Reducing the Gap Between Secondary to Post-secondary: A Case Study on a Science Focused Program

By

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Abstract

In this research project, I explored the role of an established Science Focused Program (SFP) in an Ontario high school which focuses on enriching students’ experience while developing their skills to transfer from secondary to post-secondary education. Few of the many students that initially enroll in science programs in post-secondary education, graduate with a science degree due to their lack of preparation in secondary education. By learning about this program it can help the education community explore its characteristics to apply in the Ontario Science Academic curriculum or other curricula. To explore, I interviewed three science teachers that taught both in SFP and in the Ontario Academic Science curriculum. The results were indicative that students in SFP were more intrinsically motivated and involved in extracurricular activities in comparison to their peers in Ontario Academic Science curriculum. Also, students in the SFP program were exposed to richer lessons and resources. The findings suggest that students in the SFP program might develop the necessary background and science skills for a smooth transition to post-secondary education. In the future, in-depth analysis of the program by following up with students before and after getting into post-secondary sciences could provide more insights on this topic.

Key Words: science program, intrinsic motivation, secondary to post-secondary gap, student drop out, science curriculum
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Chapter 1: Introduction

1.0 Research Context and Problem

Science is an area where there are vast opportunities that we need to explore and learn to build successful societies. Hence, it is important to train innovative minds for the future in order to build successful societies. In other words, “the more people know about math and the sciences […], the more they and society will profit from this knowledge” (Camara, Dorans, Morgan, & Myford, 2000, p. 3). Science is a challenging field to pursue scientific studies in post-secondary education (i.e. university) and to develop a career in it. Although, many students are optimistic about obtaining a science degree but only few are able to graduate with such a degree (Stinebrickner & Stinebrickner, 2014). “The main reason cited was that they [students] were not prepared for the rigors of college [university] academics in high school.” (Robinson, 2003, p. 265). This could largely be attributed to beginning post-secondary with misperceptions of doing well academically in science, as a consequence of being underprepared in secondary education (Stinebrickner & Stinebrickner, 2014). In other words, there is a disconnect between secondary and post-secondary education in science.

Educational reforms (changes to the education system) have demonstrated improvement in high school education and lead to growth in math and science achievement to reduce the knowledge gap in students (Robinson, 2003). In the United States this was addressed with the application of a non-profit organization program, like the AP (Advanced Placement) Program. This program was developed to select “talented” students to motivate and challenge them for successful college (university) work (Robinson, 2003, p. 266). Robinson (2003) showed that most AP students pursued the same course of study in college (university) as they did in AP.
This trend was particularly seen for students in biology, studio art, calculus, physics, and Spanish literature (Robinson, 2003). This program also expanded to Ontario and some of its courses have been integrated into SFP (Science Focused Program). The name of the program has been changed and its specific location omitted to respect privacy ethics of this research study. SFP has been operative at a specific high school in Ontario for more than 25 years (SFP Program, 2016). In this study, the pseudonym for this location is I.G.1. A second location has recently opened and functions independently of I.G.1. The focus in this study is on the first location, I.G.1 because it has a long-standing history in operating SFP. All information on SFP in this research study was obtained from I.G.1 location. Therefore, SFP is discussed in terms of I.G.1 in this research study. The program aims to widens students’ skills and knowledge by exceeding the “traditional”/standard curriculum, Ontario Science Academic curriculum, as it provides enriched university level and some AP courses (AP Physics and AP Math courses) (SFP Program, 2016). The program is competitive to enter and students are eligible to apply from Grade 8 until Grade 9 of Ontario curriculum to enroll in Grade 9 and Grade 10 of SFP, respectively. To be part of the program, students write an entrance exam that challenges even the “best” applicants in math, science, and English. In 2011, 60 out of the 500 applicants were successful in their application (SFP Program, 2016). In addition to the entrance exam, students need to submit a student profile which includes: activities and type of involvement, certificates and awards, interests and hobbies, and their Grade 7 report card. Students who do get into the program have the opportunity to also attend enriching events. Some of these events include school trips in and out of Canada: Camp Pinecrest (Grade 9) – leadership opportunities; Southern Ontario (Grade 9 and 10) – glaciation effects and 1800s bee pollination effects; Algonquin Park expedition 4 days (Grade 10) – learning to use equipment to collect data samples, Winter Pinecrest (Grade 11) - build igloo and
team developing skills, Graduation Trip (Grade 12) – to the United States, etc. Students also get to participate in mandatory and optional competitions, awards, and scholarships like the Canada Wide Sci-Tech, AP Exam, and others. Furthermore, students are given the possibility to be taught by dedicated teachers that carry nationally known teaching awards (original names omitted for the ethics of the study). Some of these awards are also recognized as the highest teaching awards in Canada (SFP Program, 2016).

