

Science Students:
Making the transition from high school to university

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Dedication

I would like to dedicate this work to three people who have always believed in me. To my Mom and Dad, thanks for all that you taught me and helping me to be the person that I am today. Dad, I wish you were here to see this. To my husband, William, thanks for your patience and support. You always seem to know what I need; be it food, sleep, or a break, you made sure that I got it!

Abstract

This qualitative study, grounded in phenomenology, investigated the experiences of first and second year university science students as they made the transition from high school to university, an area of research that has received less attention than earlier school transitions. The purpose of the study was to gain knowledge about aspects of their education both at high school and at university that might inform future practices related to school/university transitions. The primary source of data for the study was in-depth, semi-structured interviews. Document analysis of curriculum guides for core science subjects and both high school and university course outlines provided supporting data. Thematic analysis of the interview transcripts, using a grounded theory approach, revealed that students were generally satisfied with their high school education in terms of curriculum covered. Analysis of the curriculum documents showed a significant correlation between the curriculum at high school and university and thus supported the students' observations about curriculum coherence between the two levels. Students' concerns related to their preparation for university focused on the following: studying, independent work habits, problem solving, and critical thinking. The students critiqued their university teachers in regard to their over-reliance on exams for assessment and evaluation, and the dominance of teacher-directed methodologies that limit classroom interaction. Insights from this study will help to inform my future teaching practices. More broadly, the results may guide changes at the high school and university levels that may contribute to a smoother transition from

high school to university leading to better student performance, reduced drop out rates, and increased interest in science programs.

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CHAPTER I: INTRODUCTION

1.1 Background

Making the transition to university from high school was difficult for me and affected my overall academic standing during my first year of study. As a teacher I hope to provide a learning experience that better enables students to make a smooth transition. My research investigated the experiences of some of my past students as they navigated through this transition. The topic of this thesis developed over a two year period of time as I reflected on my past experiences both within and outside school. This section discusses key experiences that have impacted my development as a learner, a teacher, and a researcher. It was a combination of these experiences and personal reflection that led to the interest and passion that I have for this research.

1.1.1 Learning to "Do School"

When I was five years old I was very excited about going to school and had been looking forward to the experience. I was often playing teacher at the little chalkboard in my kitchen and could not wait to go to school to learn more things. At the beginning of my first year of school, I was presented with an easier book than the rest of the class. I was confused by this, and although I could not put words to it at the time, years later I understood that family history had played a role in this event. Stubborn by nature, at age five I was not willing to accept this decision. I completed the easier book and presented my teacher with plenty of information to convince her that I could do the same book as everybody else, until she finally gave in.

During grade 12, my English teacher pointed out to me that my vocabulary was extremely lacking given my choice of words in my essay writing. I did not realize it at the time, and I was of course very upset with the comment, but unfortunately he was right. When I went to university the problem became more apparent. I had good reading skills but had not built a strong vocabulary. I believe that this was largely the result of my home life and had little to do with my formal education.

My first year of university was challenging, and I felt like I did not belong there a great deal of the time. My marks were mediocre, and the level of stress was high. There were many challenges both academically and socially. I did not feel at all prepared for the experience. I was the first in my immediate family to attend university and had not really talked to anybody about what to expect. I do not recall my teachers giving me any words of wisdom, or even talking about their experiences.

The first week, frosh week, was spent doing silly games and navigating the campus and then the work started. Living in residence was a blessing as well as a curse; on one hand there were fellow students working on the same assignments and on the other there was always somebody who was not working, ready to socialize. I was comfortable with the curriculum and felt that high school had prepared me in terms of the material that we covered. I was overwhelmed by

the number and length of readings we were expected to do and the lecture style classes that only covered a small portion of what was going to be on the midterm/exam. I watched the arts degree students with envy as they only had a few hours of class a day, compared to science courses that included classes and labs. The result was in essence the same time commitment as that of high school for a given day, plus all the additional work. Finding a way to balance social, academic, and outside commitments like a part time job, was a challenge for all four years, but was most evident during year one. By the time I entered year two I knew what to expect, had developed some strategies, and had started to specialize so the courses were within my area of interest. Each year seemed get easier even though the material was becoming more comprehensive.

1.1.2 Learning to "Do Science"

For as long as I can remember I wanted to be a teacher, however I made a conscious decision not to pursue teacher education after I earned my science degree. My reasoning was that if I became a teacher immediately I would only ever have been in school and would be signing up for a career that would again put me in school. The question I continued to ask myself was "What can I offer students, if my experience is limited to just school environments?" The decision to enter the work force led me to projects like water quality testing on a local river and pollution prevention practices for businesses.

Prior to going back for my education degree I was the Water Quality Project Leader for a community organization. This position required extensive use of the material that I had learned in university and of course kept me apprized of current issues in the field. It was a wonderful opportunity to apply the knowledge from university, as well as share it with the community at large as we gave presentations to schools, government agencies, and special interest groups. The knowledge that I gained from this work experience was applied and shared on many occasions during my teaching. It allowed for real world examples such as testing for dissolved oxygen in local rivers, correlating data such as sediment in waterways to weather events, and recording species of insects present in the waterways as an indicator of the health of the system. As the Project Leader for Pollution Prevention, I was able to work with a number of businesses and show them the economic benefits that were possible by adopting practices that prevented pollution. Both of these projects required numerous presentations and it was then that I realized I was happiest when I was teaching and facilitating.

1.1.3 Learning to Teach

I entered a Bachelor of Education program in 1998. As I worked my way through the education degree there were two courses that I found most valuable. I was fortunate to have a science methods professor who was passionate about his field and brought a wealth of experience to his class, from his teaching career to his scientific research. He tested us every day and made us question our own

knowledge. Some of the most basic concepts were presented to us in demonstrations and then he would ask us to explain what happened. We were often stumped, or we were insecure enough that we did not want to take a chance and then be wrong if we were to answer. In short, he often put us in the shoes of the students that we would be teaching someday, just in case we forgot what it was like. More importantly he reminded us about being curious and the need to ask questions. What I took from his class was that I needed to provide students with an environment where they want to explore and feel safe while doing so.

The other course that I found valuable was Equity in Education. There were some students who thought that the course was useless and that in Canada this should not even be an issue. They just did not seem to understand that the home life of students cannot be changed by teachers but we can provide an education that is sensitive to their background and accommodates their needs as learners. The course hit home for me because my family was from the working class and definitely below the poverty line. I never felt poor but I knew that other kids had things that I did not.

My entire family supported me throughout my education; I think that they could see that I loved school from an early age. Despite my family's limited funds, my mother bought a set of Child Craft Books which covered a range of topics, and a new book came each year. They had stories, activities, history

lessons, and cultural information. I was the youngest of seven children, with the second youngest being nine years older than I; often I felt like an only child because the others had left to build their own homes. I had a very happy childhood; however, the public education system made me aware that I was disadvantaged from an early age. The professor for the Equity course tried to make us understand that to reach our students we had to enter their world. For example, if one teaches in a community that is largely economically driven by a fishing industry, then talk “fish” in the classroom. In essence, a teacher needs to start with what students already know if they hope to teach them new material.

1.1.4 Learning from Students

In 2002 I took a teaching position in a small rural school, approximately 450 students grades 7-12, with the teaching assignment of Biology 11, Science 10, Chemistry 11 and Chemistry 12. I had been teaching grade 8 science and math at middle level in another small rural school prior to this posting. The idea of teaching senior high science was somewhat intimidating. I had not used many of the facets of my science degree education for years and was concerned about whether I was up to the task. Old insecurities were resurfacing, but all I could do was deal with them one day at a time.

Chemistry was my biggest fear because I had problems with this subject as a student and had not used it for about 10 years. I had to start in the middle of Chemistry 11 because it ran from September to June, and I started in February. I also had a Chemistry 12 class and the added stress of preparing those students

for a provincial exam. I was frank with both classes and told them it had been a while since I had done chemistry and that there would be some days where we might be learning together. The students seemed to appreciate my honesty and the term went by quickly and without any serious difficulties.

My teaching assignment has changed somewhat, I now have 9 Science, 11 and 12 Biology and 11 and 12 Chemistry each teaching year. One year I did not have 9 Science, instead it was replaced with 7 Science. Teaching at a number of grade levels exposed me to the changes that take place as the students move through the grades and the practices that we have in place to help prepare students for these transitions.

When students are in grade 6, they are given a day of orientation where they visit the middle level teachers that they will have in grade 7. There is also much information sent home such as what supplies will be needed before the start of the school year. In September, the middle school staff hosts a “Meet the teacher” evening. It is an informal meeting for parents and students to gain greater familiarity with the new setting. Prior to students entering grade 9 we hold an evening for parents and students to discuss the changes that the students will face, such as semesters, exams, elimination of homework hotline, some course options and different policies and procedures. It occurred to me as I watched these events that we do not offer much for one of the biggest transitions that takes place, high school to university. Students in grade 11 and 12 are exposed

to things like career fairs and university recruiting days, but little is done to directly prepare them for the transition. Individual students may take advantage of orientation days offered by the institution of choice, but many students arrive for first year university without having previously visited the university campus.

Teaching in a small rural school also means that there are limited course options for students. My school has only one course of biology, chemistry, and physics whereas larger schools have more options such as human biology, advanced biology, and advanced placement biology. This creates a challenging classroom environment because there are students who just want a science credit so they can graduate and there are others who are planning to major in the subject while at university. While I try to meet the needs of the individual and maintain the integrity of an academic course, I am concerned that the situation may affect my ability to deliver a course that sufficiently prepares students who are entering science degree programs. I do make a point of doing things that I feel will help these students such as directed note taking exercises and problem solving activities; however, without talking to them, I have been unsure if these practices were of any benefit. Also I have wondered if the university situation has changed significantly since my first degree and if possible changes might make my efforts antiquated. Although I did not see it at the time, a possible thesis topic was evolving.

1.1.5 Using Students as Research Informants

Through my own experiences as a learner, a biologist and a teacher I became interested in learning more about the transitions my students experience when they leave high school. As a learner, I struggled with many different kinds of transitions as I moved through school and into post-secondary education and work. As a teacher, I want to do as well as possible by my own students, making their transitions as positive as possible. In giving a focus to my research, I decided to examine the experiences of students who have made the transition from high school to university; specifically those who entered fields related to science.

1.2 Problem Statement

For the most part I felt academically prepared for university when I graduated from high school, but I had insecurities due to past experiences. My earlier educational experiences had far-reaching impact in that they affected my confidence as a learner. I did not have the experience of family members to draw upon and there was little offered to assist with the transition from high school to university. My grades in first year university were lower than those in my following years and I believe this was largely due to my lack of understanding about the environment that I was entering.

As a teacher of senior high science I want to do everything that I can to ensure that students are well prepared for the challenges that they will face after graduation. My interests are far-reaching and one of the most difficult aspects of

this research was to narrow it down to a manageable topic. After a great deal of deliberation, I decided to focus on those students who continue with science at university.

Each year a number of students graduate from high school in June, and just two short months later they start their first year of university. As a high school science teacher I was interested in the university experiences of my past students during this transition. For grade 12 students, the excitement of graduation carries throughout much of the year, and can even make teaching the graduates a challenge on some days; nonetheless, amongst the excitement there is a great deal of planning for the future.

Entering university is a school transition that differs in many ways from those already experienced by students. In many cases, previous transitions (elementary to middle and middle to high school) have been supported by the institution, family and friends. The transition to university often involves a change of address, new friends, distance between student and family, independence, as well as new academic demands. The experiences that students have during this transition could have lasting effects on their performance and future decisions, such as whether or not they will complete their program.

I heard of students who performed very well in high school having difficulties with university course work. Some of them overcome the challenges

while others quit, fail, or underachieve. It is interesting and problematic that students who perform well at the high school level do not always perform well at the university level. I wanted to investigate the factors that contribute to this underperformance and possible solutions to improve the situation.

The purpose of this study was to investigate the experiences of first and second year science students as they made the move from high school to university studies. I was interested in questions such as the following:

- What were their educational experiences and what factors were at play during their transition from high school to university, in particular within the area of science courses?
- What factors were impeding a successful transition to university and therefore preventing them from a successful completion of their program?
- What factors were beneficial?
- What would they like to change?
- What would have made the transition a better experience?

By answering these questions, I hoped to learn about my own practices within the classroom and how they impact the transition from high school to university studies.

1.3 Rationale

As a high school biology and chemistry teacher I teach many students who plan to attend university; some of whom intend to continue in science.

Interest in the subject material varies as students take courses for different reasons. They may take certain courses because of future program requirements or because choices are limited in a small school. A small number of students take the courses with the goal of attaining a degree in biology, chemistry or a related field such as nursing. While I teach to all my students, in terms of research, it was the students who continue on at university that I was most interested in for this study. I wanted to investigate what happened educationally after they left high school. There were a number of reasons that I thought this was important research to carry out.

In my review of the literature, I found that the transition from high school to university had not been studied in as much depth as the transition from elementary to middle, and middle to high school. The research on the transition from high school to university shows that the first year has the highest rate of drop outs (Cook & Leckey, 1999). In the US, 590 000 students left high school with an interest in science but this decreased by 40% after the first year of study, and by another 40% by the end of university (Coddington, 1995). There is growing concern about the number of qualified scientists and engineers available to the work force and the impact that this has on economic growth, global competitiveness, and the labour market. In the US, the *Science and Engineering Indicators 2004 report*, showed that the US was seventeenth, compared to third in 1975, for students pursuing degrees in natural sciences and engineering (Galley, 2004). This has resulted in jobs being filled in these fields by people from

outside of the country since Americans do not have the qualifications (Galley, 2004). In Canada, an innovation survey showed that a lack of qualified personnel was one of the key barriers to innovation within the country (Bordt, M. et al. 2001).

The *Prime Ministers Advisory Council on Science and Technology* did not find a shortage of qualified people in terms of education standards; however people were lacking in skills such as communication, organization, management, and team work. Employers expect these skills to develop on the job but this is not happening. The concern remains one of a lack of qualified people to fulfil positions as people retire. Post-secondary education influences the labour market, quality of life and human resource development by contributing to an educated and skilled work force (Anisef & Axelrod, 1993, p.137). By investigating the transition from high school to university, it may be possible to uncover factors, in addition to the apparent lack of skill development, that impede students in successfully completing their programs.

Nova Scotia students have been assessed and evaluated using standards based testing such as School Achievement Indicators Program (SAIP), Program for International Student Assessment (PISA), and Nova Scotia exams. I will discuss each of these in greater detail in Chapter Two; however the results suggest that Nova Scotia students are achieving below the national average in math, science, and literacy (MacIsaac, 2002). Nonetheless, many Nova Scotia students continue to be accepted to well established universities, as well as

provided with substantial scholarships. The question remains, however: How do these students who are attending university feel that their public education prepared or did not prepare them for this transition?

1.4 Significance

Science has an important role to play within society and it needs to be given appropriate attention in our education system. Science is one of the key areas identified by the Organization for Economic Cooperation and Development for PISA testing, comparing the achievement of students in over thirty nations. The goal is to create more scientifically literate people who can help their nations compete globally. In the words of Don Johnston, OECD Secretary General, education is "pivotal to everything from economic success to disease prevention" (Janigan, 2004).

