indicate that the majority of students entering the fields of science, math and engineering are typically under prepared for the demanding curriculum and courseload. As a result, several students can take more than four years to complete their degree. The findings from my study and the literature suggest the need for administrators to reevaluate how many courses students should be advised to take, especially in their first

year in undergraduate science. This would not be an easy undertaking but might help to assist students in managing their courseload and ultimately improve their academic performance and experience.

5.3.2 Building an academic and social community

In the interviews and the focus group discussion, students placed considerable emphasis on the importance of developing both an academic and social community. Students encouraged their incoming peers to make friends with others in their program, seek out advice and support from faculty, and become involved with academic societies or programs (i.e. science undergraduate society, clubs). Doing so might not only improve their sense of belonging in university but also be beneficial in helping them with any conceptual difficulties. A social community for students was an outlet from the stresses of everyday schooling. Extracurricular sports or clubs provided students with the opportunity to get involved on-campus and to meet new peers.

The literature indicates that it is beneficial for students to belong to a community of learners early on in their degree (Astin, 1993; D'Andrea & Gosling, 2005; Kissinger et al., 2009; Kuh et al., 2005). Not only is it important for students to develop relationships with their peers, but with individuals in their departments as well (Kissinger et al., 2009). Creating connections with their peers, faculty and advisors not only can improve their academic performance, but their overall undergraduate experience as well (Kuh et al., 2005). Kuh et al. (2005) indicated that "creating a sense of community on campus and among students and faculty is a persistent challenge at commuter institutions" (p. 104).

With roughly three quarters of the students at UBC living off-campus (Connections, 2009/2010), it is important to consider how we might ensure that students experience a sense of belonging to a community both on- and off-campus.

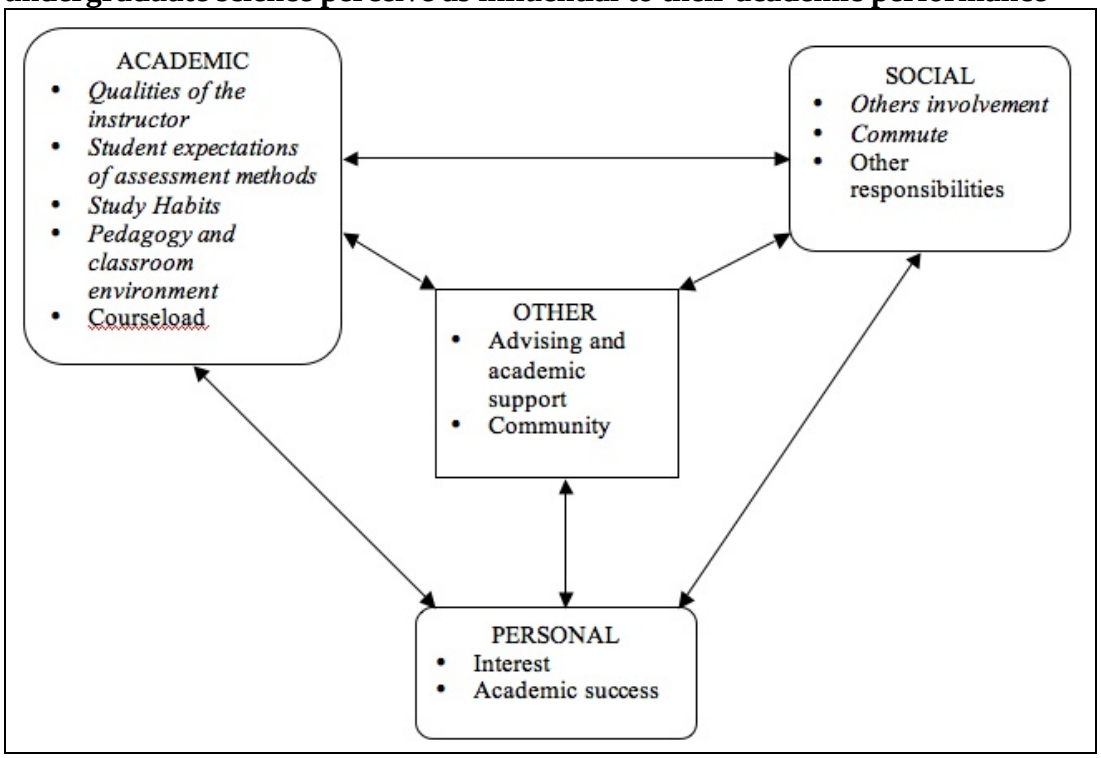
5.3.3 Seeking advising and academic support

Throughout the interviews and the focus group discussion I noticed students commenting on how a faculty member's or an advisor's advice had been integral in their undergraduate experience. Several students spoke quite highly of their relationships with faculty and indicated being inspired by their professor's enthusiasm, guidance and research. Some students found their interactions with professors influenced them to change their major, provided them with research opportunities, and helped with their conceptual understanding of difficult course material. Students also expressed that they wished they had sought more guidance as to how they might have better planned their degree and chosen appropriate courses. Having meaningful contacts with faculty and advisors can help students to feel more invested in their education and more likely to succeed (Moore, 2007). As mentioned previously, faculty and advisors can serve as role models for females in undergraduate science and this may have an influence on their persistence and performance (McKimm Stevens, 2005; Sonnert et al., 2007). With so many factors influencing students' success in university, it is important to provide support early on for students to help them cope with the challenges they might face during their degree.

5.4 Summary

This study found several academic, social and personal factors that students perceived as important to influencing their academic performance in undergraduate science. Differences between the level of importance that males and females place on particular factors were also identified and discussed. Figure 5.1 illustrates the factors that were deemed most important for academic success by the students in this study.

Figure 5.1 A summary of the academic, social and personal factors that students in undergraduate science perceive as influential to their academic performance



The double-headed arrows shown between the academic, social and personal categories indicate that relationships exist amongst these factors. For example, the lack of appropriate assessment methods (an academic factor) can influence feelings of anxiousness (a personal factor). I have positioned the other factors of "Advising and academic support" and "Community" in the middle of this diagram resting between the

academic, social and personal factors because these factors relate to all the other factors. The italicized factors represent those where gender differences were detected.

As depicted in Figure 5.1 the students in this study perceived an array of factors as influential to their academic performance in undergraduate science. Small and Fowlie (2009) indicate students need to reflect on their learning, responsibilities, social life and personal well-being to help them determine how they can best allocate their time to each aspect of their life. Although students must take an active role in their own learning, it is important for administrators and faculty to provide the appropriate support and guidance for students, especially early on in their degree. In the final chapter of this thesis I provide recommendations for administrators, faculty and students regarding how they might improve students' academic performance in undergraduate science. I also answer my research questions and indicate areas for further research.

6 Conclusions

6.1 Summary

Researchers have stressed the importance for institutions of higher education to explore the experiences of their students in order to understand what factors impede or enhance students' success (Astin, 1993; Kuh et al., 2005; Watson & Stage, 1999). Emanating from the concerns of administrators in the Faculty of Science at UBC, a mixed method study was designed to explore the perceptions of students pursuing degrees within the Faculty of Science regarding the factors influencing their academic success. That study set out to answer the following research questions:

1. What academic, social and personal factors do male and female undergraduates within the Faculty of Science perceive as most influential to impeding or enhancing their academic performance?
2. How do male and female undergraduates differ in what they perceive as being most influential to their academic performance?

The survey designed for this study assisted in answering the research questions which aimed to determine what academic, social and personal factors undergraduates perceived as influential to their academic performance and if males and females differed in their perceptions. Completing one-on-one interviews and a focus group discussion helped in focusing on why students perceived these factors as important. I have summarized the findings of this research in Table 6.1. The columns describe the factors that were detected from the survey as being most important to students. The fourth column provides an overview of what students said about why they perceived particular

academic, social and personal factors as influential to their academic performance. In the third column, **Y** (yes) represents if males and females perceived the particular factor as one of the most important to influencing their academic performance. **D** (difference) indicates that significant differences were detected in the responses of males and females. **Y/D** represents that students perceived this factor as one of the most important and that gender differences were also detected for this factor.

Table 6.1: A summary of the findings from this research

Category	Factor	Factor was important to:		Why do students perceive these factors as important?
		Males	Females	
Academic	**Qualities of the instructor** Interesting Speak clearly Approachability	**Y/D** **Y** **D**	**Y/D** **Y** **D**	• Qualities of an instructor can influence students engagement and interest • Clarity and organization allowed students to follow what the instructor was saying in class • Clickers provided feedback and indication of students' understanding • Students regarded their interactions with and advising from professors as positive influences on their performance, career objectives and overall academic experience • Females perceived developing relationships with faculty as important to their success
	Student expectations of assessment methods Lack of relevant practice problems Uncertainty in knowing what to expect	**Y/D** **Y/D**	**Y/D** **Y/D**	• Ongoing feedback helped with students understanding • Heavily weighted finals were not representative of students' work • In comparison to males, females expressed feeling more stressed, anxious, frustrated, and lost when they did not know what was expected of them as students
	Study skills and habits Importance of developing and adapting skills and habits	**Y/D**	**Y/D**	• Most students struggled with developing and adapting their habits in first and second year • Students expressed difficulty in tailoring their habits to different subjects • Students' study skills and habits affected students' grades • In comparison to males, females expressed feeling more stressed, anxious, and frustrated when they did not know how to study for a test or final exam
	Pedagogy and the classroom environment In-class learning techniques Number of students in the class	**D** **D**	**D** **D**	• Females preferred being active participants in their learning • Techniques encouraging collaboration reduced females feeling isolated in large classrooms

Category	Factor	Factor was important to:		Why do students perceive these factors as important?
		Males	**Females**	
Social	**The involvement of others** Encouragement from parents, family or guardians	**Y/D**	**Y/D**	• Family provided emotional support for students in tough circumstances • Students perceived an academic and social community as extremely important to influencing both their performance in science courses and their overall university experience • Females were more prone to relying on the suggestions from or their relationships with family/faculty/peers regarding their choice of major • Females benefited from having female faculty as role models
	Suggestions from parents, family or guardians	**D**	**D**	
	Additional Responsibilities Volunteering or work	**Y**	**Y**	• Students found it necessary to create balance between academic and social life • Extracurricular activities and work can impeded students' performance • Several students chose volunteering or work experiences to enhance their learning
	Commute Limiting	**D**	**D**	• Students indicated that long commutes limited their involvement on-campus • Commuter students might have more difficulty in building or belonging to a community
Personal	**Interest and academic success** Interest drives them to do work	**Y**	**Y**	• Being interested in a subject influenced students class attendance, drive and even influenced some students to alter their majors • It was important for students to succeed for various reasons (i.e. attaining appropriate grades for graduate school or medical school, to appease family)
	Desire to succeed academically	**Y**	**Y**	

6.2 Conclusions

This study found that students perceived several academic, social and personal factors as influencing their academic performance. The survey data assisted with the identification of a range of factors while the interviews and focus group discussion provided a more personalized look into why males and females felt particular factors were more important than others. Based on an analysis of the quantitative and qualitative data, the most important factors that students perceived as influencing their academic performance were: development and use of appropriate study skills and habits; effective pedagogy (i.e. teaching that is clear and organized) and assessment methods (i.e. provision of regular feedback); achieving balance in academic and non-academic responsibilities; interest in the subject material; and the development of positive relationships with faculty, peers and family. Females, in comparison to males placed more importance on: their relationships with faculty (especially female faculty), peers and family; the need for interactive and engaging lecturing techniques; and ongoing feedback and guidance to relieve feelings of anxiety, stress and overwhelm. These findings convey the complexity of issues pertaining to student success and provide an indication as to the concerns and experiences of students pursuing degrees within the Faculty of Science at UBC.