In SFP there is limited space and as a result only a minor fraction of the student applicants can be accepted. On average about 60 out of 500 applicants get admission to the program. Since SFP is currently being offered in two high schools (SFP Program, 2016) that makes it difficult for certain students that live further away to attend and benefit from this program. There are other programs to enrich a student’s academics such as AP sciences which are being offered throughout Ontario but that is not in all the Ontario high schools. While there is a need for reducing the gap between secondary and post-secondary science education there are also limited programs that could help with this situation.

By studying SFP we can learn about its characteristics and the influence it has on its students. Education communities can then use this as one of the exemplars to incorporate similar characteristics or strategies into the Ontario Academic Science curriculum or other curricula (national or international). Consequently, more students would become exposed to SFP characteristics. This incorporation can then possibly lead students to have a better understanding of the requirements of post-secondary science studies and careers. This can then possibly result in a reduction of the gap between secondary and post-secondary science studies. In this research project, I focused on the “traditional”/standard Ontario Academic Science curriculum and “SFP curriculum”. The curriculum used in SFP contains a modified version of the Ontario Academic
Science curriculum and other contexts as discussed in Chapter 4. I will call this curriculum, the SFP curriculum, for the purpose of distinguishing it from the standard Ontario Academic Science curriculum. SFP is also not the real name of the program but here it was chosen for the purpose of following the ethical requirements of this study.

In summary, my predictions consist of implementing such strategies in an Academic Science curriculum in order to reduce any existing gap between secondary and post-secondary education. This could further help a student to make an informed decision as to whether to continue in the field.

1.1 Purpose of the Study

Reviewing the issues above on secondary and post-secondary gap, the goal of my research is to learn about the SFP program through the following two main questions: How does SFP differ from Ontario Academic Science curriculum? What benefits can SFP bring to the Ontario Academic Science curriculum for preparation of students for post-secondary science studies?

I aim to share these findings with the educational research community in order to further inform instructional support for the education of Science students. In the future this approach can be explored in other science curricula that are facing similar issues.

1.2 Research Questions

The main questions I seek to answer through my research are: How does SFP differ from Ontario Academic Science curriculum? What benefits can SFP bring to the Ontario Academic Science curriculum for preparation of students for post-secondary science studies?
Other questions my research seeks to address are:

- What is the student profile in SFP based on teacher perspectives?
- What is the interviewed teacher’s profile in SFP?
  - What training do these teachers receive?
  - What backgrounds do these teachers bring to SFP?
- What methods do teachers use to teach SFP?

1.3 Reflexive Positioning Statement

I graduated from the Ontario Academic curriculum with a focus in the sciences, completed a Bachelor of Science, followed by a Master of Science degree, and then pursued a science-based career in the industry. Industry here refers to jobs in private science-related companies (i.e. pharmaceutical companies, food production companies, and others). I also attended the same high school (I.G.1.) that SFP is located but I was not part of the SFP program. Upon reflection of my past experience, I tried to determine the cause of some of my challenges in education. I felt that I missed out on some of the benefits that my friends in SFP gained in terms of science content, ways of learning, and future rewards. Based on my conversations with them, it became obvious that they did not face the same academic challenges in university as I did. However, I had the determination and passion for science which I think helped me manage those challenges.

In working through the scientific industry many of my colleagues expressed that they struggled through university in their science courses (more so in their first year) and as a result they had to input a lot of effort in their studies. In other words, they felt a lack of preparation for post-secondary education. I strongly believe that if these individuals had been exposed to an
enriched program earlier on, like in high school, they would have gained sufficient insights on the challenges of science education and/or career to make informed decisions about the field. In addition, the gained skills would have probably helped them advance to a more preferred science career pathway or possibly consider a different field. Instead at that time they were preoccupied with challenges that were a precursor of their knowledge gap between high school and university.