As a science teacher, I recognize the potential impact that educators can have on students. This study has contributed to improving science education in several ways:

- The findings inform me, other science teachers and university professors about our practices in the classroom. What are we currently doing that students have benefited from or have been disadvantaged by? What can we change to improve our practices in terms of getting students ready for this transition and to support them through it?

- Secondary school teachers and counsellors can offer significant guidance to students by maintaining current knowledge of post-secondary systems and gaining a better understanding of the issues that students face. The findings of the study can help to guide inservice training, one method to ensure that this knowledge is developed and maintained (Schuetze & Sweet, 2003).

As a teacher I am often asked for advice by students regarding their future plans and I find myself looking for the best possible advice that I can give. My first year of university was more than a few years ago, and things have certainly changed since then, particularly in terms of technology. This study has given me a better understanding of the student experiences and has allowed me to reflect on the practices within my classroom. I feel that this research has improved my teaching and that I can better prepare students for life after high school because of it.

CHAPTER II: LITERATURE REVIEW

2.1 The Importance of Transitions

Within one's student career there are certain transitions that stand out among the year to year progressions. Examples include the change from elementary to middle school, the change from middle to high school, and the change from high school to post-secondary institutions. Each of these changes has its own unique set of circumstances such as new location, new peers, and new expectations. Studies have been conducted within each of these areas of transition; however the transition from high school to postsecondary seems to have received the least amount of attention. The sub-sections that follow focus on several aspects of the transition: the transition from high school to university in general terms, as well as with respect to science programs; the skills necessary to succeed at university as presented by various sources; and information that is specific to Nova Scotia that supports the need for this study and provides valuable background to guide this research.

2.2 Transition from high school to university

After high school graduation, some students choose to continue their studies at the university level. In Canada, 42% of high school graduates from 1995 received university education towards a certificate, diploma or degree (Frank, 1996). The current research suggests that the majority of students who drop out of university do so in their first year by January, and that the start of their courses, perhaps the first few days, are the most crucial to a successful transition

from high school to university (Cook & Leckey, 1999; originally cited from Ozga & Sukhananda, 1997; and Earwaker, 1992). In Australia, the largest drop out rate is during the first year, and of those who enter a degree program, one third will not graduate (Cook & Leckey, 1999; originally cited from Clarke & Ramsey, 1990). The inability to make the transition from high school to post secondary education may cause students to drop out or have a significant impact on their performance level.

Cook and Leckey (1999) surveyed incoming students of the Faculty of Science at University of Ulster. Students suggested that they preferred classes where the instructor provided information in class and then based the assessments directly upon that information alone. The students indicated that they felt able to do the work and that they could do it well even though many had little experience with problem solving, group discussions, and oral presentations. Students felt competent about skills such as taking notes and meeting deadlines. They were less confident about writing papers, oral presentations, and working with computers. Students also found it difficult to juggle the extracurricular activities, part time jobs, and daily tasks required to look after themselves. Time management was a key factor within this juggling act. The area where students failed to meet their own expectations was that of working independently, or taking responsibility for their own learning without the external motivation from family or teachers. University was different from high school in that the classes were bigger and the staff was less accessible. External motivators such as parents and teachers were less available, and the teaching and assessment styles

differed. It may be that the study skills developed in high school are indeed brought to university, but do not fully meet the needs of university students.

Small (1966) investigated the experiences of first year university students in an effort to discover why some fail. His study suggested that the time students can devote to their studies and personal qualities (interests, distractions, personal problems, and adjustment to new settings) are factors affecting university success. One of his recommendations is to assess graduates academically prior to graduation to help them choose their courses at university. He also suggests that liaisons need to be developed between high schools and universities, and the conditions under which students live and work were in need of improvements.

2.3 Transition from high school to university - science programs

In the student surveys compiled by Cook and Leckey (1999) seventy five percent of the students had underestimated the amount of work expected within their science courses. Students met the prerequisites for courses, yet they still found that they were struggling with basic knowledge and skills essential to their success in biology, chemistry and math courses.

A study by Lee (1997) investigated how students make the transition to university and examined the University Transition Program in place at North Carolina State University. The UTP was designed to assist disadvantaged students primarily of African American and Native ethnicity in making the transition from high school to science based, research universities. The working

hypothesis for the study was that students went from “structured, highly supervised, collaborative learning environment (high school) to an abstract, autonomous, and competitive learning environment (research university)” (Lee, 1997, p.8). Developing an understanding of the experiences that take place during this transition is vital to developing programs that can assist with the process, thereby increasing student retention and improving student performance (Lee, 1997). Students found their learning style did not match the teaching style and that the relationship between student and teacher needed to be more developed by having faculty mentors. As in the findings of Cook & Lecky (1999), students were looking for more concrete directions for assignments and direct questioning from the material covered in class, whereas the professors were looking for greater abstract thinking and problem solving that went beyond the material covered in class.

Lee (1997) also found three common areas of concern with regard to living conditions: communal adjustments, nutritional adjustments, and feelings of safety. Emotionally, students identified problems such as homesickness, independence, and fear of failure. The study resulted in a number of possible changes to the UTP such as:

- Courses composed of only UTP students
- Tutorial sessions for Math and English
- Advising and counseling services that focus on skills
- Long term support

At the University of Calgary about 1000 students enroll in first year chemistry courses and only about 14 major in chemistry four years later (Coddling, 1995). Some problems identified include the presentation of the material, a lack of context for the material and repetition of material completed in high school. Further, teaching practices were dated, resulting in step by step labs, little interaction, and routine problem sets (Coddling, 1995). Students were faced with factual, theoretical material in a manner that lacked excitement and had little relationship to the “real world” (Coddling, 1995). The University of Calgary continues to make improvements in an effort to provide better chemistry education for all students, not just for those who plan to continue on as majors in the subject area. According to Coddling (1995), they changed their methods in response to the concerns about both quality and student outcomes in undergraduate science education and the number of students who do not continue on with science education. As noted earlier, this is further supported by the statistics from the US where 590 000 leave high school interested in science. This number decreases by 40% after the first year of university, and by another 40% by the end of university (Coddling, 1995).

In 1999, the Atlantic Provinces Council on the Sciences (APICS) held their fifth conference on Science Education, *Promoting a Seamless Transition from High School to University*. In a conference summary, Lawther stated that all students entering degree programs are average or above average students in their high schools, yet there is a significant performance difference between high school and the first year of university. Based on grade performance, Lawther

reported that about 20% of students in their first year have a smooth transition, overcome challenges and attain high grades, while about 30% are estimated to fail or drop out, leaving about 50% somewhere in the middle. Those who made a successful transition and maintained high grades generally had the following skills and attributes: good study habits, positive attitude, good communication skills, sound problem solving, strong math skills, and introductory physics and calculus. Students lacking in one or more of these attributes found the transition more difficult and achieved grades below their expectations.

Based on the presentations and discussions held at this conference, a number of recommendations were made that would improve the transition from high school to university.

Recommendations

1. A survey of student experiences during the transition to the university learning environment should be conducted.
2. A standard set of pre-requisite skills should be adopted by university science faculties which are quantifiable and transparent to high school teachers and students.
3. Universities must improve their ability to assess incoming students in relation to pre-requisite skills and be prepared to offer more extensive remedial instruction, or “bridging programs” as required.
4. University educators should increase their involvement in in-service events for senior high school educators.
5. Mentorship programs matching students with career scientists should be implemented to a greater extent.
6. University Academic Units should work more closely with Faculties of Education

to develop service courses for education students. (Lawther, 1999)

2.4 Success in First Year Chemistry

In the spring of 2000, first year chemistry professors from Atlantic universities and colleges were surveyed in a Chemical Education Trust Fund (CETF) sponsored survey. The results were presented by Mel Schriver at the *Chemical Institute of Canada, Atlantic Section (CICA) Conference, Bridging the Gap Between High School and University Chemistry*, in July 2000. A small portion of the questionnaire and the findings from this survey were in the January 2001 *Canadian Chemical News*. Professors of first year chemistry courses were asked the following question for several skills, "In your opinion what is the minimum skill level needed from high school for a student to do well in your department's first year chemistry course?". They rated the skill level as crucial (3), required (2), some (1) and none (0). The numerical values were used to create averages for each category based on the responses from all the professors. Table 1 shows the averages in descending order. I have rounded the averages and assigned them an overall rating based on the rounded number.

Table 1: Summary of Skill Level Required for First Year Chemistry Courses

Skill	Average	Rounded	Rating
Math Skills (non-calculus)	2.8	3	crucial
Problem solving	2.7	3	crucial
Interest	2.5	3	crucial
Mole concept	2.3	2	required
Balancing chemical equations	2.3	2	required
Retention/Integration	2.3	2	required
Memorization	1.8	2	required
Lab experience	1.3	1	some
Acid-base chem.	1.2	1	some
Lewis structure	1.1	1	some
Electronic configurations	1.1	1	some
VSEPR theory	.9	1	some

The three factors deemed crucial to the success of first year chemistry students were non-calculus math skills, problem solving and interest. Although chemistry is a great deal more than decontextualized calculations, many of the problems encountered in chemistry require mathematical calculations. Therefore, mastery of math skills is necessary in order to be successful. Problem solving must be taught within the context of the material covered, and the interest is unique to each individual. I was surprised by the rating of lab experience; I would have expected this to play a more crucial role. During my first year in university, I found the laboratory component quite intimidating and as a teacher, I have had parents express concern about students' lab experience.

2.5 The Nova Scotia Connection

Nova Scotia had the highest university participation rate for 18-21 year olds at 36.4% in 2002-2003, as well as the highest university attainment rate in the country for ages 20-24 (Canada Millennium Scholarship Foundation, 2007). These statistics included students who were not from Nova Scotia; however, the

estimate for 1998-99 suggest that even with those students from outside the province removed, Nova Scotia's participation rate would still have been over 30%.

Based on information available at the time of graduation for students I taught in the 2004-2005 school year, 19 out of 33 students were university bound, and 8 of 19 were intending to enter university science programs. It would seem that a large number of students whom I teach are choosing university and a significant portion of those students are choosing university science programs. Science education in Nova Scotia aims to develop scientific literacy, as exemplified by this quote:

Scientific literacy is an evolving combination of the science-related attitudes, skills, and knowledge students need to develop inquiry, problem solving, and decision making abilities; to become life-long learners; and to maintain a sense of wonder about the world around them. To develop scientific literacy, students require diverse learning experiences that provide opportunities to explore, analyze, evaluate, synthesize, appreciate, and understand the interrelationships among science, technology, society, and the environment that will affect their personal lives, their careers, and their future (Department of Education, Province of Nova Scotia, 2000a, p. 3).

Students who successfully complete science courses at the high school level in Nova Scotia should be attaining the knowledge, skills, and attitudes necessary to be successful in life after high school. A number of the criteria stated in the above quote such as problem solving and interest in the subject, have been noted as

possible factors affecting students' transitions to post-secondary education in the sciences.

2.5.1 The Nova Scotia Science Curriculum

Much work has been done in the past few years to redesign the science curriculum in Nova Scotia. Much of the restructuring is the result of the development of the *pan-Canadian Protocol for Collaboration on School Curriculum* where a common framework for primary to 12 science education was developed (Council of Ministers of Education, Canada, 1997). While not mandatory, the document provides a blueprint for outcomes at each grade level that can be adopted by provinces should they choose to do so. Nova Scotia has adopted this framework of outcomes and our current curriculum largely reflects the goals and outcomes as outlined in the pan-Canadian Framework. The new curriculum includes outcomes that are divided into four categories.

The first category, *Science, technology, society, and environment (STSE)*, includes outcomes where students are expected to develop an understanding of science and technology as they relate to each other, as well as to society, and to the environment. The second category, *Skills*, includes outcomes that enable students to engage in the processes of scientific inquiry, problem solving, and decision making required for scientific literacy. The outcomes for STSE and skills have a numerical coding system that is used across all the science subjects. For example, skill outcome "212-6" requires students to design an experiment and

identify specific variables. *Knowledge* is the third category and it is directly related to the subject being taught. This is where the key concepts and expected understandings are outlined. Knowledge outcomes are organized and connected across the subject disciplines through seven unifying concepts: change, diversity, energy, equilibrium, matter, models, and systems. These are the “big ideas” through which students ultimately filter their knowledge – they are “really ways of thinking rather than discoveries, theories, or knowledge” (Foundation for the Atlantic Canada Science Curriculum, n.d., p.32). The last category, *Attitudes*, is solely organized around key stage curriculum outcomes, meaning students are expected to attain the outcome by the end of grade 3, 6, 9 or 12. The attitude outcomes are meant to develop healthy attitudes regarding scientific and technological knowledge with respect to how this knowledge is used to benefit self, society, and the environment.

These four categories of outcomes (STSE, Skills, Knowledge, and Attitudes) were developed with the goal of scientific literacy in mind, as well as attempting to bring some unification to a provincially governed education system. Academic preparedness is considered a contributing factor to the transition from high school to university. First year university course descriptions for biology, chemistry, and physics from various universities mirror the topics taught at the high school level (Acadia University, 2005; Dalhousie University, 2005; & Mount Saint Vincent University, 2005). Assuming that the curriculum outcomes are

being met, students should be prepared for the academic demands of university based science courses.

2.5.2 Assessment of Student Achievement in Science

A number of factors impact the quality of education. Yet, the assessment of education within Nova Scotia has been largely based on various forms of testing which may not tell the whole story. Standards-based testing comes in many forms and it has certainly become a focus for the *Nova Scotia Department of Education*. The *Program of Learning Assessment for Nova Scotia (PLANS)* is an assessment program designed to provide information that will improve the overall quality of education in the province of Nova Scotia, as well guide the decision making process with regard to educational matters (Department of Education, Province of Nova Scotia, n.d.a). PLANS includes a variety of assessments, some of which count toward students' final grades and others that are used only for statistical analysis. The assessments include three levels that enable student performance to be compared provincially, nationally and internationally. The testing to date indicates that Nova Scotia students fall below the national average in reading, mathematics and science; however, in all three categories they are above the international average (Maclsaac, A 2002).

The assessment tools used by Nova Scotia consist of *The School Achievement Indicators Program (SAIP)*, *Programme for International Student Assessment (PISA)*, *Nova Scotia Examinations* and Nova Scotia designed tests for various grades in the areas of math and language arts. Although being

replaced by the Pan Canadian Assessment Program (PCAP), SAIP assessed student achievement based on the pan-Canadian outcomes in the areas of mathematics, reading and science. These tests were conducted since 1993 and included students aged 13 and 16 from across the country. Each year only one area was tested and once a cycle was completed, the testing started over. SAIP aimed to provide information on the level of achievement attained by 13 and 16 year olds as well as the development of knowledge between these ages (Department of Education, Province of Nova Scotia, n.d.c).

PISA is designed to provide policy-oriented international indicators of the skills and knowledge of 15 year old students. It is an initiative of the *Organization for Economic Co-operation and Development (OECD)*. This testing also assesses reading, mathematics and science. Like SAIP, the testing is done in cycles, with three year intervals in between. The age is significant because many students are reaching the end of their compulsory education and this enables the level of the knowledge deemed necessary for success within society to be assessed. The testing is more concerned with literacy in the areas mentioned and the OECD hopes to answer questions such as: “How well are young adults prepared to meet the challenges of the future? Are they able to analyse, reason, and communicate their ideas effectively? Do they have the capacity to continue learning throughout life? Are some kinds of teaching and school organization more effective than others? (Department of Education, Province of Nova Scotia, n.d.b).”