6.3 Recommendations

The findings from this study have implications for practice that may improve the success of students in undergraduate science programs and courses. In the following subsections I will present how particular findings might be useful for different stakeholders and can be used to inform educational practice. Recommendations will be made for

administrators, faculty and students within the Faculty of Science. I will also suggest areas for further research.

6.3.1 Recommendations for administrators

- Provide study skills workshops that reflect department-specific subjects. Students in this study indicated they felt they needed better study skills and that they didn't get this preparation in high school. Thus, providing study skill workshops linked to specific courses is strongly recommended. Such workshops may help students tailor their skills to particular courses. Involving faculty, teaching assistants or senior undergraduate students in these workshops might entice students to attend, and to change/adapt their study habits.
- Provide students with more personalized advising. Students admitted to feeling lost when planning their degree in first and second year. During this time students typically took courses that were not required or relevant to their program of study, and regretted this later. Thus, to help students plan their degree and assist them with academic problems (i.e. specific to a particular department or program) it is suggested that the Faculty of Science provide more personal advising to students throughout their undergraduate experience.
- Implement more interactive teaching and formative assessment in undergraduate courses. Students perceived regular feedback as integral to influencing their academic performance and interest in science courses. Based on students' comments, it is recommended that administration provide ongoing professional development for new and current faculty that focuses on the development and implementation of interactive teaching methods and ongoing formative

assessment. It would also be beneficial to review how to accommodate the needs of different students (i.e. those of differing gender, ethnicity, living arrangements).

- Enhance communication between professional services (i.e. counseling, advising, medical services, learning commons) and faculty. Students tend to look to instructors for guidance and advice, so informing faculty of the on-campus resources would be beneficial.
- Examine the schedules of commuter students and provide more services during the morning or early afternoon. The large population of commuting students at UBC has particular need. Arriving and staying alert during 8 am classes was a concern of commuter students. Accommodating the needs of this group of students might improve their sense of community, academic performance and experience in science programs.
- Actively counsel students on the number of courses they enroll in for first year. Remind students that they have an option of taking 4 courses in their first university semester (or even year) instead of the recommended 5 courses. This would allow students time to adjust to the academic and social demands of university.

6.3.2 Recommendations for faculty

- Provide additional opportunities for students to hear about or participate in real research. During teaching, share your research experiences and provide real world applications of course material. Students are intrigued as to the research

that their professors conduct, but they rarely get the chance to hear about it or understand its connection to the course being taught.

- Reflect on the possible impact that presentation techniques might have on students' ability to stay focused in lecture. When using PowerPoint presentations, be sure not to move through the slides too quickly. Consider creating an outline of the key concepts for each lecture.
- Create an interesting and safe learning environment in the classroom. Students commented that they were more interested themselves and thus more motivated to learn when the professor was enthusiastic about the material and interacted with the students during lecture. The use of active learning techniques (i.e. clickers, Peer Instruction, demonstrations) may be used to improve instructor-student and student-students interactions in lecture.
- Provide regular, frequent feedback to help students assess their progress in the course. Students indicated that online quizzes, small assignments or additional midterms helped them to stay on top of the material and tested their understanding. In general, students appreciated when the questions reflected those found on a midterm or exam.
- Provide advice regarding studying techniques that would help students prepare for their midterms or finals. The majority of students expressed concerns with their lack of effective study habits and difficulty in tailor their habits to particular courses. Providing suggestions as to how they might study would help them to focus their studying to relevant material and relieve some of their anxieties.

- Become an advocate for science and a role model for students. Students in this study really admired and respected their professors. As a result, you should be aware of the influence that your actions have on students academically and personally. Students, especially females place a lot of importance on the relationships they develop with faculty and can be deterred by those who are intimidating, unapproachable or "don't seem to care".

6.3.3 Recommendations for students

- Develop and adapt appropriate study habits and time management skills early on in your degree. Review your lecture notes and readings on a regular basis, complete the assigned problems, seek help early on and try not to let your problems fester, and try to balance your focus on all of your classes regardless of their difficulty or your interest.
- Seek academic and personal guidance early on in your degree. The majority of students discussed that they would have built relationships with their professors earlier on. Professors were able to help them with their conceptual difficulties, course selection, additional work experiences or career advice.
- Engage with the academic and social community at the university. Speak with your neighbours in lecture or labs, get involved with clubs or extracurricular activities on campus, volunteer or work in a lab setting of interest or seek out support from professors.
- Create a tentative course plan for your program and adjust it accordingly over time. Science advisors, professors, and senior students might help you to choose your courses and provide additional research opportunities.

6.3.4 Recommendations for further research

The findings of this study prompt the need for additional research to explore particular results in more detail. For example, we might investigate whether students of different gender, ethnicity or major perceive the same factors as important to influencing their academic performance. Within the interviews I noticed that Asian students seem to express experiencing more pressure from their parents to succeed and it would be interesting to investigate this relationship further.

As noted in this study and in previous literature (OECD, 2008; Seymour & Hewitt, 1997; Sonnert et al., 2007) undergraduate females are underrepresented in physical science and computer science programs. These low proportions of females are attributed to the lack of women faculty and sense of community associated with these programs (Sonnert et al., 2007). In this study however, three females indicated that they switched into computer science or added it as a minor to their initial degree. Examining more thoroughly why females are attracted to the computer science program at UBC might be helpful in recruiting and retaining females in programs where the female population is underrepresented.

In the interviews I noticed that students with a long commute struggled in developing community and being involved on-campus. These findings encourage the need for additional research to examine the experiences of commuter students more thoroughly. It would also be interesting to investigate how commuter students' survey responses differed or were the same based on the length of their commute. In the interviews and the

focus group discussion, students with a daily commute of over 2 hours seemed to express additional struggles in comparison to their peers who traveled only 30 minutes to school.

While this study provides some answers for those interested in the problem of student success in science, what students perceived as influential to their academic performance is just a start in understanding student performance. Additional research will help us learn more and help us establish if the factors that students describe as influential actually do affect their performance. What students perceive as influential might not be the reality.

6.4 Final thoughts

When developing and conducting this research, the number of students who willingly and candidly participated in this study surprised me. The students I spoke to directly were appreciative of this opportunity to share their perceptions and valued the fact that this research took their point of view into consideration. Moore et al. (2007) has commented that considering students' perceptions will allow us to improve how we will "challenge, inspire, support, advise, and witness students' own development" (p. 57). If we hope to improve students' experience in undergraduate science, it is essential for us to understand the complexity of student experience including the multiple factors influencing students' academic performance. It is also imperative that beyond investigation and understanding, professionals within higher education institutions begin to advocate on behalf of the students in order to tackle particular barriers and implement change.

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Appendices

Appendix A: Student survey

Factors Influencing Your Academic Performance

The following survey has been created to determine what factors play a role in limiting or enhancing students' academic performance in math and science courses at UBC. This survey is directed at second to fourth year students within the Faculty of Science. The data will be analyzed by researchers at the Carl Wieman Science Education Initiative and the overall survey results will be shared with faculty and administration to help them understand and support your academic challenges and successes. Please take the time to provide any additional comments - your experiences and opinions are important to us.

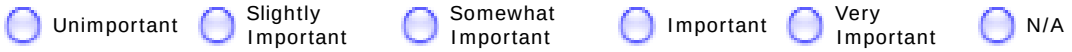
The survey should take no more than 10 minutes of your time. Be sure to click the Submit Survey button at the bottom of the survey. Your completion and submission of this survey implies your consent for your answers to be used for analysis. Your responses will remain anonymous and your instructors will not have access to your individual responses.

If you would like to be entered into the draw to win one of ten $50 UBC Bookstore gift certificates, be sure to provide your student number in the demographic section of this survey.

Thanks!

ACADEMIC FACTORS

Rate how important these items were to influencing your academic performance in math and science courses.



1) Ability for the instructor to make the course interesting
2) The instructor's ability to speak English clearly
3) The approachability of your instructor
4) The number of students in the class
5) Your comfort in being able to ask questions in class
6) The use of in-class learning techniques (i.e. clickers, group activities)
7) Use the following space if you have any comments relating to Question 6:
8) Frequent, regular quizzes, assignments and tests that provide helpful feedback on my progress in the course
9) Studying with peers
10) Developing and adapting study habits for university courses
11) My uncertainty in knowing what types and difficulties of problems will be asked on a midterm or final exam is an _____ factor limiting my academic performance.
12) My interest in a subject is a/an _____ factor in motivating me to complete the suggested homework/assignments
13) Whether an assignment is worth a percentage of my overall grade is a/an _____ factor as to whether I will complete it
14) My high school education was _____ in preparing me for the academic challenges presented in first-year courses
15) The amount of material I have to write down during class is a/an _____ factor in limiting whether I am able to follow what the instructor is saying in class

16) The lack of relevant practice problems to complete before an exam was a/an _____ factor influencing how well I performed on exams
17) My difficulty with understanding spoken English is a/an _____ factor limiting my understanding of the material presented in class
18) Use this space to comment on your experiences with the topics presented in Questions 1-16

ACADEMIC RESOURCES/ADVISING

Rate how important the following were to assisting your academic performance in math and science courses

Unimportant | Slightly Important | Somewhat Important | Important | Very Important | Did not use

19) Math Tutorial Centre
20) Chemistry Resource Centre
21) First-year Biology Learning Centre
22) Science Advising Office (Academic Advising)
23) Use this space to comment on your experiences with these or other services you have used.