1.4 Preview of the Whole Research Study

To respond to the research questions, I conducted a qualitative research study. I used purposeful sampling to interview a minimum of three science teachers in the SFP program about their instructional strategies and researched data from the program about the curriculum, profile of the students and teachers. In chapter two I review the literature in the areas of advanced science courses or programs. Next, in chapter three I elaborate on the research design followed by chapter four where I show my research findings and discuss their significance based on the existing research literature. Lastly, in chapter five I identify the connection of the research findings to my own teacher identity and practice, and more broadly to the educational research community. I also refer to a series of questions raised by the research findings, and point to areas for future research.
Chapter 2: Literature Review

2.0 Overview

Enrollment numbers have more than doubled since 1980 in post-secondary degree programs on Canadian campuses (The Association of Universities and Colleges of Canada, 2011). It is not hard to notice that hundreds of students attend these lecture rooms. These are the number of registrants in science programs in Ontario universities for the year 2015: York University – 1730, University of Toronto – 4744, Ryerson University – 532, Queen’s University – 1657, and others (The Council of Ontario Universities, 2017). Literature indicates that many students will not be able to graduate with a degree from their initial enrolled program. This is because students misperceive their success in the program (Robinson, 2003). In a Toronto newspaper students and professors voiced their opinions about how they feel frustrated that high schools did not prepare students adequately for a successful transition to university, especially for first year undergraduate courses (Freeman, 2009). The Ontario Confederation of University of Faculty Associations conducted a survey which revealed that 55 percent of university librarians and professors said that first-year post-secondary students were less prepared than students from the three years prior (Freeman, 2009).

In this chapter I review literature findings in Canada and United States to compare to SFP (Science Focused Program), a program that integrates education characteristics from both nations (i.e. Advanced Placement (AP) courses). SFP is a program that has been open for more than 25 years in an Ontario high school (I.G.1.). Recently it has opened at another Ontario high school but currently it functions independently of I.G.1. The focus in this study is on the first location, I.G.1 because it has a long-standing history in operating SFP. All the information on SFP in this
research study is in reference to I.G.1. The competition to get into this program is ambitious. As a first step the selection process consists of evaluating an individual’s academic background and SFP entrance exam scores. Then once admitted, the program focuses on enriching a student’s academics in the science stream and to prepare them for post-secondary studies. SFP is a 4-year program at the secondary level. To graduate with an Ontario Secondary School Diploma, students need 30 credits total and in the SFP program 20 of those credits are taken as SFP courses. The remainder 10 credits can be electives chosen over their 4-year high school education (SFP Program, 2016). SFP courses contain content that fulfills the requirements for the Ontario Secondary School Diploma and content specific to the program. SFP program also offers courses equivalent to AP courses and AP accredited courses (SFP Program, 2016). AP courses are part of the AP program from the United States and research has indicated that students that take these courses are more likely to succeed in post-secondary education (Robinson, 2003). Furthermore, studies have shown that students that enroll in AP courses continue to pursue post-secondary education in the same stream and graduate (Robinson, 2003).

This research project focuses on SFP and its unique characteristics. It is of great interest to understand how this program benefits its students with their academic success and how it could help for a smoother transfer between secondary and post-secondary education.

2.1 Post-Secondary First Year Students

Students in secondary school increasingly recognize that many career paths seek university education and as a result this number continues to grow. Of the three popular programs in undergraduate studies, science major was among them in 2007 (Parkin & Baldwin, 2009). Undergraduate science lecture rooms in Ontario universities for first year classes are filled
with hundreds of students (The Council of Ontario Universities, 2017). Many students enter school quite optimistic in a science degree program only to find out that there is a likely chance that he/she will not even graduate with such a degree. Furthermore, the proportion of students who believe that they will likely graduate with a science degree is higher than the proportion of students in other majors. These findings indicate the common theme that science major is an outlier among other majors (Stinebrickner & Stinebrickner, 2014).

An explanation to these findings is that students in STEM (Science, Technology, Engineering, and Mathematics) majors could discover through the course of the program that their grade performance will be worse than predicted, thus leading them to drop-out (Stinebrickner & Stinebrickner, 2014). Stinebrickner & Stinebrickner (2014) found a strong relation of how beliefs of grade performance change over a student’s education period in relevance to their choice of major. Interestingly, they also found that students from other majors do not often switch to science. This is typically because those who do not start as science majors feel that they are not “especially talented in science” (Stinebrickner & Stinebrickner, 2014, p. 467). Stinebrickner & Stinebrickner (2014) went on to suggest that if we need more science graduates, the data demonstrates that implementing policies at younger ages lead to better prepared post-secondary students to study science. Policies include institutional rules related to flexibility in the timing of major declaration, major choice, elective courses and others which vary across institutions. These rules could have an impact on a student’s ability to explore different subject areas (Stinebrickner & Stinebrickner, 2014).

Furthermore, literature indicates that positive interpersonal relationships with teachers have been associated with greater compliance with teacher expectations, increased classroom engagement, high grade point averages, and higher academic motivation (Wang & Degol, 2013).
At the university level first year students are adjusting to a new academic environment that places far more emphasis on independent learning than normally experienced in high school (Parker, Hogan, Eastabrook, Oke, & Wood, 2006).