Further to SAIP and PISA, Nova Scotia has developed its own provincial testing. The most well known are likely the *Nova Scotia Examinations (NSE)* that are given in English, Chemistry, Physics, and Math in grade 12 courses. These exams are worth 30% of the final grade in the course. The Department of Education now plans to have English and Math provincial examinations yearly, while Chemistry and Physics will be conducted on a rotational basis.

According to the *Minister's Report to Parents: Student Assessment Results for Nova Scotia 2003*, the assessment is important to student learning, determination of how well students have achieved outcomes, and decision making within the department as to where improvements and investments are needed. In addition to these reasons, measuring student achievement promotes greater achievement and accountability in the educational system (Muir, 2003). As stated previously, the results of the testing indicate that Nova Scotia students are not performing as well as those in some other provinces in literacy, math, and science. If this is accurate, what kind of impact is it having on students who continue on at the university level? Students' educational experiences at university could offer insight into the assessment of education within Nova Scotia.

2.6 Insights from the Literature Review

The literature suggests that there are significant challenges faced by students during the high school to university transition that impact their grades, as well as program completion. The high rate of student drop outs during the first

year of study and the decline in student performance compared to high school are both cause for concern. In terms of science, the cause for concern is even greater as student interest steadily declines as students move through the various levels of education: elementary to middle through high school to university. The factors that contribute to these events need to be explored in an effort to improve the situation. Areas of notable weakness included problem solving, independence, and expectations regarding work load. In conjunction with these, students were also faced with the absence of adult influences that were present during high school, such as teachers and parents. From an organization perspective, problems included learning styles versus instructional styles and the relationship between students and instructors. Investigating the readiness of students for higher education requires more than standards based testing and surveys. It requires an in depth look into the experiences of students during their high school years and as they make the transition to higher education. This can only be done through qualitative research where the researcher aims to see the story from the perspective of the participant.

CHAPTER III: METHODOLOGY

3.1 Theoretical Orientation

This is a qualitative study grounded in the principles of phenomenology. I conducted in-depth interviews to investigate the experiences of university science students who graduated from high school in 2004 and 2005. As described by Bogdan and Taylor "...qualitative methodologies refer to research procedures which produce descriptive data: people's own written or spoken words and observable behavior" (1975, p. 4). The purpose of this study was to learn about the educational experiences of the students being interviewed. There appears to be little research available on this topic and what I found was quantified or lacked depth. Qualitative research is often criticized for small sample sizes and for lacking the capacity to allow for generalizations; it has benefits, however, that make it appropriate for this study. One of the benefits of qualitative research is that it provides a detailed description about the phenomenon that is being studied.

Qualitative methods allow us to know people personally and to see them as they are developing their own definitions of the world. We experience what they experience in their daily struggles with their society. We learn about groups and experiences about which we may know nothing. Finally, qualitative methods enable us to explore concepts whose essence is lost in other research approaches. Such concepts as beauty, pain, faith, suffering, frustration, hope, and love can be studied as they are defined and experienced by real people in their everyday lives (Bogdan & Taylor, 1975, p. 4-5).

The emphasis of this study was on the experiences of the students as they perceive them. Their experiences were investigated through in-depth interviewing, based upon the theory of phenomenology, which is

... the study of experiences and the ways in which we put them together to develop a worldview. It carries an assumption that there is a "structure and essence" to shared experiences that can be determined (Patton, 1990, p. 70). This theoretical orientation has two implications, such that phenomenology can be referred to either as the subject matter of inquiry or as the methodology of the study (Marshall & Rossman, 1995, p.82).

As Bogdan and Taylor suggest, the phenomenologist is interested in the reality of the participants and being able to see the world as they see it, viewing human behavior to investigate how people interpret their world and ultimately to be able to take on their point of view (1975, p.2, p. 13-14). Brenner, Brown and Canter (1985) also point out that it is important for qualitative researchers to see the world through the eyes of the participant, as shown by the following:

Furthermore, it is essential that the qualitative researcher understand respondents as people; therefore, the more phenomenological approach, one in which the researcher tries to see the world from the respondents' point of view, is more likely to give a better understanding of the everyday experiences of the motorist, buyer, tenant, and so forth (p.121).

3.2 Research Design

Each participant was interviewed using a semi-structured format. All interviews were tape recorded. Although each participant was asked the same questions, a semi-structured format was followed to allow for topics to be further

discussed as necessary (See Appendix C for Interview Questions). The interview times were negotiated to ensure a time and place that was comfortable for both the participant and the researcher.

Typically, qualitative in-depth interviews are much more like conversations than formal events with predetermined response categories. The researcher explores a few general topics to help uncover the participant's meaning perspective, but otherwise respects how the participant frames and structures the responses. This, in fact, is an assumption fundamental to qualitative research – the participant's perspective on the phenomenon of interest should unfold as the participant views it, not as the researcher views it (Marshall and Rossman, 1995, p.80).

Each tape recorded interview was transcribed to allow for analysis of the data. Prior to a final analysis of the data, each participant was sent the transcript of his/her interview for review and to allow for changes, additions and clarification as required.

I also carried out a content analysis of documents such as curriculum guides and course outlines. According to Marshall and Rossman (1995), "The use of documents often entails a specialized approach called content analysis. Best thought of as an overall approach, a method, and an analytic strategy, content analysis entails the systematic examination of forms of communication to document patterns objectively" (p.85). I examined curriculum guides and course outlines to identify patterns, similarities, and differences that might influence

students' transition to university. I cross-referenced these findings against the interview data to see if any patterns or themes were apparent.

3.3 Participants

Participants in this study were students that I taught in their senior high science courses, who graduated in 2004 and in 2005, and subsequently entered university science programs. Following approval from the ethics committee, I contacted all known students who met the above criteria by telephone to see if they would like to have a package sent to them that would tell them more about the study. A total of twelve students were contacted from the 2004 and 2005 graduating classes and six of them participated in the study. I sent a letter to each of them describing the study (Appendix A) as well as a *Consent to Participate Form*. One of the factors that seemed to affect participation was time. While each potential participant had indicated a desire to take part, setting up a time to meet was difficult given summer jobs and later being away at university. During my initial contact I had explained that I would not be trying to contact them further and would wait for them to contact me about setting up an interview. Some of the participants had called me back but unfortunately I was not home. Since I had explained that it was up to them to get back to me, I returned each call and left a message and then the further contact was up to the individual.

I assigned each participant a pseudonym. One participant was in a nursing program, another in a kinesiology program and the others were in

Bachelor of Science Programs. Three of the participants had completed two years of university education, while two had completed one year. One participant who had entered a Bachelor of Science program completed one term of study at university and then moved to a college program to study forestry.

3.4 Data Collection

In designing the study I reflected at length about the kind of data that would best help me explore my research question(s). I considered distributing a survey to gather information from a wide cross-section of students but determined that a qualitative design would allow me to generate richer and deeper insights through conversations with students. Further, I decided that interviewing students that I once taught, rather than strangers, would provide insights that would better inform my own practices, which is one of the central purposes of this practitioner research. By establishing this purpose from the outset and informing students of that purpose I think that students were more able to respond to my questions honestly and openly.

I contacted students by phone to assess if they were willing to receive a package of information that further described the study and included the informed consent paper work. I requested a mailing address and explained that my contact information would be included should they decide to participate in the study. I obtained all phone numbers from the local phone book. Central to the purpose of this study was my desire to improve my own practices. The participation of past

students was crucial to this component of the study as they provided insight into my teaching practice and its impact on them.

The informed consent packages included:

- € An invitation to participate
- € Name of researcher
- € Contact information
- € Supervisor information
- € Purpose of investigation
- € Tasks to be performed and time commitment
- € Assurance of confidentiality
- € Any potential harm or benefit
- € The option to withdraw from study at any time
- € Arms length contact information
- € Option to be sent completed thesis

3.5 Data Analysis

During interviews, I gathered the data to be transcribed, as well as listened and observed in an effort to identify relationships, consider meanings and explanations, and probe for further information as required. Glesne and Peshkin (1992) describe analysis as:

...a continuous process that should begin just as soon as your research begins. It follows, then, that interviewing is not simply devoted to data acquisition. It is also a time to consider relationships, salience, meanings, and explanations – four analytic acts that not only lead to new questions, but also prepare you for the more concentrated period of analysis that follows the completion of your data collection (p.81).

Interpreting and analyzing interview data is a complex process that involves making sense of large volumes of transcribed text. The researcher must look for patterns and relationships in an effort to understand the experiences of participants. As described by Patton (1990), “Data interpretation and analysis involve making sense out of what people have said, looking for patterns, putting together what is said in one place with what is said in another place, and integrating what different people have said ” (p.347).

I analyzed the data collected during this study using a grounded theory approach.

A grounded theory is one that is inductively derived from the study of the phenomenon it represents. That is, it is discovered, developed, and provisionally verified through systematic data collection and

analysis of data pertaining to that phenomenon. Therefore, data collection, analysis, and theory stand in reciprocal relationship with each other. One does not begin with a theory, then prove it. Rather, one begins with an area of study and what is relevant to that area is allowed to emerge (Strauss & Corbin, 1990, p.23).

Developed by Glaser and Strauss, grounded theory is a qualitative research method “that uses a systematic set of procedures to develop an inductively derived grounded theory about a phenomenon” (Strauss & Corbin, 1990, p.24). As stated, the researcher strives to develop theory, rather than support existing theory. The approach can be used by researchers of “any discipline or theoretical orientation desirous of developing grounded theory” (Strauss & Corbin, 1990, p.31-32). The procedures associated with grounded theory are intended to:

- (1) Build rather than only test theory.
- (2) Give the research process the rigor necessary to make the theory “good” science.
- (3) Help the analyst to break through the biases and assumptions brought to, and that can develop during, the research process.
- (4) Provide grounding, build the density, and develop the sensitivity and integration needed to generate a rich, tightly woven, explanatory theory that closely approximates the reality it represents (Strauss & Corbin, 1990, p. 57).

To begin the analysis process, I open coded the data, so that they were broken down, examined, compared, conceptualized, and categorized (Strauss & Corbin, 1990, p.61). “Grounded theorists suggest a careful, line-by-line reading of the text while looking for processes, actions, assumptions, and consequences”

(Denzin & Lincoln, 2003, p.275). The process of assigning categories based on similarities and differences, asking questions, and reflecting on data make it possible to examine assumptions and make new discoveries (Strauss & Corbin, 1990). Making comparisons and asking questions are central procedures to the grounded theory approach, otherwise known as the constant comparative method of analysis, as they provide precision and specificity (Strauss & Corbin, 1990). Coding involves assigning categories that enable the researcher to group similar concepts, ideas, and themes that arise from the data. “You can code for names, evidence, or time sequences. You can also code for hesitations, blocking, signs of emotion, and indications of fear or amusement” (Rubin & Rubin, 1995, p.238).

In practice, coding can be thought of as a range of approaches that aid the organization, retrieval, and interpretation of data. Miles and Huberman (1994) suggest that coding constitutes the “stuff of analysis” (p.56), allowing one to “differentiate and combine the data you have retrieved and the reflections you make about this information” (p.56). They argue that coding is a process that enables the researcher to identify meaningful data and set the stage for interpreting and drawing conclusions (Coffey & Atkinson, 1996, p.27).

Cross case analysis involves answers from participants being grouped together based on questions (Patton, 1990, p.376). Taking apart the whole to isolate discrete phenomenon from within each question asked during the interviews led to conceptualization. That is to say, I used constant comparative analysis to focus on individual words, phrases, and sentences. One of the techniques in this method is to question the meaning of each word, phrase or

sentence, rather than settling for the first impression. This method can illuminate the researcher's assumptions while forcing those assumptions to be examined (Strauss & Corbin, 1990, p.81).

After completing open coding, using a number of the above techniques in an integrated way, I reorganized the data and regrouped similar categories. In this axial coding stage, the goal was to develop main categories with sub-categories.

3.6 Ethical Issues

The success of this study was dependent on the relationships that developed between the researcher and the participants. As I noted earlier, in designing the study I purposely chose to interview students to whom I had taught high school science courses. I recognized at the onset of the study that this was a possible issue. I was concerned that students may share information that I would rather not know, such as critical comments about teaching colleagues. I was fortunate that this did not occur. For the most part, the participants were discrete with any negative comments that they made so as not to name the individual and more often the comments were quite positive.

Our former teacher/student relationships were another concern. The first issue was my position of power as the researcher. This did not seem to be a problem; however I did notice that students tended to get nervous, as shown by laughter, when topics like socializing and partying came up. The second issue

was my own bias given my past relationship with each participant. Throughout the study I tried to focus on what the students described rather than what I remembered about them.

CHAPTER IV: INTERVIEW ANALYSIS

4.1 Introduction

I conducted a total of six open-ended interviews, guided by ten questions, during this study. The interviews varied in length from forty minutes to almost two hours. I was impressed by the willingness of the participants to share their stories. As their past teacher, I found myself feeling very proud of each of them for the way that they carried themselves and the level of maturity that they demonstrated as we discussed different topics.

In this chapter, the sections provide a description of the participants and their grades achieved both from high school and university, as well as a question by question summary of the findings from the interviews. There is further discussion of the interview data in Chapter V.

To allow for ease of recording, the grade ranges have been assigned a letter. Since each university had slightly different grading scales, the letter grades from each university could not be compared directly. The letter grades have also been used to describe the grades achieved from high school.

91-100	A+
81-90	A-
71-80	B
61-70	C+
51-60	C-
41-50	D
Below 41	F

4.2 Description of Participants

Participant #1: Karen

Karen had completed one year towards a Bachelor of Science (no major declared) at a small university. In high school she was one of the top students in her class with an overall average of 99%. She took biology, chemistry, physics, and the highest academic math course offered and attained A+ in all of these courses. Her provincial examination grades for chemistry, physics and math were all A-. During her first year of university her overall grades in biology, chemistry, physics, and math courses ranged from A- to A+.

Participant #2: John

John had completed two years towards a Bachelor of Science (Nursing) at a small university. In high school he did well with an overall average of 87.5%. He took biology, chemistry, and the highest academic math course offered. He performed better in biology (A-) than chemistry or math (C+). He failed both his chemistry and math provincial examinations in grade 12. During his first year his marks ranged from C- to B. During his second year of university, his marks ranged from C+ to B, showing a moderate improvement from the previous year of study.

Participant #3: William

William had completed two years of university toward a Bachelor of Science (Chemistry). In high school he took biology, chemistry, and math. His overall average was A-. During his first year of university his grades ranged from

C- to A+. Half of the first year courses fell into the range of C-. First year chemistry fell into the range of B and C+ for first and second term respectively. Calculus and physics fell into the range of C- for both terms. William took a first year biology course during his second year of university and achieved an average in the range of A- and A+ for each term respectively. William took Intro to Calculus 2 over in his second year and raised his grade from the range of C- to C+. In general, William's grades were better during his second year of university, although he did fail a math course called Calculations of Several Variables 1.