SOCIAL/PERSONAL FACTORS

Indicate how strongly you agree or disagree with the following items

Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree | N/A

24) It is important for me to succeed academically
25) Receiving encouragement from my parents/family/guardians assists my academic performance
26) The pressure I receive from my parents/family/guardians to succeed academically is discouraging
27) Suggestions from parents, teachers and/or advisors influenced my decision to major in math and/or science
28) Living on campus is an important factor aiding my academic performance
29) My commute to campus limits the amount of time I spend studying
30) My living conditions are favorable to studying
31) Where I live makes it hard for me to study with my peers
32) Volunteering or working during the school year limits the amount of time I spend studying
33) Use this space to comment on your experiences with the topics presented in Questions 23-31

DEMOGRAPHIC INFORMATION

Collecting demographic information provides the researchers with a more thorough description of the student body within the math and sciences at UBC. You do not have to answer any questions that make you uncomfortable. Your instructors will not have access to any data that might identify you in any way.

34) What is your student number? (Optional)
35) What is your sex?

Male
Female

36) What is your citizenship?

Canadian

- Permanent Canadian Resident
- International Student

37) To which race/ethnicity do you most closely identify?

- Aboriginal
- Arab
- Black
- Chinese
- Filipino
- Japanese
- Korean
- Latin American
- South Asian (e.g. East Indian, Pakistani, Sri Lankan)
- Southeast Asian (e.g. Vietnamese, Cambodian, Malaysian, Laotian)
- West Asian (e.g. Iranian, Afghan)
- White
- Multiracial
- Other
- I prefer not to respond

38) Where do you live?

- Home of parents/relatives/guardians
- Off-campus rental house/apartment
- On campus in university apartment or residence hall
- Other (please specify)

39) How often is English spoken where you currently live?

- Always
- Most of the time
- Half of the time
- Sometimes
- Infrequently
- Never

40) On average, how long is your one-way commute from where you live to UBC campus?

- less than 15 minutes
- 15-30 minutes
- 30-45 minutes
- 45-60 minutes

- greater than 60 minutes

41) How often do you study with your peers?

- Always
- Most of the time
- Half of the time
- Sometimes
- Infrequently
- Never

42) What is your current academic year of study?

- 1st
- 2nd
- 3rd
- 4th
- 5th
- greater than 5th

43) What is your home faculty/program?

- Applied Science (Engineering)
- Arts
- Forestry
- Human Kinetics
- Land & Food Systems
- Sauder School of Business
- Science
- Other (please specify)

44) If in the Faculty of Science, please indicate your department

Biology
Biochemistry
Chemistry
Computer Science
Earth and Ocean Sciences
Geographical biogeoscience (physical geography)
Mathematics
Microbiology and Immunology
Pharmacology
Physics and Astronomy
Physiology
Psychology
Statistics
General Science
Integrated Science
Not yet decided
Other (please specify)

45) What is your average grade for courses taken at UBC?

80-100%
70-80%
60-70%
below 60%

46) Use this space to discuss any additional experiences and/or issues impeding or enhancing your academic performance

47) If you would like to participate in an in-depth interview or a focus group discussion to talk about the contents of this survey, please provide your e-mail address.

We are trying to get as many students within the Faculty of Science to complete this survey so please forward the link to your friends and encourage them to fill it out. Also, if you would like to be entered in the draw to win a UBC Bookstore gift certificate, please provide your student number in the demographic section. Thank you for your time and be sure to click the Submit Survey button to make your answers count!

Appendix B: Kolmogorov-Smirnov test for normality

		Ability for the instructor to make the course interesting	The instructor's ability to speak English clearly	The approachability of your instructor	The number of students in the class
Most Extreme Differences	Absolute	0.088	0.042	0.117	0.122
	Positive	0	0.042	0	0
	Negative	-0.088	-0.039	-0.117	-0.122
Kolmogorov-Smirnov Z		0.959	0.457	1.28	1.326
Asymp. Sig. (2-tailed)		**0.317**	**0.985**	**0.075**	**0.06**

		Your comfort in being able to ask questions in class	The use of in-class learning techniques (i.e. clickers, group activities)	Frequent, regular quizzes, assignments and tests that provide helpful feedback on my progress in the course	Studying with peers
Most Extreme Differences	Absolute	0.056	0.133	0.052	0.045
	Positive	0.002	0	0	0.042
	Negative	-0.056	-0.133	-0.052	-0.045
Kolmogorov-Smirnov Z		0.609	1.443	0.572	0.492
Asymp. Sig. (2-tailed)		**0.852**	**0.031**	**0.9**	**0.969**

		Developing and adapting study habits for university courses	My uncertainty in knowing what types and difficulties of problems will be asked on a midterm or final exam is an _____ factor limiting my academic performance.	My interest in a subject is a/an _____ factor in motivating me to complete the suggested homework/assignments	Whether an assignment is worth a percentage of my overall grade is a/an _____ factor as to whether I will complete it
Most Extreme Differences	Absolute	0.095	0.098	0.074	0.091
	Positive	0	0	0.074	0
	Negative	-0.095	-0.098	-0.04	-0.091
Kolmogorov-Smirnov Z		1.034	1.066	0.797	0.992
Asymp. Sig. (2-tailed)		**0.235**	**0.206**	**0.55**	**0.279**

		My high school education was _____ in preparing me for the academic challenges presented in first-year courses	The amount of material I have to write down during class is a/an _____ factor in limiting whether I am able to follow what the instructor is saying in class	The lack of relevant practice problems to complete before an exam was a/an _____ factor influencing how well I performed on exams	It is important for me to succeed academically
Most Extreme Differences	Absolute	0.052	0.073	0.153	0.051
	Positive	0	0	0	0.051
	Negative	-0.052	-0.073	-0.153	-0.036
Kolmogorov-Smirnov Z		**0.561**	**0.793**	**1.655**	**0.559**
Asymp. Sig. (2-tailed)		0.911	0.556	0.008	0.913

		Receiving encouragement from my parents/family/guardians assists my academic performance	The pressure I receive from my parents/family/guardians to succeed academically is discouraging	Suggestions from parents, teachers and/or advisors influenced my decision to major in math and/or science	Living on campus is an important factor aiding my academic performance
Most Extreme Differences	Absolute	0.141	0.062	0.085	0.118
	Positive	0	0.053	0	0.118
	Negative	-0.141	-0.062	-0.085	-0.008
Kolmogorov-Smirnov Z		1.521	0.639	0.919	0.977
Asymp. Sig. (2-tailed)		**0.02**	**0.808**	**0.367**	**0.296**

		My commute to campus limits the amount of time I spend studying	My living conditions are favorable to studying	Where I live makes it hard for me to study with my peers	Volunteering or working during the school year limits the amount of time I spend studying
Most Extreme Differences	Absolute	0.127	0.046	0.051	0.078
	Positive	0	0.046	0.051	0
	Negative	-0.127	-0.044	-0.051	-0.078
Kolmogorov-Smirnov Z		1.232	0.503	0.547	0.788
Asymp. Sig. (2-tailed)		**0.096**	**0.962**	**0.926**	**0.563**

Appendix C: Interview consent form

THE UNIVERSITY OF BRITISH COLUMBIA

Carl Wieman Science Education Initiative (CWSEI)
University of British Columbia
Wesbrook Bldg.
#300- 6174 University Blvd.
Vancouver, BC Canada V6T 1Z3

Tel: (604) 827-3119
Fax: (604) 827-3118

Interview Consent Form

Investigating the Factors Influencing Students' Academic Performance in Math and Science

Principal Investigator: Dr. Carl Wieman
Carl Wieman Science Education Initiative (CWSEI)

Co-Investigator: Ashley Welsh
Graduate Student/Faculty of Education

Study Team Members/Researchers:
Jackie Stewart, Chemistry
George Spiegelman, Life Sciences
Jared Taylor, Life Sciences
Jim Carolan, Physics & Astronomy
Costanza Piccolo, Mathematics
Benjamin Yu, Computer Science

You are invited to participate in a study aimed at determining the academic, social and personal factors that students' perceive as important to influencing their academic performance in math and science courses at UBC. The Carl Wieman Science Education Initiative (CWSEI) will conduct this study. Conclusions may be published in some form and/or presented publicly, but without any information that could be used to identify you. If interested in the outcome of this study, the published results will be made available to you by one of the researchers.

Purpose:
The purpose of this study is to provide a more thorough understanding as to the reasons influencing students' academic performance within the math and sciences at UBC. One-on-one interviews will be conducted with students from all grade levels and grade point averages to elaborate on their undergraduate academic experiences. The interviews will

impart valuable insight regarding students' perceptions as to the factors influencing their educational experience.

Study Procedures:
Your participation will involve completing a one-on-one interview with a researcher to discuss your undergraduate academic experience. The interviewer will ask questions regarding your perception as to how study habits, living arrangements, gender, ethnicity, curriculum, courses, classroom instructors, teaching and grading methods, etc. might influence your academic success. You have the right to refuse responding to questions you are not comfortable answering. Typical interviews will last no more than one hour. An additional interview of 15-30 minutes in length might be required to ensure the researcher has accurately interpreted your answers. All interviews will be audio and video recorded.

This study aims to conduct a full exploration of the academic and social factors influencing students' academic success. The academic factors might include high school and university grades, program details, previous institutions attended, registration add/drops, and registration status. The social factors might include age, gender, citizenship, primary language, and living arrangements. If you choose to complete an interview, you will be contacted via e-mail by a researcher to set up an interview time.

Potential Risks:
This research poses minimal risk.

Potential Benefits:
You might benefit directly from participating in this study. After their analysis of the interview, the researcher might encourage you to seek applicable support services, which address your academic and personal needs.

The benefits to you are indirect; these interviews are part of a major UBC initiative to improve science education. Your input is an essential component in understanding what educational approaches are working well and where further improvements are needed. This may result in improvements to science courses you take in future semesters.