Participant #4: Aaron

Aaron has completed two years towards a Bachelor of Kinesiology. His overall average in high school was A+. He took biology and math where he achieved an A and B respectively. His provincial math examination grade was a D. During his first year of university he showed consistency and attained an overall average in the range of B in all of his courses. During his second year he continued to work in this range, however two of eight courses fell within the A-range, and one fell in the C+ range. During his second year he took Statistics for Behavioural Science and achieved an overall average of B.

Participant #5: Brenda

Brenda completed a term at university and then left the program. She worked for a while and then entered a two year college program related to forestry, which she completed in April 2007. We corresponded through e-mail

throughout this study and as a result some information has not been as complete as with the other participants. During high school she was an above average student who graduated with an overall average A+. She completed chemistry in high school with an overall average of A+ and a provincial examination grade of C+. In math her overall average was A- while her provincial examination was B. During her first term of university she took chemistry, calculus and biology and achieved C-, C- and C+ respectively. In her first year of study at forestry college, second year of post secondary education, she took many specialized biology courses. Her grades achieved included two B's and two C+'s. She also took math and achieved an A-.

Participant #6: Susan

Susan had completed one year of university in a Bachelor of Science (undeclared major). In high school she had an overall average of 84%. She took biology (A-), chemistry (A-), and math (C+). Her provincial examination scores were C- and D for chemistry and math respectively. Her overall grade in these subjects in high school was A- for chemistry and C+ for math. During her first year of university her grades ranged from 50-62%. She achieved a C+ in chemistry, a C- and a D for first and second term calculus, and C- and C+ for first and second term biology.

4.3 Summary of Participants' Grades Achieved

It is apparent that the overall grade in high school was higher than that of university or was in the same range. Karen and Susan both did better in

university than on the provincial exam for chemistry. William achieved the same grade on his chemistry provincial and his first term introductory chemistry. Brenda did moderately better on her provincial exam compared to her university chemistry grade. In math, Karen performed about the same, and somewhat better at university than on the provincial exam. Susan's math grade in university was higher first term and the same during second term as her high school provincial examination. John failed the provincial math exam but went on to university to attain a grade in the C+ range. William did quite well on the math provincial exam; however he performed poorly by comparison while at university. Brenda achieved a moderately better grade on her provincial math exam compared to her first year math course at university. There does not appear to be a clear correlation between grade achieved on provincial exams given in high school and overall grades achieved in introductory courses at university. See Table 2 for a summary of the grades achieved by each participant.

Table 2: High School, provincial examinations, and university letter grades achieved

NOTE: Courses in university that were split into half credits have been shown using a slash between the grades for first and second term.

Participant	Biology		Chemistry			Physics			Math		
	High School	Uni- versity	High School	Provincial Exam	Uni- versity	High School	Provincial Exam	Uni- versity	High School	Provincial Exam	Uni- versity
Karen	A+	A-	A+	A-	A+	A+	A-	A+/A-	A+	A-	A-/A+
Susan	A-	C-/C+	A-	C-	C+				C+	D	C-/D
John First Year Second Year	A-	C-/C+	C+	F					C+	F	C+
William First Year Second Year	A-	A-/A+	A-	B	B/C+ C+(4) ,B			C-/C-	A-	A-	C-/C- F
Aaron First Year Second Year	A-	B							B	D	B
Brenda First Year Second Year	A+	C C+ , B	A+	C+	C-				A-	B	C-

4.4 Summary Responses to Interview Questions

4.4.1 Question 1: Tell me about your transition from high school to university.

I began each interview by asking students to tell me about their transition from high school to university. Participants' responses reflected a number of similarities, despite the generality of this question. Discussion around **study habits, how to study, and how long to study** came up frequently. Five of the six interviewees raised issues around studying. They each addressed them in his/her own way. Karen felt that she had to study more, while the others cited problems with knowing how to study and particularly with how to study for such a large amount of information. Aaron suggested there was a time period of adjustment to a new routine. He first talked about his experience with high school

and the well set routine that was supervised by his parents. While at university there is a new found freedom: “When you’re in university you’re dropped off and you can just do whatever you want...”. He suggested that after a few bad quizzes and tests “you figure out what you need to do and make up your, a new routine.” Susan felt fortunate to have a non-credit course offered, called Excel, which helped first year students with study skills, provided information on where to study, as well assisting with things like computer skills.

Exams also were a common thread of conversation. For John there was an initial fear due to the weight of exams and his inexperience with writing exams. The school from which all of the participants graduated had an exam exemption policy that allowed many students to leave high school with limited exam experience. Students could get an exemption from an exam in two ways. The first option which applies to most of the participants in this study, was to obtain an overall mark of 85% or greater, have completed all assigned work and to have no unexcused absences. The second option was to have completed all assigned work, to have no more than five excused absences, and to have at least a 50% for an overall mark. The students in this study usually met the requirements of the first option, and if they did not they almost certainly met the requirements for the second option. Therefore, it was not until grade 12, when they faced provincial examinations for which there was no exemption, that they had the experience of writing exams.

John, for example, went to university with the experience of writing only two exams; both were provincial examinations and he failed both. Susan also expressed concern over exams both in terms of studying for them as well as finishing them in the allotted time period. "...it didn't hit me until, I thought it was all fine and easy until exam time....how am I going to study for all this information" and "we wouldn't have enough time for some of them but what can you do they only give you so much time and they don't really care." Brenda also cited problems with exams as a result of having not written them in high school. She said, "It was hard to get used to all the information to study for on exams and how to study."

Three of the interviewees mentioned **class size**. Karen and John were both expecting class size to be an issue based on what people had told them about university; however they both found that a smaller university came with smaller classes. For Karen the classes were not much different in size from those in high school, while for John the classes were around sixty which he did not feel was a problem.

One participant mentioned **parental influence** at the high school level and how it had influenced time management and studying. Parents were there to ask questions and help the students stay focused. While at university the parents were not physically there, leaving the student to exercise their own decision making about time management/studying. **Feeling intimidated** was mentioned

twice. John expanded on this to explain that it was during a clinical setting where practical skills had to be applied based on the theory that was learned. Many of the others in the program had past life experience within the field and were coming back for further training. John found their level of knowledge, vocabulary, and skills intimidating. He didn't want to "feel like an idiot" or "act like an idiot".

Some **other concerns** included not knowing people, marks dropping compared to high school, and the faster pace of university. Regardless of the problems cited there was a sense that with time the participants figured out what they had to do in order to succeed. They adjusted to a new routine, recognized the increased demand due to large amount of information being covered in a short period of time, as well a need to modify their study habits to meet these new demands.

4.4.2 Question 2: What aspects of this transition have you found challenging and what have you found easy?

Finding a **balance between work and socializing** was one factor that students found challenging. Aaron found it difficult to "choose when to do work and when not to". He cited the feeling that somebody was always partying as a key issue. It was difficult to stay focused on work when the temptation of joining the fun was ever present. During exam time this feeling actually seem to subside because everybody had exams so everybody had to be studying versus throughout the term when students have midterms at different times. Quiet hours are a reality in residence during exam time and everybody's in study mode. John

was also most challenged by the pressure to socialize. Finding a balance between social life and study life was difficult. John focused on the books his first year and did not make a great many friends in the dorm. It was not that he could not go hang out with the guys, but “50 guys who want to drink all the time and it makes it hard to study.” He had to find a better way of studying so that he could have more time to socialize. In high school John admits that he was not likely to put studying before socializing. It was more likely that he would be heard saying “let’s go do something, let’s go out.” By second year he had found a better balance, changed his studying techniques and had a routine that worked. He attributed his better marks in second year to this change, saying he “felt healthier.” John pointed out that the social part of university is just as important as the academic part, that you are “developing as a person....learning as much, or if not more, than you do in school.”

At university, students encountered problems with **independent work expectations**, such as completion of assigned readings and self study requirements. For example, Aaron had difficulty with assigned readings and stated, “doing the readings cause you’re not getting tested on that, there’s no real inspiration for you to do this, it’s just gonna help your class the next day.” Susan and William found that learning how to study was quite a challenge given that they did not have to in high school. They were able to get by without putting in a great deal of effort into high school. They also found the pace of university much faster. Susan felt that in high school the teachers went at a slow pace, one that

students could keep up with, while at university the professors spoke about topics at a speed that sometimes made it difficult to keep up and often notes were missed as a result. In high school William had not done much home work, while at university he quickly realized that more time had to be spent on the material outside of class time. Brenda also discussed the need to learn how to study, but expanded on this to include the challenges of learning on one's own, knowing what to study, and forming study groups when living off campus. Karen was challenged by the need to study rather than procrastinate. She felt that in high school she had gained good study skills, however she needed to make more use of them in university. The labs took some time to get used to in terms of the format and because students were working individually as opposed to in groups like in high school.

There were aspects that the students found easy. For Aaron the reduced time spent in class allowed for time that could be dedicated to other activities, such as volunteering. "It's not just all about being in school, it more your own time, I found it was easy to adapt to, not having school all the time (*lol*), it's kind of fun (*lol.*)"

Karen had left for university with the impression that the professors would not know your name and that the one on one exchange between students and professors was limited. She was surprised in her second semester when she got to know some of her professors and when they in fact knew her name. This was

not an experience that she expected to have in her first year and she thought developing that relationship would be more difficult.

William felt that university was not much different from high school, “just moved up a level and as you moved up a level, things got a little deeper and faster.” Susan, Brenda and Aaron found the labs were easy. John did not think that any thing stood out as easy, although some aspects were easier than others, everything required effort to succeed.

4.4.3 Question3: What aspects of your high school education contributed positively to your transition? Negatively?

The **background knowledge** gained in high school received more positive comments than negative and it would seem that students were generally content with the material that they had been taught. Brenda knew the basic knowledge required for most courses and was “used to the busy life due to all the extracurricular activities in high school”. The **availability of teachers** to provide assistance to students was a positive aspect for Susan. She found that this helped a great deal to ensure that she understood the material. The university chemistry was very similar in content to that of high school according to Karen. There was a great deal of repetition, however there was also some new material and some material that was covered in greater depth. The physics was also well connected to the material covered in high school. She saw the first year as a transition period used by universities to get everybody on the same level academically regardless of their learning experience in high school.

High school was a positive experience overall for John. **Learning who he was**, gaining the background knowledge, and learning his strengths and weaknesses were all cited as positive aspects of high school. He felt that the individual had the biggest impact on how s/he used the experience from high school. He also mentioned that enjoying high school may have been the best thing because he learned about himself which made it easier to do well in university. Aaron thought that high school was a “good learning opportunity” and said “if you want it to be, if you really want to like apply yourself to high school, then you’re going to be able to apply yourself to anything.” The material learned in high school courses like biology was used in university classes; the neuron which is covered in grade 12 biology was seen again in psychology and physiology classes. Aaron discussed how he remembered studying the eye and the brain and how these were later an emphasis in courses for his program. The basic knowledge of terminology was helpful; however he felt more content in the area of anatomy would have been beneficial. He cited **course options** as an issue that contributed to some of the areas where he found himself lacking knowledge. As previously explained, their small high school provided these students with very limited course options.

A few of the participants discussed the **exam exemption policy** and **teacher preparation for testing** from high school. The policy left these students with little experience writing exams. Brenda states that she “wasn’t prepared for

the amount of studying needed, high school tests could have been harder, and high school teachers could make students do more on their own learning instead of in class.” Susan pointed out another problem with how teachers prepare students for tests compared to the approach used by professors. Teachers provided outlines, and in her words “provided too much information as to what kinds of things would be on the exams” compared to “in university they are just like yeah, it’s on the course.” The professors stated the chapters to be covered but gave little indication of the specifics, leaving students to have to figure this out for themselves. Karen also cited inexperience with exams as a problem. Although she felt she had good study skills, she found it overwhelming to have to study for five exams within such a short time period and trying to study for so much information at once. John also thought that the exemption policy was not a good way to prepare students for university and suggested that exams should be gradually introduced throughout the high school years. That being said, he also talked about fellow students who had written exams in their high schools and had in fact failed out of the program.

William was able to go through high school with little effort so when he got to university he did not know how to study or know how to manage his time, as well as not being accustomed to having to devote time outside of class for homework. Karen said the advice/information that is given during high school regarding things like what to expect for class size was helpful. Experience taking notes during lectures was also noted as a useful skill gained in high school.

4.4.4 Question 4: Is there anything you would change about your high school science courses to improve your current situation and if so what would it be?

Participants cited **course options** as something they would like to change about their high school science courses. There were two factors at play: choices available to them and choices that they made. Karen would like to have had more advanced level courses available. She said “in high school I was thrown in with a bunch of people who didn’t really care.” Aaron would have made more courses available. John would have liked more course options, such as biology that was more specialized on anatomy and physiology. Susan did not think she would change anything other than her own choices. She did not take physics because it was not required by the university, yet she found when she got to university a basic knowledge of physics would have been helpful in her chemistry course.

Another area for change was **degree of difficulty**. William would like the assignments to have been more difficult, perhaps more in depth, and providing an opportunity for students to teach themselves. Brenda would like the courses to have been more difficult, to raise the degree of difficulty on tests and to expect more understanding of material rather than memorization. She also suggested that material be presented more in depth. Karen would like to have done more labs.

4.4.5 Questions 5: What aspects of your high school science courses contributed positively to your university transition?

The course material covered in high school science classes was again brought up in this question, with an emphasis on the **basic knowledge** provided. Although Karen would like to have done things more in depth, she suggested that covering a large number of topics gave a little bit of knowledge about many things and helped students to discover their interests. The basic knowledge needed to succeed in the university courses was provided. William valued the occasions when basic knowledge had to be applied to critical thinking exercises and labs. He also felt that he had the basic knowledge needed for everything at university. Susan found that the **repetition** in high school through a variety of activities for one concept helped her to retain the information. When the concept was introduced at university she was ready to discover it in greater depth because some basic knowledge about it was already present. She also found that the use of **visual aids** helped her to learn the material and retain it. Brenda also felt that she had the basic knowledge needed such as terms and their definitions, as well as hands on work. Aaron felt that he had learned information that he needed to continue his learning at a higher level and that much of the information was still being used. He also said that studying for science was different than studying for any other course. The readings in a science text required greater focus and could not simply be skimmed. Although university classes are different than those in high school, the study skills gained in high school prepared him for university.

Note taking was also discussed; most professors put their slide shows and notes on line where students can access them. Students then print the notes prior to class and can add notes to the side during the lecture. Aaron did not find this helpful and he would rather have a more **interactive learning** environment. John found that note taking was very difficult in high school and did not feel that he was much better at it in university. Nonetheless, he still felt that it was a valuable skill to be exposed to in high school. He also mentioned the notes being on line, however he did find this useful because it allowed him to see what material was important and because he already had the notes, it was easier to listen during the lecture. Aaron did not think that university was interactive at all, and basically students were expected to use the notes and figure it out themselves. The labs did provide some opportunity for interactive learning although there still was not a great deal of discussion. He said “high school really had it right, ...high school that’s what I think was the best way to teach a small crowd, to get interactive...”.