The benefits to society in general will be improved science education that most students will find more interesting and relevant to their lives.

Confidentiality:
Your confidentiality will be respected. Interviews will be transcribed and no one except the researchers will have access to your identity. The interviewer will not be an instructor of any course in which you are currently enrolled. Any written or printed out materials with identifiable information will be stored in a locked filing cabinet and will not be available to any of your current instructors. Any information in electronic format will be stored on password protected computers. No individual student identifiers will be used in any published or publicly presented work.

Remuneration/Compensation:
Upon the completion of an interview, you will be paid a monetary value of $15/hr with a half-an-hour minimum.

Contact for information about the study:
If you have any questions or would like further information about this study, you may contact the following researcher:

Education Ashley Welsh

Contact for concerns about the rights of research subjects:
If you have any concerns about your treatment or rights as a research subject, you may contact the Research Subject Information Line in the UBC Office of Research Services at 604-822-8598 or if long distance e-mail to RSIL@ors.ubc.ca.

Consent:
Your participation in this study is entirely voluntary and you may refuse to participate or withdraw from the study at any time without jeopardy to your class standing.

*Please bring this signed consent form with you to your interview and present it to the researcher.

Your signature below indicates that you have received a copy of this consent form for your own records.

Your signature indicates that you consent to participate in this study.

_____
Participant's Signature Date

_____
Printed Name of the Participant signing above

Appendix D: Focus group discussion consent form

THE UNIVERSITY OF BRITISH COLUMBIA

Carl Wieman Science Education Initiative (CWSEI)
University of British Columbia
Wesbrook Bldg.
#300- 6174 University Blvd.
Vancouver, BC Canada V6T 1Z3

Tel: (604) 827-3119
Fax: (604) 827-3118

Focus Group Discussion Consent Form

Investigating the Factors Influencing Students' Academic Performance Within the Math and Sciences

Principal Investigator: Dr. Carl Wieman
Carl Wieman Science Education Initiative (CWSEI)

Co-Investigator: Ashley Welsh
Graduate Student/Faculty of Education

Study Team Members/Researchers:
Jackie Stewart, Chemistry
George Spiegelman, Life Sciences
Jared Taylor, Life Sciences
Jim Carolan, Physics & Astronomy
Costanza Piccolo, Mathematics
Benjamin Yu, Computer Science

You are invited to participate in a study aimed at determining the factors influencing students' academic performance within the math and sciences at UBC. The Carl Wieman Science Education Initiative (CWSEI) will conduct this study. Conclusions may be published in some form and/or presented publicly, but without any information that could be used to identify you. If interested in the outcome of this study, the published results will be made available to you by one of the researchers. The data collected during the focus group discussion might be used for the co-investigator's master's thesis.

Purpose:
The purpose of this study is to provide a more thorough understanding as to the factors influencing students' academic performance within the math and sciences at UBC. Focus groups discussions will be conducted with students from all grade levels and grade point averages to elaborate on their undergraduate academic experiences (focus groups will be made up of 6-9 students). The focus group discussions will impart valuable insight

regarding students' perceptions as to the factors influencing students' academic performance.

Study Procedures:
Your participation will involve completing a focus group discussion with 5-8 of your peers and a researcher to discuss your undergraduate academic experience. The researcher will ask questions regarding your perception as to how study habits, living arrangements, gender, ethnicity, curriculum, courses, classroom instructors, teaching and grading methods, etc. might influence your academic performance. You have the right to refuse responding to questions you are not comfortable answering. Typical discussions will last no more than one hour. All focus group discussions will be audio and video recorded.

This study aims to conduct a full exploration of the academic and social factors influencing students' academic performance. The academic factors might include high school and university grades, program details, previous institutions attended, registration add/drops, and registration status. The social factors might include age, gender, citizenship, primary language, and living arrangements. If you choose to participate in a focus group discussion, you will be contacted via e-mail by a researcher to set choose a timeslot.

Potential Risks:
This research poses minimal risk.

Potential Benefits:
You might benefit directly from participating in this study. After their analysis of the discussion, the researcher might encourage you to seek applicable support services, which address your academic and personal needs.

The benefits to you are indirect; these focus group discussions are part of a major UBC initiative to improve science education. Your input is an essential component in understanding what educational approaches are working well and where further improvements are needed. This may result in improvements to science courses you take in future semesters.

The benefits to society in general will be improved science education that most students will find more interesting and relevant to their lives.

Confidentiality:
Your confidentiality will be respected, but cannot be guaranteed in the group setting. Discussions will be transcribed and no one except the researchers will have access to your identity. The researcher will not be an instructor of any course in which you are currently enrolled. Any written or printed out materials with identifiable information will be stored in a locked filing cabinet and will not be available to any of your current instructors. Any information in electronic format will be stored on password protected

computers. No individual student identifiers will be used in any published or publicly presented work.

Remuneration/Compensation:
Upon the completion of the focus group discussion, you will be paid a monetary value of $10/hr with a half-an-hour minimum.

Contact for information about the study:
If you have any questions or would like further information about this study, you may contact Ashley Welsh.

Contact for concerns about the rights of research subjects:
If you have any concerns about your treatment or rights as a research subject, you may contact the Research Subject Information Line in the UBC Office of Research Services at 604-822-8598 or if long distance e-mail to RSIL@ors.ubc.ca.

Consent:
Your participation in this study is entirely voluntary and you may refuse to participate or withdraw from the study at any time without jeopardy to your class standing.

*Please bring this signed consent form with you to your focus group discussion and present it to the researcher.

Your signature below indicates that you have received a copy of this consent form for your own records.

Your signature indicates that you consent to participate in this study.

_____
Participant's Signature Date

_____
Printed Name of the Participant signing above

Appendix E: Interview questions

Demographic questions

- What is your major/department? Year of study? Average grade for courses at UBC? Citizenship? Ethnicity? Living Arrangements?

1. Can you tell me what your experience as a student in the sciences at UBC has been like?

Academic-based questions

You mentioned the role of the **instructor**, what qualities do you hope for in a course instructor?

- What makes the instructor or their teaching interesting, good, helpful?
- How have active learning techniques been introduced?

What is your preferred method of **note-taking** in lecture?

- Can you explain why this is so?

How do you feel about the **workload** you have had during your time as a student?

- How did you manage it (your time)?
- How have you been **assessed** throughout your degree? Does that work well for you?

What do you do if you're having **difficulty understanding the coursework**?

- Have you noticed any change during your degree?
- How might this affect your **confidence** in your academic abilities?
- Do you seek out help when needed?

Have you ever used any **academic resources** to assist with your learning?

- If so, what have your experiences been like?
- If not, why have you not sought to use them?

From your perspective, what are '**good' grades**?

- How much emphasis do you put on your grades?
- Did you experience a drop in your high school to university grades? If so, how have you coped with that? What did you learn from this?

How might **high school** classes **prepared** you for your degree?

- What did you learn from this?

Please describe your **study habits**.

- Where or how did you learn your habits?
- How have they changed during your degree?
- How might you improve your study habits?

- Do you typically study on your own or with others?

Social- & Personal-based questions

What were your reasons for **choosing your major**?
- How important was this persons' influence on your choice?
- How satisfied are you with your choice of major? (interest)
- What type of job/profession do you hope to attain upon the completion of your degree?
- Has your perspective changed throughout your university experience?

Are you satisfied with your **parents' involvement** in your education?
- What role have they played?
- How do you deal with this pressure?
- What makes their involvement important to you?

Where to you **live**?
- Does that work well for you?
- What about… studying with peers, commuting, access to resources?

Do you have any **other major responsibilities** outside of school (work, volunteering, extra-curricular?)
- If so, how does that work for you?

Closing Questions

When looking back, what would you keep the **same** about your degree? What would be the most important things to **change**?

If you could give some **advice** to students as to how to be successful in the sciences, what would it be?

If you had to indicate the **3 most important factors** influencing your academic performance, what would they be and why?

Appendix F: Focus group discussion questions

Go around the table and ask each person:

- What is your year of study? Major/department? Average grade for courses at UBC? Citizenship? Ethnicity? Living arrangements?

Ask the students to write the top 5 factors they perceive as influencing their academic performance on the piece of paper provided. Instruct students to then fold this paper and leave it until the end of the discussion.

Ask each student to talk about their experience in science at UBC.

If you were given the responsibility of teaching and organizing a science class, what type of teaching and assessment methods would you use?

- Why would you use these?
- Why do you prefer that method?
- How would you address students' difficulties, stress, anxieties?

How has your work ethic changed over the years?

- What has been influential your academic performance?
- What would you do to improve your work ethic?

How might the influence of others affect your academic performance?

- How has this changed over the course of your degree?

If you could change three things about your undergraduate experience, what would they be?

- What was your reasoning for choosing these?
- What would you keep the same or what did you enjoy?

Refer the students back to the top 5 factors they wrote down earlier and ask them to share them with the group.

- Why did you choose these factors?
- How has your opinion changed now that you have heard everyone else's responses?
- How would you rank the importance of these factors?