4.4.6 Question 6: What problems have you encountered within your university science courses?

Course options came up again during this question, however this time it was at the university level. Karen attributed the difficulty that she experienced with first year - second semester biology course to not having yet taken organic chemistry, a second year course that she would not likely get until her third year. She also found that the course was not as organized as other courses, perhaps due to having more than one professor teaching the course.

Issues around **study skills** and **independent work expectations** were once again mentioned by the participants. William's problems centred on a lack of knowing how to study and how to manage time. He also said "I've had to teach myself how to teach myself" and "how to go through a text book and take out important information and then learn and apply that above and beyond what the prof lectures." Susan experienced problems in chemistry class during the electrochemistry unit. This unit was rushed in high school so she did not feel that she had learned it at the time. When faced with it again at university, she went back through her notes from high school to get comfortable with the material. She felt that if she had not done this she would have been lost in the university class. **Exams** were another problematic area. Brenda encountered problems with exams in terms of not knowing how or what to study for them. She also thought that the **large class size** and the **pace** at which the professor covered material were contributing factors to difficulty understanding the material.

Study habits, learning how to study, and the lack of interaction in class were problems for Aaron. He talked about the need to **figure things out on one's own** because it was not conveyed during class time; the student was responsible for solving problems. Although challenging, he made an effort to work through it on his own before asking for help from his peers. He did not consider asking for help from the professors as an option in most of his courses. The **relationship between students and professors** did not foster a comfort

level for Aaron to talk to the professors following a class about any problems he might be having. One of the contributing factors given was the large class sizes; however, he also mentioned the **level of interaction** as an issue. After being bored for an hour, the incentive to talk to the professor was not there. Aaron was not sure if the problem was the class size, or if it had more to do with the class atmosphere. The relationship that he witnessed was one of information being given and then students left the class.

Adaptations to learning needs were minimal as were the **assessment techniques**. A lot of the classes Aaron took were graded largely based upon a midterm exam and a final exam. In his words, “that’s a hard way to, I think, judge someone’s knowledge of the course.” Aaron did not feel that high school prepared him for the realities of midterms and final exams; however he also was not sure that having had exams in high school would have made a big difference to his performance. His problem with midterms and exams was more focused on the content of the testing and the types of questions. He felt that the assessment criteria tested his knowledge in one way, rather than in several. The midterm exams and final exams were more of a reflection of what you studied in the past week, and not necessary what you had learned, “knowing something is a lot different than spewing it out on that true and false piece of paper there, that’s really just what you can remember from what you studied in the past week directly like.” He discussed the use of multiple choice and how it seemed like the questions were intended to trick the student. He would like to see a greater

emphasis on longer answer questions. His experience was mostly multiple choice, and even the long answer questions were usually set up in a format where the student was choosing from a list, and not using their own words. John also experienced difficulty with assessment and cited an example of one “bad, very very bad” lab teacher. She had taught a number of things but then would seemingly test on other things. John found it hard to determine what material was important even with the help of fellow classmates who seemed to experience the same problem. Her knowledge was not brought into question, but rather her ability to teach it to the students and to correlate what she taught to her test questions. The use of multiple choice questions came up as an issue in John’s courses, specifically in pharmacology. The answers were very similar and “she was kind of trying to trick ya, ...she’d make insulin hard to figure out what it was and everybody knew what it was and how it worked and how long it worked for but it was just the way she worded it...”

4.4.7 Question 7: How well do you think your high school science prepared you for the courses you are taking now at university? Do you have the necessary prerequisites? Basic knowledge? Skills? Experience with varied forms of assessments? What role have literacy skills and language acquisition played?

4.4.7.1 Prerequisites

Course options was a recurring theme in this section. Aaron pointed out that his field of study, kinesiology, is highly specialized compared to the courses of study offered during high school. He noted that courses like biology were helpful, but the sports and sociology aspects of his field were largely new to him.

He also suggested that coming from a small school influenced his level of knowledge and found the differences between high schools frustrating. Aaron found that fellow students in his program who attended larger high schools had the benefit of knowledge that he did not due to the limited courses offered at a small high school. He found that his biology and math backgrounds were good, however he could have used more physics. He had not taken it in high school because it was not a required credit for his program of study. He went on to say however that he would likely still make the same decision if he had to do it all over again because he simply had to do some extra work for a couple of hours at university, but taking physics at high school would have been time devoted to a class all year.

William also did not choose to take physics because it was not required for his program, but he would change his choice if he could do it all over again. He also wished that he had been able to take calculus which was not offered at the time. He did not recommend science students going to university without calculus. Susan felt prepared for most of her courses, but she also wished that she had taken physics in high school. She also felt that chemistry was a weak area for her and she struggled with it at university. She felt 100% prepared for biology. Brenda believed that she had the necessary prerequisites, but more courses offered at high school or better scheduling to allow more choices would have been beneficial.

4.4.7.2 Basic Knowledge & Skills

According to Brenda, high school courses provided an outline for first semester courses. William said that he felt prepared and that the **basic knowledge** from high school was simply built on in most courses; however he felt that biology was basically a repeat of high school material. His biggest criticism of high school education was that the answers were given to students too quickly and that by doing so teachers did not foster good **problem solving** or **critical thinking skills**. Karen was generally pleased with her high school preparation and felt that the background knowledge attained was satisfactory. Specifically she felt that math and physics courses were fine, and for the most part so was chemistry with exception of the unit on electrochemistry. This unit was rushed in high school due to time constraints and then she missed it again due to a strike at her university. Karen did not take grade 11 Biology and found that many concepts covered in her first year were related back to this course. Despite not having taken 11 Biology, Karen performed exceptionally well in 12 Biology and noted that genetics was easy for her at university due to the material taught in high school. John placed a numerical value on how well high school science prepared him; he gave it 7.5 out of 10. He liked having material taught that covered a wide variety of topics. He found that a problem area for him was math skills such as multiplication, division, adding and subtraction. In John's program the use of calculators was not permitted in some situations and the answers required going to decimal places. Aaron felt the focus was narrow in terms of knowledge and skills. He felt this was a problem at both high school and university, although more prominent at university. The emphasis seems to be on

one skill, regurgitating words and their meaning, basically being able to memorize a word and then be tested on it.

4.4.7.3 Varied forms of Assessment

The general consensus seemed to be that in high school there was a variety of assessment strategies used, while at university assessment was largely based on testing in the forms of quizzes, mid-terms and exams. Assignments and labs were usually weighted less than the tests. Depending on the course, assignments may not have been graded for correctness, but rather for completion. William pointed out that in high school quizzes allowed him to assess himself prior to a major test; however this method does not work at university because the quizzes are worth too much of the overall grade. Aaron discussed a need to have students do more research, using sources like journal articles, for lab reports. In high school most of the work was done in class, so it was a bit of a surprise to have to do research to complete a lab and it was a learning experience to navigate the journal articles.

4.4.7.4 Literacy and Language Acquisition

A theme that emerged here was the amount of **vocabulary** that students are exposed to within a science degree. John felt that language acquisition played a large role as there was a lot of vocabulary to learn, plus students were expected to expand their knowledge by reading the textbook, which of course would be very difficult to do without the appropriate discourse.

William felt that high school provided the bulk of vocabulary, saying that he had not come across many new words in university and that it was basically

building on vocabulary from high school. He also commented on his strong **reading** skill and ability to skim well. He actually found it difficult to complete readings in full because he was accustomed to skimming material. Skimming is a valuable skill; however he could not get all the information that he needed using this method. The outcome was that he would go over the same page several times as he continued to fall in the trap of skimming rather than thoroughly reading. Karen also felt that she had a strong vocabulary going into university, and in addition mentioned her knowledge of breaking words into their parts, such as having an understanding of prefixes and suffixes. She found that this helped her to learn new vocabulary and to understand its meaning. She also felt she was a strong reader and that this was a definite asset. Interestingly, she did state that she was not sure if these skills could be more attributed to her high school education or to her parental influence. Both of her parents are well educated and avid readers and Karen felt that this influence may have been just as, if not more, important than that of her high school education.

Aaron found that there was a great deal of **writing** required in his courses and that he was still being penalized for grammatical errors. He took a communication course which he found useful, but noted that he soon forgot most of the information when the course was over. Brenda and Susan both felt that their knowledge of vocabulary helped them to understand the lecture material. Susan added that she learned more from class than from the text book.

4.4.8 Question 8: How are university science courses different from those in high school?

Themes that emerged during this question were: independent learning, assessment, pace, and depth of course of material.

4.4.8.1 Independent Learning

The participants seemed to have the feeling that at university “you’re on your own.” There was a great sense of you had to “figure it out for yourself” because nobody was going to help you. In contrast to high school, Karen summed it up by saying that in university there is “less one on one help”. William said that help was available but you had to be willing to ask for it and it would take place outside of class time during office hours. He found that during class there was a wide use of PowerPoint presentations and the notes were given in this format, often posted on line, with the problems already completed. Problems were rarely completed in the class in a sequential way so that students could see the steps taken or gain a better understanding. Even if a question was asked during class it was unlikely that the professor would go through the problem. William felt that a student was lucky if his/her question was answered. This lack of support during class time led to many hours of time being spent attempting to solve problems on one’s own. Susan echoed much of what William said. She said that the expectation at university is that you will teach yourself and if you do not understand it then you will go look it up and figure it out for yourself or with the help of fellow students. She did not feel that you could ask questions during class because of the number of students, for example her biology course was around 200 and chemistry was around 120. She felt that in high school you had

to be “a little bit independent”, but at university you had to be “a lot independent”. Brenda also felt that she was learning how to study on her own because classes were not providing her with all that she needed. She also mentioned the large classes.

4.4.8.2 Assessment & Evaluation

Karen and John both commented on the differences with assessment and evaluation. Karen pointed out that her courses had a section of time devoted to labs outside of class and that this had its own grade. The weight of the labs varied depending on the course. Her other observation was the weight of exams; she felt that they were worth a lot. At university, John recognized a greater emphasis on formal testing and a lack of assessment items like projects and papers, which he felt had helped to improve his overall grades in high school courses.

4.4.8.3 Pace & Depth of Course Material

William mentioned the amount of material covered and how quickly it was covered, noting that the pace at university was much faster than that of high school. Brenda found that the material covered at university was more in depth and that the exams were harder given the amount of information to study. Aaron and John both focused on how the material became more in depth and more focused to their specific field of study. Aaron’s biology course was designed to teach human anatomy and physiology, while in high school he was exposed to material about humans, as well as plants and other animals. John also found that

the material was more specific to his profession with the emphasis being on the human body.

4.4.9 Question 9: What advice do you have for high school science teachers to better prepare students for university science?

Each participant seemed to have a unique outlook on this question and there were not any strong themes that stood out. John would advise teachers to change the policy on exam exemptions. He thinks that having exams would get students used to the routine of studying and help students to deal with the stress of exams. The other point that he made was that even at high school class size is a factor. He thought that during labs in particular, teachers should have assistants so that students can get the guidance they need in a timely manner, whereas the current situation leaves students waiting for long periods which translates to unproductive time and possibly safety issues due to student boredom. Last, he felt it was important for teachers to make courses enjoyable and for teachers to know their material.

Aaron would like teachers to focus more on teaching human biology, but recognizes this may help people like him but not everybody. He also thought that teachers should try to help students see where the information that they are learning will be used later.

Brenda wants teachers to make tests harder and cover material in greater depth. She also thinks teachers need to emphasize understanding over memorization. Susan thinks that teachers need to expect students to figure things out for themselves and not give answers so readily. She also suggested that reading the text book needs to be a necessary part of the courses to prepare

students for the realities they will face at university. William felt that teachers needed to increase the number of advance problems and give fewer of the basic ones. He also felt that teachers should emphasize students having to teach themselves and using the textbook more so to find important information. Karen was pleased with the curriculum covered, however she would like teachers to move at a faster pace because the pace at high school left some students bored.

4.4.10 Question 10: What advice do you have for university professors to help students make the transition from high school to university science?

Again this question did not seem to bring out any recurring themes. Karen was quite content with both her high school and university education. She did not have any advice for professors; she felt they were good teachers and you could do well as long as you tried. William would like to see the professors spending more time on the basics so that students will be prepared to handle the more advanced problems. He also noted that past exams were placed on file, but the answer key was not provided so the student would not know if the answers were in fact correct. He felt that having old exams on file was a good practice; however for students to truly benefit from it that the answers need to be available. Susan would like professors to take the emphasis off midterms and exams and to place more value on essays and assignments that would check for understanding. She also thought that assignments having a greater weight towards the final grade would serve as a good motivator for students to both do the assignments and to do them to the best of their ability. Brenda thinks that professors could do more to offer extra help and to assist with the set of study groups. Aaron would like

professors to make their classes more interactive and to demonstrate that they care whether or not the students are in fact learning.

Finally, John suggested that in first year courses should be less in depth because many first year students are trying to figure out what they want to major in. He also felt professors should try to keep a relaxed atmosphere in their classes and try to make learning as fun as possible.

CHAPTER V: SUMMARY/DISCUSSION OF INTERVIEW THEMES

5.1 Comparison of High School and University

A number of themes emerged from the responses of the participants during the interviews. The key differences between high school and university are summarized in Table 3.

Table 3: University Versus High School

University	High School
Emphasis on testing	Varied assessments
Figure work out for one's self	One on one help
Part of mark devoted to labs	
More material covered	Less Material Covered
Faster Pace	Slow Pace
Help by appointment	Help during class
Notes on Line	
Independent Student	Dependent Student
Large Class sizes	Small Class sizes
Expected to teach one's self	Teacher directed lessons
Information was specific within topic of study	Information was broad within topic

5.2 Positive Aspects of High School Education

Participants pointed out many aspects that were positive about their high school experience. In a time where there seems to be a negative slant on education in Nova Scotia it was a welcomed outlook. Prior to the start of my study, I had briefly reviewed the curriculum guides for high school science courses compared to the course descriptions of first year university science courses found on the university websites. This information led me to believe that a student who did well in high school science should have the necessary prerequisites for university science, assuming that the high school curriculum

was in fact followed. The participants in this study indicated throughout the questions asked that they had the basic knowledge needed for their courses. The content in first year courses was similar to that of high school courses and largely differed in terms of depth; the information was becoming more specific, more specialized.

The curriculum is a topic of much debate among teachers. Like many, I have questioned the “mile wide, centimetre deep” philosophy that we seem to have. There are numerous topics covered and the amount of material that has to be covered in a short amount of time, ultimately leaves little time for investigation, discovery, and deeper learning experiences. However after doing this study, I now see the benefit of the large number of topics more clearly. Participants liked the number of topics covered because it helped them to identify their interests, to choose their current programs, and gave them a broad background of knowledge to draw upon during their university study. My concern is whether or not teachers can ever get students to develop deep understanding given all that they are expected to cover. I will discuss this aspect further later, as some participants did mention a need for greater understanding and less memorization.

Some other positive aspects of high school included the availability of teacher assistance, note taking skills, repetition of material during class time, use of visual aids, and assignments where critical thinking was required. Participants were satisfied with both teaching methods and assessment at high school,

although as one student noted those methods may not have prepared students for the realities of university, however “high school had it right”. So if high school did have it right, should the teachers at the high school level attempt to change their practices to better prepare students for a university setting or should the professors at universities examine their practices and perhaps modify both teaching and assessment practices?

5.3 Challenges in Rural High Schools

Each of the participants in this study attended the same high school located in a rural area, housing grades 7-12, and having an enrolment of about 450 students. The size and location of the school leads to some significant challenges for school administrators and guidance counsellors to ensure that students have all the course requirements for graduation. The big factors that impact on scheduling at this school are cross over teachers and number of teachers. Cross over teachers are those who teach at both the middle (7 & 8) and the senior level (9-12). Given the small size of our cafeteria and only one gymnasium, there are two lunch periods, one for middle and one for senior. Two lunch periods helps with the scheduling for physical fitness classes in that it adds eight periods in the cycle that can be used, however there are still classes that are double booked. The Department of Education’s new plan to make physical fitness a required credit is only going to compound this problem.

The number of teachers is largely based on the number of students. Like most things that are done using this kind of system, there is a critical point at

which the formula does not work anymore. In a small school, it means that students have fewer options for courses and that courses may overlap in a way that prevents them from being able to take the courses they want or even need. The issue of course options came up several times during the interviews. In particular the participants noted that classmates who graduated from other larger high schools had many more options than they had. One participant pointed out that the lack of options also impacted the level of seriousness in the class since not all of the students were there because they needed the course in the future, rather some were just there to fulfil a credit requirement. Some of the participants in this study had calculus available while others did not.

Calculus was actually offered to students at my school for a number of years before the school day started. This was done due to scheduling conflicts. The teachers agreed to teach the course prior to the start of the regular school day, so students who wanted to take the course came in early to do so, using their own methods of transportation or taking the elementary school bus run. In addition to the options available, and scheduling difficulties, two participants pointed out how physics would have been beneficial but it was not a required course for their programs of study. One of the two would take physics if she had it to do over again, while the other stated that it was only a few extra hours of work at university and the benefits from taking physics would not have been significant enough to warrant taking the full course in high school. Instead of

seeing improvements in this area, I think that small schools are going to experience greater challenges.

As the Department of Education adds to the list of required courses, teachers in small schools have to be reorganized in order to accommodate the new courses. It is likely that the formula for the number of teachers will not reflect the changes in required courses, therefore course options may in fact become more limited and scheduling may become even more difficult. As an example, this year the schedule had Physics 12 and Calculus at the same time. Most students chose physics, and the enrolment for calculus was only three students. At first glance, it may seem like students at my school do not want/need calculus, however that is not the case. Many of the students in the physics class would have liked to take calculus, but they had to make a choice. One of the participants who did not have the option of taking calculus suggested that it was a significant disadvantage during his university science and math courses. The CETF survey had ranked math skills (non-calculus) as crucial. Calculus was not ranked in this survey which was based on the opinion of chemistry professors. I find it interesting that William, who is majoring in chemistry, felt that science students should definitely have calculus, yet the CETF survey did not include it in the list of skills ranked by chemistry professors.

5.4 Areas of Concern Regarding Adequacy of High School Preparation

The wide coverage of material was seen as both a positive and negative aspect of high school. It was positive because it gave students exposure to a

wide variety of topics, however it was negative because deeper understandings were not developed. Participants also felt that there was a need to make the work in high school more challenging and to raise the degree of difficulty. The participants noted that the pace of university is much faster than that of high school. The slower pace in high school leaves some students bored and unchallenged. The most common issue that came up throughout the questions was that of study skills – how to study, what to study, how long to study, and the amount to study. Participants seemed to feel that while these skills may have been presented in high school, the material lacked the depth and challenge that would require them to put these skills into practice; therefore when taking university courses these skills, while present, had been lying dormant and were underutilized.

The inexperience of writing exams was the other major factor that participants brought up. Each had come from a high school system where students were rewarded at the end of the course with an exemption from exams based on academic achievement, or attendance and work completed. The participants in this study represent a sector of students who achieved academic success in high school and were therefore rewarded with exam exemptions in most of their courses until grade 12 when the provincial examinations were required. Add to their inexperience the weight that many university courses place on exams, and the students were feeling anxiety, fear, and intimidation before ever seeing the exams.

Literacy and language acquisition was asked about, however I am not confident that the question was properly presented. I am not sure if the participants fully understood the question, or perhaps the question needed to be broken into more parts. The responses on this topic were quite limited and did not yield a great deal of insight into this aspect of the educational experience. The participants agreed that it was important but said little to expand on it. One student did mention that it was useful to know prefixes and suffixes as this helped her to understand terms and remember the definitions. Readings were difficult to accomplish simply due to a lack of motivation. One participant pointed out that science readings were quite different from those of other courses, suggesting that they required greater focus and that skimming was not an appropriate technique. Content vocabulary was generally considered to be strong and this contributed positively to the completion of reading assignments.

As the researcher, I was walking a fine line on this question as I tried to get them to say more on the topic without leading them. Given the opportunity to interview again, I would ensure that this question was improved and consider ways in which I could get at more detailed information, as the information that I gained was quite vague.

CHAPTER VI: DOCUMENT ANALYSIS

The goal was to compare course outlines from university to those of the high school that the participants attended, however only two of six participants provided university course outlines as requested. One participant provided the course descriptions as given in the university calendar. The remaining three participants did not have the course outlines in their possession any longer and therefore could not make them available to me. I reviewed the outlines received for similarities and differences between assessment/evaluation and topics covered. I was able to use the course descriptions to compare the topics covered but they did not provide any information about assessment/evaluation. I further compared these documents to the Nova Scotia Department of Education Curriculum Guides for each subject. The following tables summarize the findings regarding topics covered as suggested by these documents for biology, chemistry and physics. All participants had the same course outlines in high school, therefore only one “X” appears in that column to indicate if the topic was included in the course outline. In the “First Year University” course heading, an “X” HAS been placed for each course outline/description that included the topic. Some outlines were more detailed than others, in that broad topics were further described by providing sub-topics. If only the broad topic was given, then it was checked, however if the broad topic included sub-topics these were also checked. When the broad topic is checked, it does not mean that all the sub-topics were covered; that information was not available from the documents. The high school and university courses were compared to the curriculum guide for

each course. Any topics not mentioned in the curriculum guide, but that were covered in the university courses, have been noted at the bottom of each table.

Table 4: Topics covered within the subject area of Chemistry

NS Curriculum Guide Chemistry 11 & 12 (Department of Education, Province of Nova Scotia, 2005)	High School Chemistry 11 & 12	First Year University Chemistry
Stoichiometry <ul style="list-style-type: none"> • Mole and molar mass • Calculations and chemical equations 	X	XXX
Structures to Properties <ul style="list-style-type: none"> • Properties of ionic & molecular compounds • Properties of metallic substances • Classifying compounds • Bonding • Structural models of bonding • Bond energies • Polar and pure covalent bonding • Intermolecular forces (hydrogen bonds, van der Waal's forces) 	X	X X XXX XX
Organic Chemistry <ul style="list-style-type: none"> • Classifying organic compounds • Naming and writing organic compounds • Isomers of organic compounds • Writing and balancing chemical equations • Polymerization • Influence, risks, benefits, applications: STSE perspectives 	X	X
Thermochemistry <ul style="list-style-type: none"> • Energy changes – potential & kinetic • Calculations using bond energies • Hess's Law 	X	XXX

Table 4 Continued

Solutions, Kinetics, & Equilibrium <ul style="list-style-type: none"> • Concentration, properties, and solubility • Solubility and precipitates • Kinetics and rate of reaction • Collision theory, reaction mechanisms, & catalysts • Equilibrium • Le Chatelier's Principle 	X	XXX XX XXX XX XXX XX
Acids & Bases <ul style="list-style-type: none"> • Properties of acids & bases • Acid/base reactions • Equilibrium & acids/bases • Indicators • Titrations • Le Chatelier & acids/bases 	X	X X XXX X
Electrochemistry <ul style="list-style-type: none"> • Oxidation & reduction • Redox and half reactions • Electrochemical and electrolyti cells • Redox reactions and standard reduction potentials • Energy efficiency of cells 	X	XX
Topics that were not covered by 11 & 12 Chemistry High School Curriculum		
Matter- Properties/Measurement (X)		
Atoms, molecules, & ions (XX)		
Atomic theory (X)		
Periodic Table & Some atomic properties (XXX)		
Intermolecular forces, liquids, and solids (XX)		
Gases (XXX)		
Electronic Structure of atoms (XX)		
Entropy & Free Energy (XX)		
Nuclear Chemistry (X)		

As the table shows there is a significant correlation between the topics covered in high school and those covered in university. Many of the topics that were not covered in 11 and 12 chemistry, but were in university, were introduced in grades 9 and 10 science courses. These documents would suggest that students who

have completed high school chemistry would have the necessary skills to meet the academic demands of university chemistry. One of the outlines specifically states that high school chemistry is a prerequisite to the course.

Assessment and evaluation were somewhat different. In grade 12 chemistry, 60% of the students' evaluation resulted from testing (30% exam, 20% tests, and 10% quizzes). The remaining 40% was based on projects and assignments. For one university course 80% of the students' evaluation was based on testing (50% exam, 30% tests). Lab reports were valued at 17% and lab notebooks at 3%. Another university course had testing weighted at 70% (40% exam, 30% quizzes,). Assignments, Laboratory, and tutorial quizzes were each weighted at 10%. The main difference seems to be where the emphasis is placed. In the first university example students are being assessed 80% of the time using one method – formal testing - with 50% being a one time event, the final exam. Compare this to high school where students have numerous ways to demonstrate their knowledge and less emphasis is placed on any one event, rather it is a culmination of many events that determines the students' grade. At 60%, the emphasis on testing is still great at high school, however it is important to consider that testing in high school takes place more frequently and covers smaller portions of information during each testing event. For the two university examples given above the testing that took place involved only three events, where as the testing in high school involved approximately ten events.

Table 5: Topics covered within the subject area of Physics

NS Curriculum Guide Physics 11 & 12 (Department of Education, Province of Nova Scotia, 2002)	High School Physics 11 & 12	First Year University Physics
Kinematics • Vectors	X	X
Dynamics • Newton's Laws • Momentum Introduction	X	XX
Momentum & Energy • Conservation of Momentum • Work, Power, Efficiency	X	
Waves • Sound Waves • Electromagnetic Radiation	X	XX
Force, Motion, Work and Energy • Collisions in two dimensions • Projectiles • Circular motion • Harmonic motion • Universal gravitation	X	X
Waves and Modern Physics • Quantum Physics • Compton and de Broglie • Particles and Waves • Bohr Atoms and Quantum Atoms	X	X
Fields • Magnetic, Electric, Gravitational • Coulombs Law • Cicuits (optional) • Electromagnetism/Electromagne tic Induction • Generators and Motors	X Not done	XX XX XX XX
Radioactivity • Natural and Artificial • Radioactive decay • Fission and fusion	X	
Topics that were not covered by 11 & 12 Physics High School Curriculum		
Waves: Optics (X)		
Fluids (X)		
Thermodynamics (x)		
Systems of particles (X)		
Gauss's Law (X)		

Once again, the physics outlines show strong correlation between the topics covered in high school and those covered in first university courses. I did find it interesting that the circuits unit is an optional topic in high school yet it appeared in both course outlines from universities. I also found it interesting that radioactivity was not covered in university. I had heard the physics teacher at my school comment that the content of that unit was of a nature that the vast majority would never see or use it again. He suggested that the material would not be seen until third or fourth year physics courses, or possibly even later at graduate school. My own knowledge of physics is limited, however the opinion of this physics teacher coupled with the absence of this topic in first year courses, causes me to question the validity of this unit of instruction at the high school level. I was surprised by the number of topics that are required in the high school physics curriculum, as well as by the lack of cohesion between the topics.

Again assessment and evaluation at high school and university showed great differences, however only one course outline was received for physics. The one university course reviewed had quizzes at 45% and the final exam at 40% for a total of 85% on testing. The remainder of the evaluation was based on labs. On the positive side, there were 10 quizzes in total and the lowest quiz mark was dropped. Basically the quizzes would take place weekly and test the students on material from assignments for the previous week. This appears to set up a good system of feedback and allows students to self monitor their progress throughout

the term, rather than with one or two events like mid-term exams. By having regular quizzes, students would be aware of where their strengths and weaknesses were, thereby able to address any areas of concern before the final exam. In high school, the evaluation consisted of a 30% exam, test at 18%, and quizzes/interviews at 18%, for a total of approximately 66% on testing. Labs and research/presentations were each valued at 17%. Testing is still an emphasis; however like chemistry there would be a number of tests and a number of quizzes throughout the course.

Table 6: Topics covered within the subject area of Biology

NS Curriculum Guide 11 & 12 Biology (Department of Education, Province of Nova Scotia, 2000a & 2001)	High School Biology 11 & 12	First Year University Biology
Matter and Energy for Life <ul style="list-style-type: none"> • Cell theory • Cell structure & function • Membranes • Important Biochemical Compounds <ul style="list-style-type: none"> ○ Carbohydrates ○ Proteins ○ Lipids ○ Nucleic acids • Photosynthesis • Respiration 	X	X X XX XX XX X XX XX X
Biodiversity <ul style="list-style-type: none"> • Classification & diversity • Anatomy, physiology & life cycle of representatives from major groups 	X	XX
Maintaining Dynamic Equilibrium I <ul style="list-style-type: none"> • Two of following systems: circulatory, respiratory, digestive, excretory, immune 	X	
Interactions Among Living Things <ul style="list-style-type: none"> • Biospheres • Biomes • Energy pyramid • population growth 	X	XX

Table 6 continued

Maintaining Dynamic Equilibrium II <ul style="list-style-type: none"> • Nervous System • Endocrine System 	X	
Reproduction & Development <ul style="list-style-type: none"> • Cell division • Genetic continuity • Reproductive systems • Reproductive technologies • Embryonic development 	X	XX X X
Genetic Continuity <ul style="list-style-type: none"> • Molecular genetics • Inheritance • Societal issues 	X	XX X XX
Evolution, Change, and Diversity <ul style="list-style-type: none"> • Modern evolution theory • Genetics & evolution • Mechanisms affecting biodiversity 	X	X

The correlation between topics covered in high school and those covered in university is again quite high. Only two participants provided outlines for biology and each of these were for Bachelor of Science with an undeclared major. It would have been interesting to see the outlines for those participants that were in the nursing and kinesiology programs as I suspect that their biology courses had a greater emphasis on human systems and would have included the topics “Maintaining Dynamic Equilibrium 1” and “Maintaining Dynamic Equilibrium II”.

Assessment and evaluation differed for this subject both in comparison to high school and in comparison to the other subject areas. The first difference that stood out from the other subjects at university was the value attached to the final exam which was 35% in both university biology courses, compared to 40% and

50% for physics and chemistry courses. That being said, this decrease is likely due to the addition of a final lab exam valued at 20%. Given quizzes, midterms, final exam, and final lab exam the testing still accounts for a large portion of the evaluation; a total of 98%, over 80%, and 85% in the three courses reviewed. In high school biology 60% of the evaluation was based on testing, however if the student received an exemption from the exam then only 50% (40% of the possible 80%) of their evaluation was in fact derived from testing. The remaining 40% is made up of a number of events under two categories, projects/presentations and assignments/labs, which provided students an opportunity to demonstrate their knowledge in a number of ways.