Appendix G: Coding scheme for interview and focus group discussion analysis

Coding Symbol	Code	Types of Comments
QoI	Quality of an Instructor	• Approachable, interesting, organized, clear, knowledgeable, good to approach for guidance •
L/NT	Lecturing methods and note-taking in lecture	• Written notes and Power Point slides • Pace of lecture • What is effective/not effective • Active learning techniques •
GtoC	What makes students want to go to class	• Interest in the material • Professor • Lecture gives you more than notes alone • Friends •
Expec	Informing students as to what is expected of them	• Relevant practice problems that reflect testing • Learning goals • Course, unit or assessment outlines •
AM	Frequency and balance of assessment methods throughout the year	• What they have experienced and prefer (1 or 2 midterms, assignments, finals, etc.) • Timely or not so timely feedback •
Gr	Grades	• How much emphasis the student puts on their grades • What do they consider 'good' grades • Coping with drop in grades from High School •
CD	Conceptual Difficulties	• Process of ameliorating their understanding • How does it affect their confidence •
CW/L	Dealing with the coursework and courseload in math and science	• Taking less courses a term • Difficulty transitioning (keeping up with the material) • Summer courses • How students' choose their courses •
SH	Study Habits and High School Preparation	• Time management, not cramming, good practice problems, working with others, distributing attention to all courses • Difficult transition from high school to university • Trying to adapt and develop study habits (struggle of not knowing how) • Change that has occurred
R4Ch	Reasons for Choice of Major	• Interest, parental influences • If they changed their major, why so? • Job/career hopes/ Finding direction •
OI	Influence that "others" involvement might have on the student	• Parental pressure/encouragement • Friend/Partner support
LA	Effects that living arrangements have on	• Commuting • Pros/cons of living on/off-campus

Coding Symbol	Code	Types of Comments
	the students' academics/experience	• Access to resources • Involvement on-campus
OR	The effect of other responsibilities	• Volunteering, work • Priorities • Finding balance •
App/WE	Application/Work Experience	• Experience in field of interest • Seeing connections b/w subject and real world •
Comm	Community	• Social and Academic • Interactions with peers, faculty, staff • Making friends •
Per	Personal qualities	• Stress, anxiety, struggle, motivated, interest, overwhelm •

- Transition, interest, things to change: prereqs, advising
- Advice: related to studying, professor, community/friends, seeking help
- Language: lost, frustrated, stuck, lonely, interest, motivated, waste of time

Appendix H: Ethics certificate of approval H09-00998

The University of British Columbia
Office of Research Services
Behavioural Research Ethics Board
Suite 102, 6190 Agronomy Road,
Vancouver, B.C. V6T 1Z3

CERTIFICATE OF APPROVAL - MINIMAL RISK

PRINCIPAL INVESTIGATOR:	INSTITUTION / DEPARTMENT:	UBC BREB NUMBER:
Carl Wieman	UBC/Science/Physics and Astronomy	H09-00998

INSTITUTION(S) WHERE RESEARCH WILL BE CARRIED OUT:

Institution	Site
UBC	Vancouver (excludes UBC Hospital)

Other locations where the research will be conducted:
There may be some collaboration with the University of Colorado, Boulder to complete the student survey. The findings from their research may be used for statistical analysis and comparison of the research populations. However, the University of Colorado, Boulder already has been granted approval from its own human research ethics board to conduct this research.

CO-INVESTIGATOR(S):
Ashley J. Welsh

SPONSORING AGENCIES:
UBC Carl Wieman Science Education Initiative

PROJECT TITLE:
Investigating the Reasons Influencing Student Failure Within the Math and Sciences

CERTIFICATE EXPIRY DATE: June 26, 2010

DOCUMENTS INCLUDED IN THIS APPROVAL:	DATE APPROVED: June 26, 2009	
Document Name	**Version**	**Date**
Protocol:		
Protocol for Student Failure Investigation	N/A	May 28, 2009
Consent Forms:		
Interview Consent Form	N/A	May 28, 2009
Questionnaire, Questionnaire Cover Letter, Tests:		
Survey and Interview Description	N/A	April 24, 2009
Letter of Initial Contact:		
Introductory Interview Letter	N/A	May 28, 2009
Introductory Survey Letter	N/A	May 28, 2009
Other:		
N/A		

The application for ethical review and the document(s) listed above have been reviewed and the procedures were found to be acceptable on ethical grounds for research involving human subjects.

Approval is issued on behalf of the Behavioural Research Ethics Board and signed electronically by one of the following:

Dr. M. Judith Lynam, Chair
Dr. Ken Craig, Chair
Dr. Jim Rupert, Associate Chair
Dr. Laurie Ford, Associate Chair
Dr. Anita Ho, Associate Chair

Appendix I: Ethics certificate of approval H09-00998 amendment and yearly renewal

The University of British Columbia
Office of Research Services
Behavioural Research Ethics Board
Suite 102, 6190 Agronomy Road,
Vancouver, B.C. V6T 1Z3

CERTIFICATE OF APPROVAL - AMENDMENT & RENEWAL

PRINCIPAL INVESTIGATOR:	DEPARTMENT:	UBC BREB NUMBER:
Carl Wieman	UBC/Science/Physics and Astronomy	H09-00998

INSTITUTION(S) WHERE RESEARCH WILL BE CARRIED OUT:

Institution	Site
UBC	Vancouver (excludes UBC Hospital)

Other locations where the research will be conducted:
There may be some collaboration with the University of Colorado, Boulder to complete the student survey. The findings from their research may be used for statistical analysis and comparison of the research populations. However, the University of Colorado, Boulder already has been granted approval from its own human research ethics board to conduct this research.

CO-INVESTIGATOR(S):
Ashley J. Welsh

SPONSORING AGENCIES:
UBC Carl Wieman Science Education Initiative

PROJECT TITLE:
Investigating the Factors Influencing Students' Academic Performance Within the Math and Sciences

CERTIFICATE EXPIRY DATE: June 8, 2011

AMENDMENT(S):	RENEWAL AND AMENDMENT APPROVAL DATE: June 8, 2010

Document Name	Version	Date
Consent Forms:		
Focus Group Discussion Consent Form	N/A	May 27, 2010
Interview Consent Form	N/A	May 27, 2010
Letter of Initial Contact:		
Introductory Letter for Focus Group Discussions	N/A	May 27, 2010
Introductory Letter for Interviews	N/A	May 27, 2010
Introductory Letter for Survey	N/A	May 27, 2010
Other:		
N/A		

The application for continuing ethical review and the amendment(s) for the above-named project have been

reviewed and the procedures were found to be acceptable on ethical grounds for research involving human subjects.

Approval is issued on behalf of the Behavioural Research Ethics Board and signed electronically by one of the following:

Dr. M. Judith Lynam, Chair
Dr. Ken Craig, Chair
Dr. Jim Rupert, Associate Chair
Dr. Laurie Ford, Associate Chair
Dr. Anita Ho, Associate Chair

Appendix J: Descriptive frequency charts for overall students, males and females

OVERALL

Ability for the instructor to make the course interesting

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Important	261	53.0	53.3	53.3
	Important	177	36.0	36.1	89.4
	Somewhat Important	39	7.9	8.0	97.3
	Slightly Important	8	1.6	1.6	99.0
	Unimportant	5	1.0	1.0	100.0
	Total	490	99.6	100.0	

The instructor's ability to speak English clearly

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Important	221	44.9	45.1	45.1
	Important	189	38.4	38.6	83.7
	Somewhat Important	64	13.0	13.1	96.7
	Slightly Important	13	2.6	2.7	99.4
	Unimportant	3	.6	.6	100.0
	Total	490	99.6	100.0	

Developing and adapting study habits for university courses

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Important	215	43.7	44.5	44.5
	Important	194	39.4	40.2	84.7
	Somewhat Important	54	11.0	11.2	95.9
	Slightly Important	10	2.0	2.1	97.9
	Unimportant	10	2.0	2.1	100.0
	Total	483	98.2	100.0	

My uncertainty in knowing what types and difficulties of problems will be asked on a midterm or final exam is an _____ factor limiting my academic performance.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Important	165	33.5	34.0	34.0
	Important	186	37.8	38.3	72.2
	Somewhat Important	96	19.5	19.8	92.0
	Slightly Important	28	5.7	5.8	97.7
	Unimportant	11	2.2	2.3	100.0
	Total	486	98.8	100.0	

The lack of relevant practice problems to complete before an exam was a/an _____ factor influencing how well I performed on exams

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very Important	229	46.5	47.7	47.7
	Important	170	34.6	35.4	83.1
	Somewhat Important	59	12.0	12.3	95.4
	Slightly Important	18	3.7	3.8	99.2
	Unimportant	4	.8	.8	100.0
	Total	480	97.6	100.0	

It is important for me to succeed academically

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	161	32.7	32.8	32.8
	Strongly Agree	321	65.2	65.4	98.2
	Neutral	8	1.6	1.6	99.8
	Disagree	1	.2	.2	100.0
	Total	491	99.8	100.0	

Receiving encouragement from my parents/family/guardians assists my academic performance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	143	29.1	29.9	29.9
	Agree	222	45.1	46.3	76.2
	Neutral	81	16.5	16.9	93.1
	Disagree	21	4.3	4.4	97.5
	Strongly Disagree	12	2.4	2.5	100.0
	Total	479	97.4	100.0	

Volunteering or working during the school year limits the amount of time I spend studying

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	116	23.6	27.2	27.2
	Agree	183	37.2	42.9	70.0
	Neutral	71	14.4	16.6	86.7
	Disagree	48	9.8	11.2	97.9
	Strongly Disagree	9	1.8	2.1	100.0
	Total	427	86.8	100.0	

MALES AND FEMALES

Ability for the instructor to make the course interesting

What is your sex?			Frequency	Percent	Valid Percent	Cumulative Percent
Male	Valid	Very Important	100	48.8	49.3	49.3
		Important	71	34.6	35.0	84.2
		Somewhat Important	20	9.8	9.9	94.1
		Slightly Important	7	3.4	3.4	97.5
		Unimportant	5	2.4	2.5	100.0
		Total	203	99.0	100.0	
Female	Valid	Very Important	161	56.1	56.1	56.1
		Important	106	36.9	36.9	93.0
		Somewhat Important	19	6.6	6.6	99.7
		Slightly Important	1	.3	.3	100.0
		Total	287	100.0	100.0	

The instructor's ability to speak English clearly

What is your sex?			Frequency	Percent	Valid Percent	Cumulative Percent
Male	Valid	Very Important	97	47.3	47.5	47.5
		Important	69	33.7	33.8	81.4
		Somewhat Important	28	13.7	13.7	95.1
		Slightly Important	8	3.9	3.9	99.0
		Unimportant	2	1.0	1.0	100.0
		Total	204	99.5	100.0	
Female	Valid	Very Important	124	43.2	43.4	43.4
		Important	120	41.8	42.0	85.3
		Somewhat Important	36	12.5	12.6	97.9
		Slightly Important	5	1.7	1.7	99.7
		Unimportant	1	.3	.3	100.0
		Total	286	99.7	100.0	

The approachability of your instructor

What is your sex?			Frequency	Percent	Valid Percent	Cumulative Percent
Male	Valid	Very Important	41	20.0	20.1	20.1
		Important	82	40.0	40.2	60.3
		Somewhat Important	56	27.3	27.5	87.7
		Slightly Important	14	6.8	6.9	94.6
		Unimportant	11	5.4	5.4	100.0
		Total	204	99.5	100.0	
Female	Valid	Very Important	88	30.7	30.8	30.8
		Important	118	41.1	41.3	72.0
		Somewhat Important	63	22.0	22.0	94.1
		Slightly Important	13	4.5	4.5	98.6
		Unimportant	4	1.4	1.4	100.0
		Total	286	99.7	100.0	