Other than topics and assessment/evaluation the course outlines also emphasized some of the same things, such as attendance, required materials, and conduct during class. One course outline from university biology contained a page of study tips including read your text, take notes, rewrite lecture notes the same day, and study with a partner.

University course descriptions, as well as course outlines from both high school and university tend to focus on the topics that will be covered. The high school curriculum guides contain a great deal more information including essential graduation learnings, definition of scientific literacy, four general curriculum outcomes (STSE, skills, knowledge, and attitudes), key stage curriculum outcomes, and specific curricular outcomes. Key stage curriculum

outcomes are those that must be met by the end of grades 3, 6, 9, and 12 where as specific curricular outcomes are to be reached by the end of each course for which they apply. The course outlines largely contain information that falls under the knowledge heading. For example a specific curricular outcome for knowledge in Biology 12 is to describe in detail mitosis and meiosis, outcome 314-2 (Department of Education, Province of Nova Scotia, 2001).

On many occasions during professional development days the discussion has been centred on the balance between knowledge and skills. Various factors can interfere with the implementation of a course and result in not all material being covered. In my experience it is the skills, as well as STSE and attitude outcomes, that do not get covered completely in order to ensure that the knowledge outcomes are completed. These are the outcomes that are typically assessed using a traditional test. Interestingly enough, at a school based inservice, we were asked as a staff which was more important, knowledge or skills and unanimously agreed that skills were more important and would be used throughout ones learning, rather than simply being regurgitated for a test situation. In a comparison of biology, chemistry, and physics at the grade 11 and 12 level there were a number of skill outcomes that were required for four or more courses of the six. The following table shows these skills and the courses which required them, as well as an overall total for how many courses required them.

Table 7: Selected Skill Outcomes from 11 & 12 Nova Scotia Curriculum Guides for Biology, Chemistry, and Physics (Department of Education, Province of Nova Scotia, 2000a, 2000b, 2001, 2002, & 2005)

Skill	11 Che	11 Bio	12 Che	12 Bio	11 Phy	12 Phy	Total
<i>Initiating & Planning</i>							
212-1 identify questions to investigate that arise from practical problems and issues		1	1	1	1	1	5
212-3 design an experiment identifying and controlling major variables	1		1	1	1	1	5
212-4 state a prediction and an hypothesis based on available evidence and background information	1		1	1	1	1	5
<i>Performing & Recording</i>							
213-3 use instruments effectively and accurately for collecting data	1	1	1	1	1	1	6
213-5 compile and organize data using appropriate formats and data treatments to facilitate interpretation of the data		1	1	1		1	4
213-6 use library and electronic research tools to collect information on a given topic	1	1	1	1		1	5
213-7 select and integrate information from various print and electronic sources or from several parts of the same source	1		1	1	1	1	5
213-8 select and use apparatus and materials safely	1	1	1			1	4
<i>Analyzing & Interpreting</i>							
214-3 compile and display evidence and information by hand or computer in a variety of formats, including diagrams, flow charts, tables, graphs, and scatter plots	1	1	1		1	1	5
214-5 interpret patterns and trends in data and infer or calculate linear and nonlinear relationships among variables		1	1	1	1	1	5
214-8 evaluate relevance, reliability, and adequacy of data and data collection methods		1	1	1	1		4
214-10 identify and explain sources of error and uncertainty in measurement and express results in a form that acknowledges the degree of uncertainty	1	1	1	1			4
<i>Communication & Teamwork</i>							
215-2 select and use appropriate numeric, symbolic, graphical, and linguistic modes of representation to communicate ideas, plans, and results		1	1	1		1	4

There are many more skills contained in the curriculum guides; however the table above includes the most common ones for 11 and 12 biology, chemistry, and physics courses. In my courses I often make use of observational checklists to assess these skills. I also incorporate these skills within larger pieces of work and include the required criteria in a rubric/marking guide provided to students. As mentioned, my high school teaching colleagues and I consider skills more important than knowledge. The skills included in the table above have direct impact on the success of students within their knowledge outcomes, which appear to be the emphasis within assessment and evaluation at both high school and university. Yet by not emphasizing the skills, both levels of education are guilty of providing a sub par education. Students who have these skills are better able to comprehend and extend knowledge outcomes than those who do not. For example, a student who has skills 214-3 and 214-5 can better comprehend heating curves and potential energy diagrams, as well as see how these visuals relate to formulas used to complete energy calculations.

CHAPTER VII: DISCUSSION AND CONCLUDING THOUGHTS

7.1 Reflections on Teaching Practices

There were a number of questions that I hoped to gain insight into through this study. I hoped to learn about myself as a teacher and discover some beneficial practices that could be used by me, other science teachers, and professors. As I listened to the students both during the interview and while transcribing, I found myself reflecting on my own teaching practice a great deal. I have always felt that reflecting on one's practice was a valuable exercise to foster ongoing professional growth. The nature of the teaching profession has not always allowed time for this important review of my practices. By completing this study, I was provided an opportunity to gain insight into the experiences that students have in my class room. Once I began to analyze the data collected, I could see that there were a number of things that I was doing to benefit students, as well as some that I could be doing to better their experience. I also noticed that there were some things that I had already started to change since I taught these students.

7.1.1 Beneficial Practices

The comments from participants and the comfort level that they displayed while being interviewed, led me to conclude that I had provided a **positive learning environment** where the relationship between students and teacher was one of mutual respect. I have always believed that a class room where comfort, safety, and enjoyment are provided is one where students will have better

learning experiences. Judging from the responses of participants, I feel this belief has been confirmed. I have aimed to provide a class room where students feel free to be themselves, to have a say in the way the class is run, and to have fun while learning. I also try to make students feel like they can talk to me and to get to know them both by taking an interest in their experiences at school and beyond. I do not have scheduled times for extra help, rather the students are encouraged to let me know if they need help and we arrange a time that is convenient for both of us. Availability of the instructor at university was an area of concern for participants. In high school they were accustomed to having one on one contact with the teacher and a sense that the teacher was willing to help them. The impression given by participants was that the university professors did not care, and although they did not elaborate, they did seem upset by this. My sense of the situation was that the participants' learning style did not match the professors' instructional style, and the instructional style often led to a lack of direct contact with between participants and professors. Lee (1997) cited learning style and instructional style as two factors that contributed to a difficult transition to university in that the learning style of the students did not match the instructional style being used by the professors. Furthermore the relationship between student and professor was under developed. Some of these issues may be related to the size of the university; however there were not enough participants from universities of various sizes in this study to explore that factor.

The participants indicated that their **background knowledge attained in high school** had been satisfactory and that it tied in well with their university courses. Although there are occasions when time prevents me from covering some aspects of the course, the objective is to cover the material as prescribed by the Department of Education. Given the correlation of content between high school curriculum and university curriculum within the sciences, and the experiences described by students, I feel that covering the curriculum is a benefit to the students.

Teaching methods were also a factor that the students had faulted at university. I try to use a variety of methods and some are quite traditional such as lecturing while others involve dynamic models using students to represent the parts involved. The latter method increases student interaction and often leads to a more memorable, as well as enjoyable, lesson. The lecture method used at university was a complaint more than once. Coddling (1995) identified retention as a major problem in the chemistry program at University of Calgary. Teaching methods that did not put material into context and lack of interaction were among the problems identified. The participants in this study would like to see greater interaction which can be achieved through varied teaching methods. Repetition and visual aids were cited as beneficial teaching practices that helped participants to learn and retain concepts while in high school. I try to stay focused on the idea that in order for a person to retain vocabulary they have to use it, so there is a great deal of repetition in my classroom often through simple

activities. These may include short reviews at the beginning and end of class using questions, games, role playing, and finding matching pairs for cards distributed to the students.

In my attempt to get to know students, I also take the time to share my personal experiences so that they get to know me. I think that it is important that **students know about their teacher** beyond the classroom and that they are aware of our outside interests, continued education, and community ties. In the process of sharing such things with students, my experiences at university often came up. Sometimes this was simply a funny story while other times it described the academic demands of university. One participant felt this advice and sharing of experiences was beneficial. Although they did not all discuss this as a factor, it is an easy practice to incorporate in the daily routine and one that I intend to continue.

7.1.2 Practices to Improve

As I mentioned above, I believe that reflection on one's own practice is imperative to professional development. While there are many things that I am doing well, there are some things that I could be doing better. One of the areas that I need to get better at is requiring students to work independently in areas like problem solving, thinking critically and preparing for tests. As Cook and Leckey (1999) found, working independently was an area where students had struggled. It is not that I do not give work that requires this, but rather that I am

too quick to help. I recognized this before I did my interviews and had already started to implement changes; however the information from the participants supports this short fall. The participants had concerns over the amount of information that was given about the material on tests and amount of help that was given to students as they worked on problems.

Since I taught the participants, I have implemented some changes within these areas. Rather than giving directed notes I have been assigning chapter readings and note taking. The material is then discussed in class and a variety of instructional techniques are applied to ensure that students understand the concepts that they have read. To guide them on the note taking, students are directed to use the section review questions as an indicator of the important ideas in the chapter. The students complete the questions and add notes to support the material that was not covered by the questions. This material can then be discussed in class with greater ease since the students have been introduced to the terminology and the concepts. It allows me to spend more time on interactive activities that lead to better understanding and more memorable learning opportunities.

I also noticed the acquired helplessness that students had demonstrated during activities that required problem solving and critical thinking. Students were quick to ask for help, and by help they meant the answer. Little attention was being paid to background readings, directions, and basic understandings that

would allow the students to solve the problems on their own. I decided that I was not going to be so quick to give “answers” and would insist that they demonstrate how they had already attempted to solve the problem. The limited class time and difficulty of getting to all students who need help made this a difficult transition; however in a very short time I noticed that the students took on greater independence and my time was now being spent in more productive and beneficial ways. In a review of Mary Budd Rowe’s work on effective questioning, McNergney and Haberman (1986) point out the benefits of adding wait time after questions have been asked, as well as after the students have responded to questions. In essence, adding wait time is what I was doing, but I was not limiting the approach to just my questioning technique. I integrated the approach into the routine followed during independent work time. The benefits mentioned by McNergney and Haberman (1986) in response to additional wait time while questioning students are quite similar to my own observations in the classroom and they include: greater depth of thinking, longer responses, greater inferences, improved arguments, greater idea exchanges, greater participation, and greater confidence. By allowing more time before giving answers and pausing to consider student responses, the students were in fact given more time to think. My favorite moment is when they ask me a question and I pause which ultimately leads to more talking on their part and I get to hear the thinking process, and most of the time they answer their own question. I have to come to respond to this by saying “Glad I could help” and we share a little laugh as they realize that they solved the problem without my help. The key was to be patient and to

realize that my bad habit of giving the answer and their bad habit of wanting the answer would take some time to overcome. It was reassuring to hear the participants in this study saying that they would have liked more emphasis on independent learning which instilled good problem solving skills, the ability to think critically, and to recognize what material is important.

When I first made these changes I did not have data from this study; it was more of a hunch based on the experience that I was having as a teacher. I found myself in the staff room complaining, wondering what was wrong with these students and asking questions like “why can’t they do...”. Since what I was doing was not working, I decided to try something different. When I taught the participants I was doing the work for them in many cases, such as providing directed notes, being specific about the material and types of questions on the test, and coming to their rescue too quickly. It would be interesting to interview the students I have now in a few years to see how their experience differs from the participants in this study. It is difficult to know whether or not the changes that I have made have been beneficial, but the information from participants certainly supports the changes that I have made.

A greater emphasis on skill outcomes within the high school curriculum is another area where improvements are needed. Many of these outcomes directly tie to the skills of problem solving, thinking critically, and analyzing material. By putting knowledge ahead of skills we are disabling our students as life long

learners. Discussion with colleagues at in-service training indicates that it is common to place the knowledge outcomes ahead of the skills outcomes, especially if a Nova Scotia Provincial Examination is a requirement. These exams primarily assess knowledge outcomes and are valued at 30% of the students' grade. It is not surprising that teachers feel the pressure to ensure that all knowledge outcomes are met, and given time constraints that may mean that not all skill outcomes are met, as well as STSE and attitude outcomes (See Chapter II: Literature Review, 2.5.1, for a review of categories of outcomes used in the NS Science Curriculum). That being said, teachers need to find a way to ensure that those skill outcomes are integrated into the instruction of the course. Within my own small school, this problem can be readily addressed as there are only two people, sometimes three, who teach senior high science classes. In the upcoming school year, collaboration among teachers is a professional development mandate, therefore professional development days should be possible for us to look at the skill outcomes for each of our courses. By examining the curriculum we can discuss ways that we can each address these skills in our classrooms and we can ensure that we meet all of them. As Table 7 showed there are a number of skills that are common between the science courses. Curriculum alignment and cross curricular plans may be the solution to getting the skill outcomes implemented, as well as the STSE and attitude outcomes.

7.2 Larger Instructional Issues

There is work that still needs to be done to aid in a smooth transition to university for science, and likely all students of any discipline.

7.2.1 Study Skills

The most unifying topic from the participants was a lack of study skills. The curriculum has a number of outcomes, as discussed in the literature review there are knowledge, skill, attitude, and STSE outcomes. In reviewing these outcomes there is little that points to study skills. I believe this may be one of those areas where teachers make assumptions. In my case, teaching at grade 11 and 12, I have “assumed” that students have certain skills around studying from their previous grades. The problem is that teachers are not always taking the time to teach skills around studying. One of the things that I hope to improve in my lessons is that of “how” to study. There are some good resources that have techniques in them. One example is Teaching Students with Learning Disabilities produced by the Alberta Education Special Education Branch. It is directed at students who have learning disabilities; nonetheless the strategies in this resource are beneficial to all students. There are a number of strategies covered in this document to assist with goal setting, time management, organization, note-taking, studying and taking exams (Alberta Education Special Education Branch, 1996). For example it provides a five day strategy to prepare for a test, as well as tips on how to tackle a variety of questions that may be found on tests/exams such as true/false and multiple choice.

7.2.2 Exam Preparation

In addition to study skills, students need more direction on how to prepare for exams. Simply writing more exams will solve little if there is not any attempt to improve the skills associated with taking an exam. The exam exemption policy was brought up a few times as a contributing factor to student difficulties. This policy has been changed such that exemptions are now done course by course and based on academic achievement. As a staff, we agreed that any course that has a provincial examination at the grade 12 level, would not give exemptions in the previous levels. For example, math courses in grade 10 and 11 do not have exemptions. The mixed approach provides exam experience but still rewards those who consistently perform well academically. Exemptions are still done in all Grade 9 courses as this is a transition year from middle school to high school. The students seem to have adjusted to the new policy and did so with very little complaining. My students will now have three to four years of exam experience when they leave high school. This experience alone is not enough; the students must be taught the skills and knowledge that are required to prepare properly for an exam. The resource mentioned above, *Teaching Students with Learning Disabilities*, has test taking tips that are quite simple and easily brought to the attention of students. Again I think that teachers assume that students have certain skills that were gained in earlier grades when in fact those skills are quite lacking.