The number of students in the class

What is your sex?			Frequency	Percent	Valid Percent	Cumulative Percent
Male	Valid	Very Important	18	8.8	8.9	8.9
		Important	47	22.9	23.2	32.0
		Somewhat Important	62	30.2	30.5	62.6
		Slightly Important	40	19.5	19.7	82.3
		Unimportant	36	17.6	17.7	100.0
		Total	203	99.0	100.0	
Female	Valid	Very Important	39	13.6	13.7	13.7
		Important	62	21.6	21.8	35.4
		Somewhat Important	112	39.0	39.3	74.7
		Slightly Important	48	16.7	16.8	91.6
		Unimportant	24	8.4	8.4	100.0
		Total	285	99.3	100.0	

Your comfort in being able to ask questions in class

What is your sex?			Frequency	Percent	Valid Percent	Cumulative Percent
Male	Valid	Very Important	39	19.0	19.4	19.4
		Important	67	32.7	33.3	52.7
		Somewhat Important	62	30.2	30.8	83.6
		Slightly Important	23	11.2	11.4	95.0
		Unimportant	10	4.9	5.0	100.0
		Total	201	98.0	100.0	
Female	Valid	Very Important	54	18.8	19.2	19.2
		Important	110	38.3	39.1	58.4
		Somewhat Important	76	26.5	27.0	85.4
		Slightly Important	31	10.8	11.0	96.4
		Unimportant	10	3.5	3.6	100.0
		Total	281	97.9	100.0	

The use of in-class learning techniques (i.e. clickers, group activities)

What is your sex?			Frequency	Percent	Valid Percent	Cumulative Percent
Male	Valid	Very Important	18	8.8	8.9	8.9
		Important	48	23.4	23.6	32.5
		Somewhat Important	57	27.8	28.1	60.6
		Slightly Important	36	17.6	17.7	78.3
		Unimportant	44	21.5	21.7	100.0
		Total	203	99.0	100.0	
Female	Valid	Very Important	33	11.5	11.6	11.6
		Important	84	29.3	29.5	41.1
		Somewhat Important	91	31.7	31.9	73.0
		Slightly Important	53	18.5	18.6	91.6
		Unimportant	24	8.4	8.4	100.0
		Total	285	99.3	100.0	

Developing and adapting study habits for university courses

What is your sex?			Frequency	Percent	Valid Percent	Cumulative Percent
Male	Valid	Very Important	80	39.0	39.8	39.8
		Important	79	38.5	39.3	79.1
		Somewhat Important	27	13.2	13.4	92.5
		Slightly Important	7	3.4	3.5	96.0
		Unimportant	8	3.9	4.0	100.0
		Total	201	98.0	100.0	
Female	Valid	Very Important	135	47.0	47.9	47.9
		Important	115	40.1	40.8	88.7
		Somewhat Important	27	9.4	9.6	98.2
		Slightly Important	3	1.0	1.1	99.3
		Unimportant	2	.7	.7	100.0
		Total	282	98.3	100.0	

My uncertainty in knowing what types and difficulties of problems will be asked on a midterm or final exam is an _____ factor limiting my academic performance.

What is your sex?			Frequency	Percent	Valid Percent	Cumulative Percent
Male	Valid	Very Important	57	27.8	28.2	28.2
		Important	82	40.0	40.6	68.8
		Somewhat Important	42	20.5	20.8	89.6
		Slightly Important	14	6.8	6.9	96.5
		Unimportant	7	3.4	3.5	100.0
		Total	202	98.5	100.0	
Female	Valid	Very Important	108	37.6	38.0	38.0
		Important	104	36.2	36.6	74.6
		Somewhat Important	54	18.8	19.0	93.7
		Slightly Important	14	4.9	4.9	98.6
		Unimportant	4	1.4	1.4	100.0
		Total	284	99.0	100.0	

The lack of relevant practice problems to complete before an exam was a/an _____ factor influencing how well I performed on exams

What is your sex?			Frequency	Percent	Valid Percent	Cumulative Percent
Male	Valid	Very Important	78	38.0	38.8	38.8
		Important	74	36.1	36.8	75.6
		Somewhat Important	35	17.1	17.4	93.0
		Slightly Important	11	5.4	5.5	98.5
		Unimportant	3	1.5	1.5	100.0
		Total	201	98.0	100.0	
Female	Valid	Very Important	151	52.6	54.1	54.1
		Important	96	33.4	34.4	88.5
		Somewhat Important	24	8.4	8.6	97.1
		Slightly Important	7	2.4	2.5	99.6
		Unimportant	1	.3	.4	100.0
		Total	279	97.2	100.0	

It is important for me to succeed academically

What is your sex?			Frequency	Percent	Valid Percent	Cumulative Percent
Male	Valid	Agree	73	35.6	35.8	35.8
		Strongly Agree	123	60.0	60.3	96.1
		Neutral	7	3.4	3.4	99.5
		Disagree	1	.5	.5	100.0
		Total	204	99.5	100.0	
Female	Valid	Agree	88	30.7	30.7	30.7
		Strongly Agree	198	69.0	69.0	99.7
		Neutral	1	.3	.3	100.0
		Total	287	100.0	100.0	

Receiving encouragement from my parents/family/guardians assists my academic performance

What is your sex?			Frequency	Percent	Valid Percent	Cumulative Percent
Male	Valid	Strongly Agree	43	21.0	21.6	21.6
		Agree	99	48.3	49.7	71.4
		Neutral	42	20.5	21.1	92.5
		Disagree	9	4.4	4.5	97.0
		Strongly Disagree	6	2.9	3.0	100.0
		Total	199	97.1	100.0	
Female	Valid	Strongly Agree	100	34.8	35.7	35.7
		Agree	123	42.9	43.9	79.6
		Neutral	39	13.6	13.9	93.6
		Disagree	12	4.2	4.3	97.9
		Strongly Disagree	6	2.1	2.1	100.0
		Total	280	97.6	100.0	

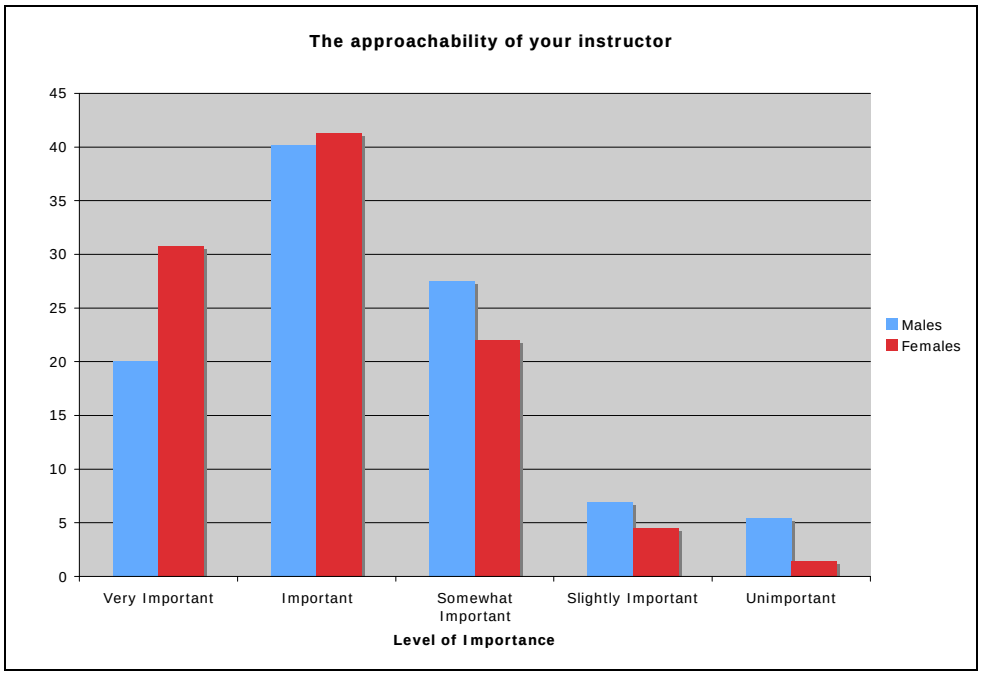
Suggestions from parents, teachers and/or advisors influenced my decision to major in math and/or science

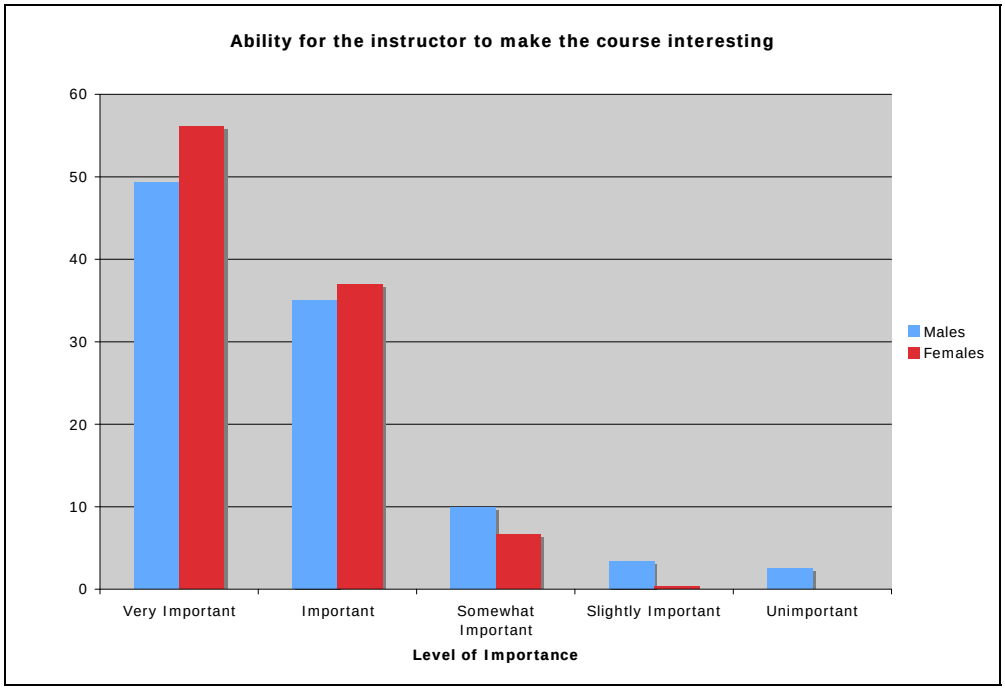
What is your sex?			Frequency	Percent	Valid Percent	Cumulative Percent
Male	Valid	Strongly Agree	10	4.9	5.1	5.1
		Agree	58	28.3	29.4	34.5
		Neutral	48	23.4	24.4	58.9
		Disagree	42	20.5	21.3	80.2
		Strongly Disagree	39	19.0	19.8	100.0
		Total	197	96.1	100.0	
Female	Valid	Strongly Agree	30	10.5	10.7	10.7
		Agree	91	31.7	32.4	43.1
		Neutral	66	23.0	23.5	66.5
		Disagree	57	19.9	20.3	86.8
		Strongly Disagree	37	12.9	13.2	100.0
		Total	281	97.9	100.0	

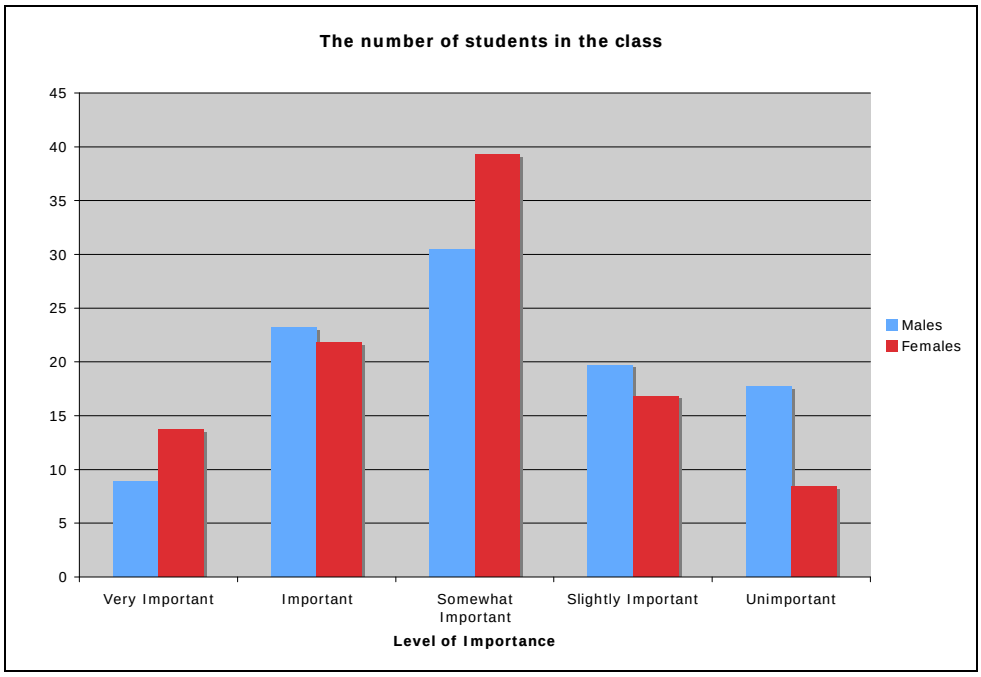
My commute to campus limits the amount of time I spend studying

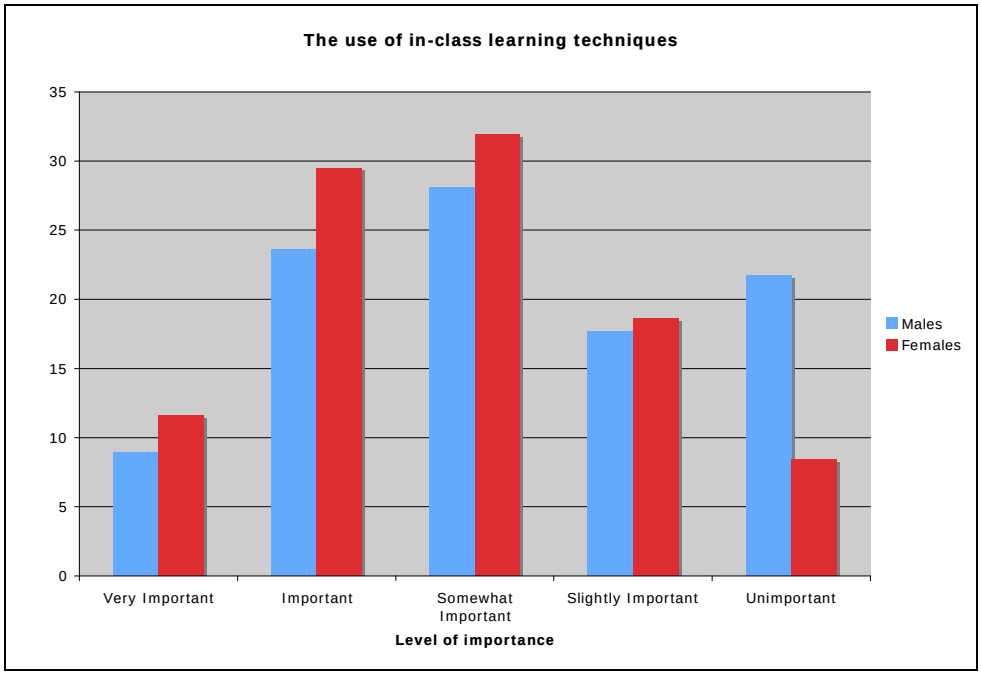
What is your sex?			Frequency	Percent	Valid Percent	Cumulative Percent
Male	Valid	Strongly Agree	37	18.0	23.0	23.0
		Agree	47	22.9	29.2	52.2
		Neutral	37	18.0	23.0	75.2
		Disagree	26	12.7	16.1	91.3
		Strongly Disagree	14	6.8	8.7	100.0
		Total	161	78.5	100.0	
Female	Valid	Strongly Agree	61	21.3	27.1	27.1
		Agree	85	29.6	37.8	64.9
		Neutral	32	11.1	14.2	79.1
		Disagree	37	12.9	16.4	95.6
		Strongly Disagree	10	3.5	4.4	100.0
		Total	225	78.4	100.0	

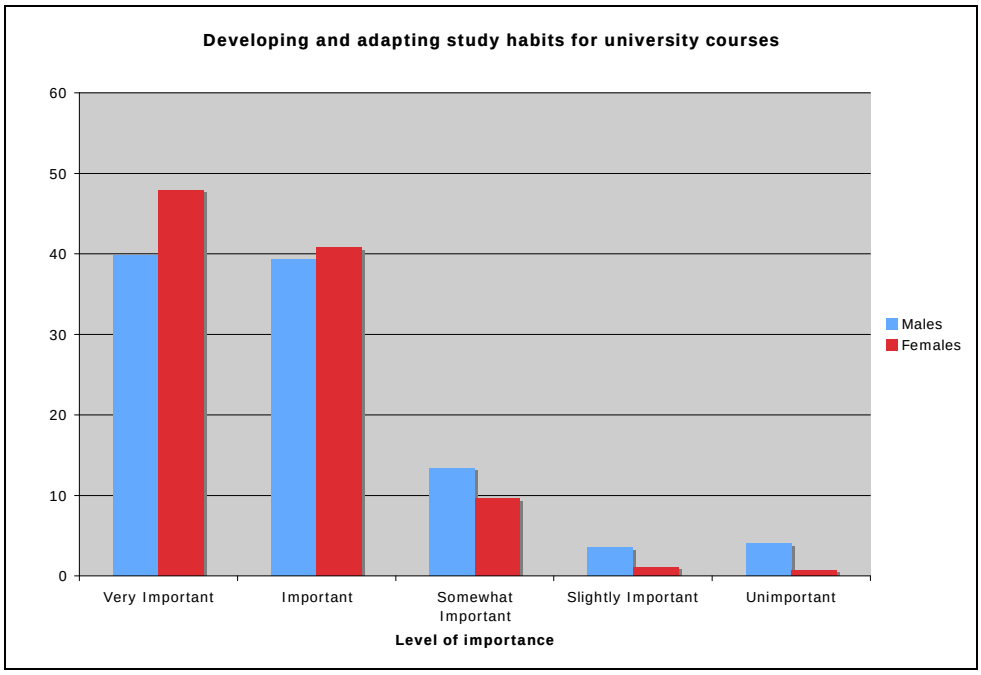
Appendix K: Bar graphs depicting males and females responses to the survey questions where significant differences were detected