A few participants mentioned the types of questions that were on exams as problematic, such as multiple choice and true or false. As mentioned in the

previous section, there are resources available to help students prepare for the types of testing that they may encounter. Students need to be exposed to a number of different types of testing questions and the approaches to these need to be modeled. In reviewing my own tests I have found that I use fill in the blanks more so than some other short answer types of questions. I have started to build banks of questions of different types that I can pull from when it is time to make the test. The question bank allows me to tailor the test to the class and to change the test so that it is different from years past. This is a time consuming task in the beginning stages, however once complete it will be a time saver.

I have completed a bank of multiple choice questions for Chemistry 12 which includes all four units. It takes very little time to select questions and make a new quiz, test, or exam. I hope to create a bank of questions that consist of true or false, fill in the blanks, and extended responses. When I do reviews with the students, I have also started to use different types of questions during that time and to model how to approach it. For example, if the question is multiple choice I tell students not to look at the answers until they have thought about it first, and try to answer it without looking. Often they know the answer and when they see it in the list it gives an added sense of confidence. The other method I tell them to use is the process of elimination; check to see which answers are not correct and eliminate them from your choices.

Secondary teachers play a significant role in the preparing students for university. Although not all students are destined for university, implementing practices that provide students with skills that have been discussed will benefit all students regardless of their future plans. Many of the suggestions for change that participants gave can easily be added to the regular routine in a class room and will benefit the entire group, not just a few.

7.3 Areas of Improvement for Universities

Class atmosphere and assessment/evaluation were the key themes cited by participants that needed change at university.

7.3.1 Class Atmosphere and Relationships

In general participants found that large classes contributed to a class atmosphere where little dialogue between student and professor was fostered. The large classes are not within the control of professors and it is unlikely that this factor could be changed. That does not mean that professors could not work to improve the situation. By being aware of the issue, perhaps they could work to foster greater interaction during class time. The students need to feel comfortable in order for this to happen. A simple starting point may be to ask a small sample of students to talk on the first day of class about what they are taking, why they chose this course, and possibly future plans. This could be a good ice breaker and open the door to more interaction in later classes. It would also address another concern that participants had which was that the professors had little interest in them. For the participants in this study, this may have come up

because they came from a small school where there was a great deal of sharing of both the ups and downs in life. Their accomplishments were celebrated by students and staff and when tragedies happened support flowed from staff and students. I think that at university this may have been something the students were missing. Unfortunately I can only speculate as this thought did not occur to me until after the interviews were completed.

7.3.2 Broadening Teaching and Assessment Methods

Participants also wanted to see a move away from the lecture method and a move to teaching methods that were more interactive. In addition to the change of teaching methods, the participants would like to see more varied assessment and a move away from the emphasis on testing in evaluations. In the literature review, I discussed the problem of student retention in first year. By making changes in these areas improvements might take place in the area of retention. A change in teaching practice could lead to a better learning experience and maintain the interest of first year students. Varied assessment would allow students to demonstrate strengths and weaknesses. One participant felt that the formal testing that took place was really just an activity of regurgitation and that it poorly assessed actual learning. Class size may again be a limiting factor because some types of assessment require more time to grade.

Since team work and communication are areas of weakness that have been cited in the innovation survey, the answer may be to implement greater use

of group work at university and have students present to the class. This method was used in a number of courses that I took, some of my favorites actually, but it was used in my third and fourth years of study, and not in my first two years. It gave context and real world connections to the material that we were learning in class. The learning from this kind of assessment was far more valuable than when I memorized material for a midterm. In short, professors need to get more creative in order to provide students with interesting, interactive, and long lasting learning experiences. They need to be creative not only in how they teach, but how they assess, as well as critically looking at their evaluation schemes. Should a one time event be worth 50% of an overall grade? Do their assessment and evaluation practices provide a clear picture of what the student knows? Do these practices assess the essential learning outcomes that professors want students to have when the course is completed?

According to the Public School Programs: 2003-2004, assessment is defined as a “systematic process of gathering information on student learning” (Department of Education, Province of Nova Scotia, 2003, p.C-3). When done well, assessment impacts learning in a positive way by providing information that can both improve student achievement and improve instruction. Often used interchangeably, assessment and evaluation are not the same thing, however they are closely related to one another. The assessment practices provide the basis for evaluation. According to the PSP: 2003-2004, evaluation is defined as a “process of analysing, reflecting upon, and summarizing assessment information

and making judgments or decisions based upon the information gathered” (Department of Education, Province of Nova Scotia, 2003, p. C-4). The PSP provides guiding principles for assessment and evaluation; do university professors have such a document to guide them in their course planning? Of the principles found in the PSP, I believe one of the most important is to ensure that the assessment used “informs teaching and promotes learning” (Department of Education, Province of Nova Scotia, 2003, p.C-4). I am not convinced that the emphasis on testing within university course assessments is meeting this need. How can as little as three testing events inform teaching or promote learning? Once the test is completed the students move on to the next topic and have little time to revisit areas of difficulty; albeit the final exam will assess work from the entire term.

7.4 Need for Action and Further Research Related to School/University Transitions

This study was my first experience implementing qualitative research. I had read and discussed literature on qualitative methods, but I had not put the methods into practice. Having completed this study, I see areas where a greater level of experience may have yielded more in depth answers from participants and perhaps more insights into their experiences. The use of semi-structured interviews was a good method for this study, however I feel my own inexperience caused me to miss opportunities to “dig deeper.” For example, I would like to have clarified what study skills meant to each participant as it was a recurring theme throughout the interviews. I noticed that with each interview it became easier to respond to what the participants were saying and in doing so I was able

to get more information about the experiences of the participant. My knowledge of qualitative methods was largely theoretical, rather than practical. I would compare it to having read about doing a dissection on a frog, but not having actually completed the task. The theory guided my process, just as directions would guide the dissection, however the implementation of the theory yielded the unforeseen and required me to respond to the situation.

When I embarked on this study, I had only hearsay to inform me about the experiences that students from my high school were having at university. The review of literature, curricular documents, and interview data has given me a much more comprehensive understanding of those experiences, as well as what can be done at various levels to improve those experiences. I have gained a great deal of insight about my own practices in the classroom; I have learned about practices that participants found beneficial as well as areas where I need to make improvements. This study both required and allowed me to reflect on my practices, which is a valuable method of professional development. During my Bachelor of Education degree self reflections about our teaching assignment were often required. While many of my friends found this an annoying process, I found it beneficial. Doing this study reminded me of the importance of such reflections and I reinstated them into my practice, although in a much more informal manner.

I believe that the information from this study can benefit not only my practices, but those of other high school science teachers and university professors. It also can inform special organizations committed to excellence in science teaching, such as the Association of Science Teachers (AST) and Atlantic Provinces Council on the Sciences (APICS), so that they can encourage improvement of current practices at all levels of education through initiatives like inservice training, conferences and communication plans.

The participants in this study had experienced an overall drop in averages compared to high school, but they were achieving passing and often good grades in science courses as well as the others. I did not talk to anyone who had been unsuccessful in the transition therefore it is difficult to determine what characteristic allowed these students to be successful while others drop out or fail their courses at university. I often hear about past students who do not continue with their university education after the first term of study ends. Some of these students graduated at or near the top of their class, yet they experienced failure at university. This is an area that would be interesting to study further.

Course options are a challenging concern to address given our small school. This is an issue that requires outside intervention by the NS Department of Education. The inequities between large and small schools need to be addressed and more needs to be done to ensure that our students have similar opportunities to those who live in more populated areas.

I am also curious as to whether students from different high schools have similar experiences as the participants in this study. The experiences that students have may be very dependent on the instructors that they have so it would be interesting to discuss this transition with students from other high schools.

I would also like to discuss the findings of this study with university professors. The discussion that I have provided about professors is from the student's perspective. It would be interesting to see what professors think about changing teaching methods and assessment/evaluation. Universities need to implement practices that will aid in smoother transitions and address the concerns that students have raised. What are the challenges associated with each of these problem areas? What are professors willing to change?

There is still much that can be investigated about this transition and much that can be implemented to ensure that students have better experiences. In my own classroom, I plan to further:

- Emphasize independent learning
- Emphasize skill outcomes
- Teach study skills
- Teach exam preparation skills

- Vary test/exam question types
- Model solution solving for various question types

University professors can make changes within their own courses such as:

- Develop teacher/student relationships
- Vary assessment practices
- Re-examine evaluation practices
- Vary teaching methods to ensure interaction and understanding

The Association for Science Teachers (AST) and Atlantic Provinces Council on the Sciences (APICS) are two organizations that could have a significant role in addressing the concerns raised by this and other studies in relation to the transition from high school to university. The mission of the AST is “to foster excellence in the practice of science teaching” and one of their goals is “to promote and establish the AST as a positive and active participant in the decision-making and goal-setting aspects of science education, both in Nova Scotia and nationally” (Association for Science Teachers, n.d.). APICS goal “is the advancement of science and technology through education and public awareness and the promotion of scientific literacy, education, and research throughout the region” (Atlantic Provinces Council on the Sciences, n.d.). Organizations that are committed to science education, like AST and APICS, need to combine efforts to ensure that the best possible methods are being used

at all levels of education. Communication between such organizations regarding the transition from high school to university needs to be improved and common goals need to be set. Opportunities need to be available for high school teachers and university professors to discuss the issues faced by students. This interaction is necessary to ensure that the recommendations are consistent with educational requirements and realistic to implement successfully. Science education is a pivotal component to the progression of society and should be given the attention necessary to ensure its success.

More students need to be interviewed, and instructors at both the high school and university level need to be asked for their input. The areas of concern that were highlighted by this study can be addressed for the most part. I look forward to seeing the work that is done on this topic and possibly continuing my investigation in further studies. It was very rewarding to talk to past students and hear that they were mostly satisfied with the education provided by myself and my coworkers.

Finally, I believe this study has benefited my practice as a teacher and I believe that the experiences of the participants could benefit other teachers and the professors. As I said before, reflecting on one's own practice is an important part of professional development and we have to be willing to make changes based on what we learn.

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APPENDIX A: Letter to participants & Consent to participate

Date

Dear Participant:

I am writing to invite you to participate in research for my *Master of Arts in Education Thesis* requirement. I have asked for your participation because you were in one or more of my science courses during your senior high school experience and you have chosen a program within the sciences at university.

My thesis topic is "Science Students: Making the transition from high school to university". As part of my research, I would like to interview you to discuss your experiences as you make this transition. I believe that this study may provide me and other science teachers with valuable insights into our teaching practices and the education that we are providing our students.

Participation is completely voluntary and you can remove yourself from the study at any time without penalty. The interviews will take about 2 hours and will be audio recorded. Once the interviews are completed the content will be transcribed and then sent to you for review and further comments. To maintain confidentiality, you will be given a pseudonym that will be used in all work subsequent to the interview. A summary of results will be sent to those participants who would like to receive it. Simply indicate this on the informed consent form. All information collected during the study will be maintained in a locked filing cabinet and upon completion of the study all data will be shredded.

Should you choose to participate in the study please contact me. We will set up an interview and complete the informed consent paper work at that time. You can also contact me if you have questions or concerns. I can be reached at [REDACTED], as well as by e-mail [REDACTED]

My supervisor is Dr. Susan Church who can be contacted at Mount Saint Vincent University, (902) 457-6192 or e-mail Susan.Church@msvu.ca . If you wish to speak to someone who is not directly involved in the conduct of this study, you may contact the Chair of the University Ethics Board (UREB) at (902) 457-6350 or email brenda.gagne@msvu.ca .

This research has the potential to help teachers at the high school level better prepare students for university education. I look forward to talking with you about your experiences and personal reflections about the transition from high school to university.

Jeannie Montgomery
Masters of Arts in Education Student
Mount Saint Vincent University

Consent to Participate Form

I, _____, hereby agree to participate in a study entitled “Science Students: Making the Transition from High School to University” being conducted by Jeannie Montgomery, a student in the Master of Arts in Education Program at Mount Saint Vincent University. I understand that the study has the potential to help teachers at the high school level better prepare students for university education.

I have been assured that participation is completely voluntary and that I may remove myself from the study at any time, without consequence.

I understand the interviews will take place at a time and place agreed upon by the researcher and myself. Interview locations will preferably be in public settings. I understand that the interview will be audio recorded and it will last approximately 2 hours. I will be sent a copy of my transcribed interview for review and further comment. Upon request, a summary of the results of the study will be mailed to an address as indicated by myself.

I understand that confidentiality will be maintained by the use of a pseudonym in all work subsequent to the interview. I have also been assured that all data will be stored in a locked filing cabinet for the duration of the study and that upon completion of the study, all data will be shredded.

If I have questions or concerns regarding the study, I may contact Jeannie Montgomery at _____, and RR1 Annapolis Royal, NS B0S 1A0. I may also contact the thesis supervisor, Dr. Susan Church at Mount Saint Vincent University, (902)457-6192, Susan.Church@msvu.ca . If I wish to contact someone not directly involved in the conduct of the study, I may contact the Chair of the University Research Ethics Board at (902)457-6350 or brenda.gagne@msvu.ca .

I share the researchers concern that familiarity with the participants could have a negative impact on the gathering of data due to the hesitancy of former students to make what could be perceived as negative comments. I understand that I will be asked to provide grades (both high school and university) and university course outlines for science courses, past and present. Should the course outline not be in my possession, then I will provide the researcher with the course name, number, and section, such that she may obtain the outline from the university professor.

I understand that the interviews will include the following questions and discussion that may result from responses to those questions.

1. Tell me about your transition from high school to university.
2. What aspects of this transition have you found challenging? Easy?
3. What aspects of your high school education contributed positively to your transition? Negatively?
4. If you could change anything about your high school science courses to improve your current situation, what would it be?
5. What aspects about your high school science courses contributed positively to your university transition?

6. What problems have you encountered within your university science courses?
7. How well do you think your high school science prepared you for the courses you are taking now at university? Do you have the necessary pre-requisites? Basic knowledge? Skills? Experience with varied forms of assessments? What role have literacy skills and language acquisition played?
8. How are university science courses different from those in high school?
9. What advice do you have for high school science teachers to better prepare students for university science?
10. What advice do you have for university professors to help students make the transition from high school science to university science?

Date: _____

Name of Participant (Print): _____

Signature of Participant: _____

Name of Parent/Guardian (required if participant is under 19):

Signature of Parent/Guardian (required if participant is under 19):

Signature of Researcher: _____

If you would like to receive a summary of the results of this study, provide the address to which you would like it sent.

APPENDIX C: Participant Interview Questions

1. Tell me about your transition from high school to university.
2. What aspects of this transition have you found challenging? Easy?
3. What aspects of your high school education contributed positively to your transition? Negatively?
4. If you could change anything about your high school science courses to improve your current situation, what would it be?
5. What aspects about your high school science courses contributed positively to your university transition?
6. What problems have you encountered within your university science courses?
7. How well do you think your high school science prepared you for the courses you are taking now at university? Do you have the necessary pre-requisites? Basic knowledge? Skills? Experience with varied forms of assessments? What role have literacy skills and language acquisition played?
8. How are university science courses different from those in high school?
9. What advice do you have for high school science teachers to better prepare students for university science?
10. What advice do you have for university professors to help students make the transition from high school science to university science?