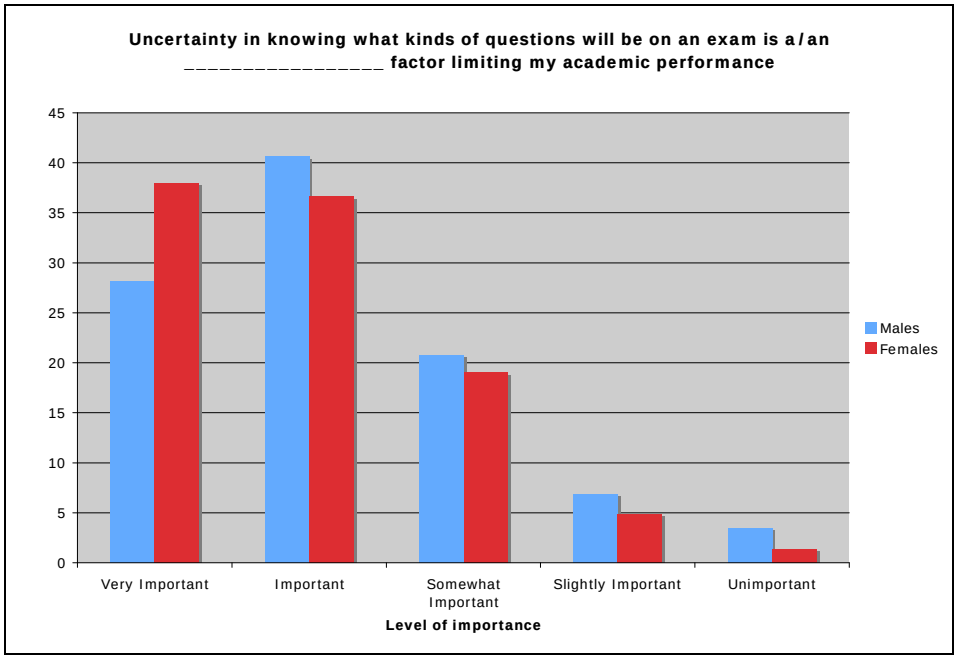


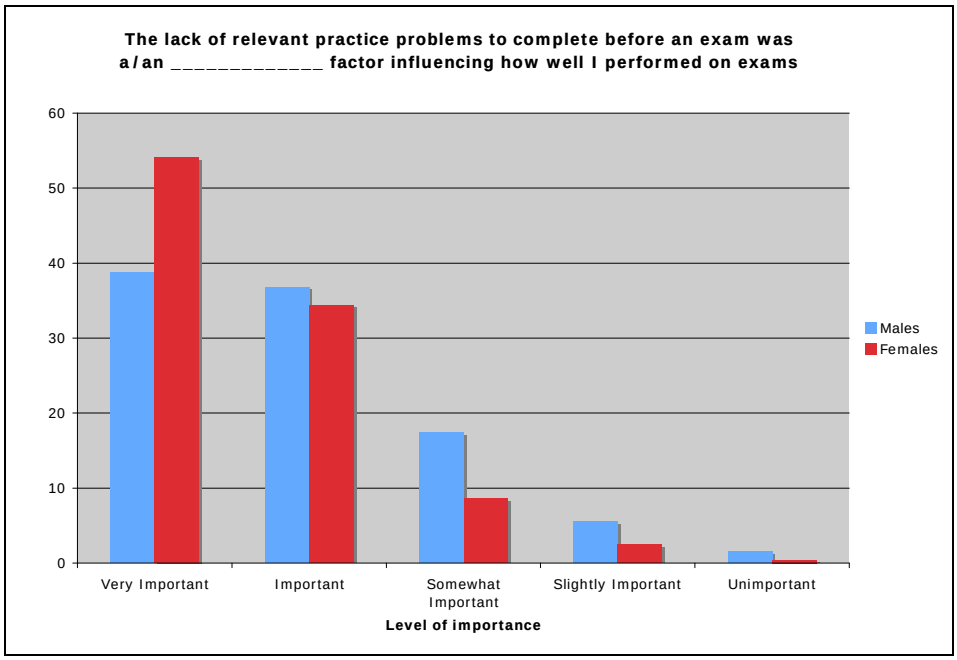


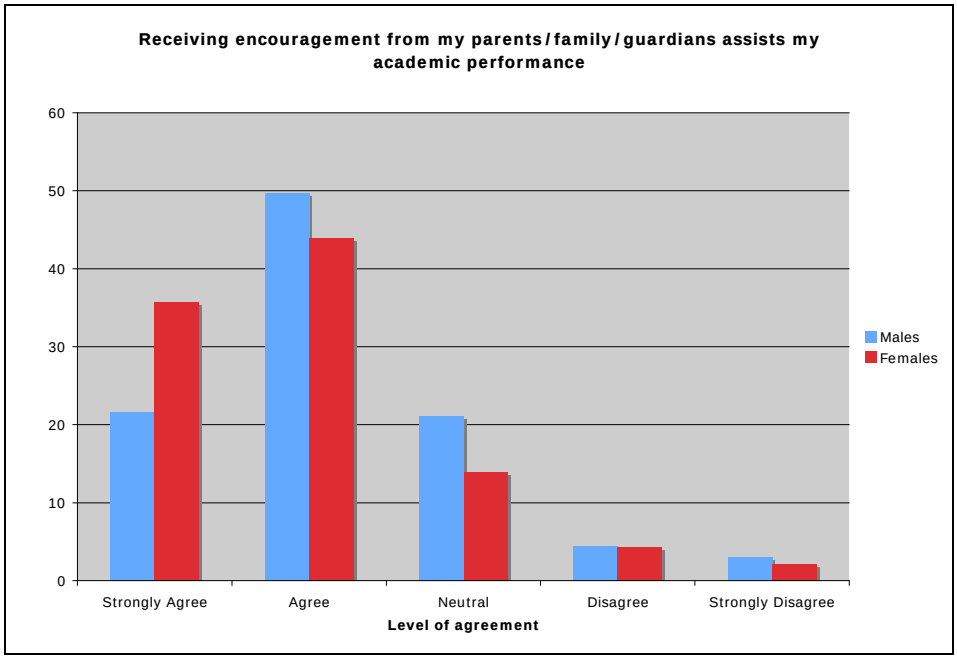

The number of students in the class
45
40
35
30
25
20
15
10
5
0
Very Important
Important
Somewhat Important
Slightly Important
Unimportant
Level of Importance
Males
Females

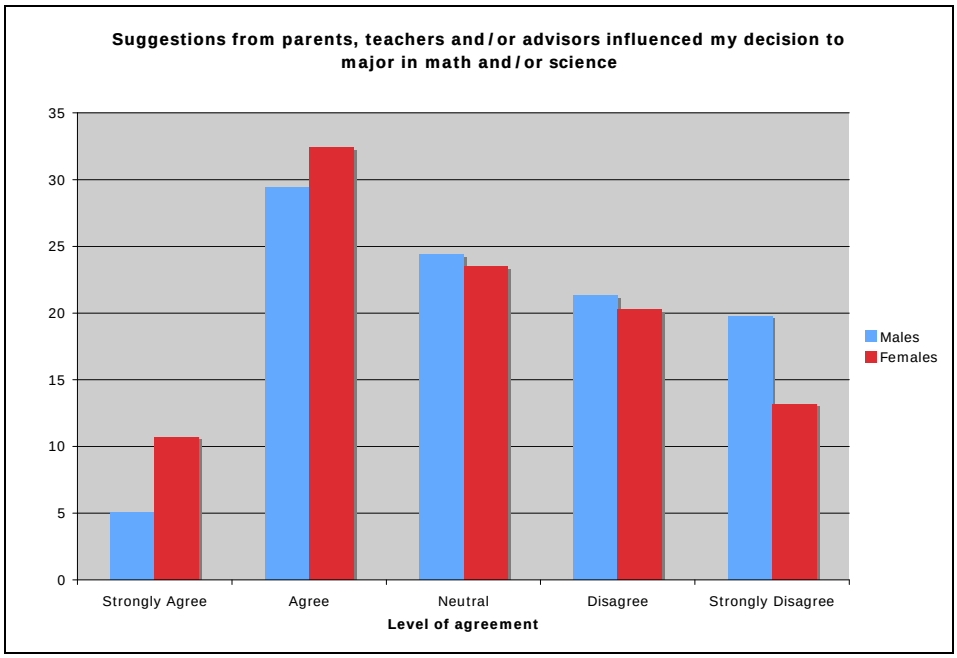

The use of in-class learning techniques
35
30
25
20
15
10
5
0
Very Important
Important
Somewhat Important
Slightly Important
Unimportant
Level of importance
Males
Females

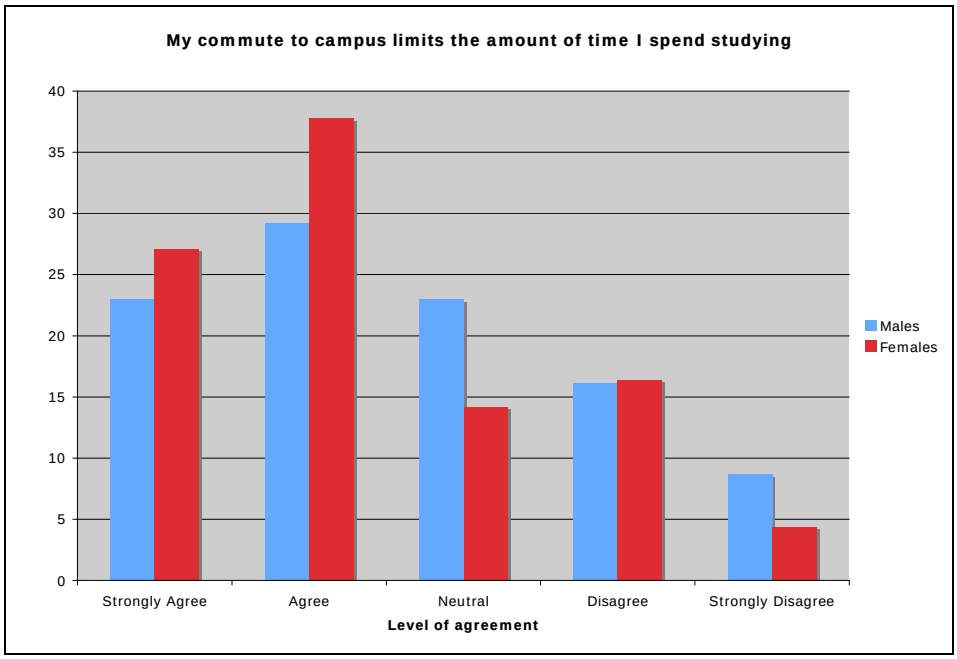

Developing and adapting study habits for university courses
60
50
40
30
20
10
0
Very Important
Important
Somewhat Important
Slightly Important
Unimportant
Level of importance
Males
Females


Uncertainty in knowing what kinds of questions will be on an exam is a/an _____ factor limiting my academic performance
45
40
35
30
25
20
15
10
5
0
Very Important
Important
Somewhat Important
Slightly Important
Unimportant
Level of importance
Males
Females


The lack of relevant practice problems to complete before an exam was a/an _____ factor influencing how well I performed on exams
60
50
40
30
20
10
0
Very Important
Important
Somewhat Important
Slightly Important
Unimportant
Level of importance
Males
Females


Receiving encouragement from my parents/family/guardians assists my academic performance
60
50
40
30
20
10
0
Strongly Agree
Agree
Neutral
Disagree
Strongly Disagree
Level of agreement
Males
Females


Suggestions from parents, teachers and/or advisors influenced my decision to major in math and/or science
35
30
25
20
15
10
5
0
Strongly Agree
Agree
Neutral
Disagree
Strongly Disagree
Level of agreement
Males
Females


My commute to campus limits the amount of time I spend studying
40
35
30
25
20
15
10
5
0
Strongly Agree
Agree
Neutral
Disagree
Strongly Disagree
Level of agreement
Males
Females