In Ontario, it is not surprising to hear that first-year students are not adequately prepared. According to James Cote, a University of Western Ontario professor, he commented that about one-third of the students find their studies “really stressful” partly due to feeling inadequately prepared for the academic requirements of university (Freeman, 2009). In the Arts and Science department at the University of Toronto, the schedule has been altered to give students a fall reading week during the time students would typically experience peak fatigue and stress. Data from University of Toronto suggests that about 10% of all students enrolled in first year university do not return for second year. Statistics indicate that if students persist through first year they are likely to graduate (Freeman, 2009).

2.1.1 Canada: Youth in transition survey. An analysis by Youth in Transition Survey in Canadian Youth (Finnie & Qiu, 2008) was done to investigate patterns of persistence in post-secondary education in Canada. The analysis showed that the five-year graduation rates of the university students was 52.1 percent with respect to their initial enrolled program. Furthermore, 18 percent of university students leave their first post-secondary education program by the end of their first year. Half of these students switch to a different program and the rest leave post-secondary education to possibly return later. The greatest number of switchers and leavers have identified the reason of their leave or switch due to dislike of their current program, and very few (2.3 percent) did so for financial reasons. The rate of switchers and leavers greatly drops after the first year of post-secondary education (Bachelor’s degree).
Among their findings: non-immigrants, male students, and non-minorities tend to switch or leave post secondary-education more than visible minorities, immigrants, and female students. Another factor linked to determining one’s chance in continuing in the program is the age that one starts post-secondary education. Those who started university at the age of 21 or older had a higher chance of not continuing in the program than those that started at a very young age. This rate drastically increases in those 21 or older. Another strong relationship was seen between grades and persistence. If a university student had at least an 80% in high school it also decreased their chances of leaving the university program. Those that had higher grades in post-secondary were even more likely to continue in the program. It was concluded that it is the academic side (i.e. grades and work habits) that are better predictors more than the social side (i.e. connected to others) for persistence. (Finnie & Qiu, 2008)

Among the many factors that could contribute to a student’s persistence was also parental education and family status. Those that came from single parent families were more likely to continue in the program for any year than those from two parent families. Those that had parents with less school were also more likely to leave their current program. However, because the effect of parent education and family structure was so minimal it was considered as not having a significant impact. Thus, this counters literature findings that indicate parent education and family structure have some significant influence in university students to continue their program (Finnie & Qiu, 2008).

Overall, there are many factors (or predictors) that affect student success in not dropping out of their first year of their current post-secondary program: age, grades in high school, grades in post-secondary education, work habits, and society groups (i.e. minority, immigrants, etc.). The background that students bring with them to university is a strong determinant for their
success rate, especially their high school background (i.e. work habits and grades) (Finnie & Qiu, 2008).

### 2.2 SFP

SFP is an enrichment program in two Ontario high schools with an emphasis on math, science, and English. It has been open at I.G.1 for more than 25 years. The second location has recently opened and currently functions independently of I.G.1. The focus and discussions in this study are based on the first location, I.G.1 because it has a long-standing history in operating SFP. Thus the SFP information presented from this research study are in reference to I.G.1. SFP is an enrichment program that enriches a student’s academics by offering SFP level courses including equivalent AP courses and a few AP courses in sciences (i.e. AP Physics). Among the 30 credits required to obtain an Ontario Secondary School Diploma, 20 credits are SFP courses and 10 are electives (SFP Program, 2016). SFP courses include content that satisfies the requirements for obtaining an Ontario Secondary School Diploma in addition to other content that is beyond the Ontario Academic Science curriculum.

SFP has high standards for the students that get in and they face a tough competition to enroll. On average about 60 out of 500 applicants get into SFP. According to SFP, the program widens the students’ skills and knowledge by “greatly” exceeding the standard curriculum (SFP Program, 2016). There is no research available on this program and it would be interesting and educating to learn about what makes this program enriching as a long running pioneer for more than 25 years and how does it benefit students in the science education system.

### 2.3 Specialized Programs: AP Courses

In this research study I used data from other specialized programs (i.e. AP courses) as
part of literature analysis to discuss SFP. This is because SFP contains courses that are considered equivalent to AP and accredited AP courses. Additionally, literature in SFP is scarce. This is to help the reader understand the practices involved in teaching. In the United States, the AP Program is a non-profit organization program which offers AP courses. This program was developed to select “talented” students to motivate and challenge them for successful post-secondary work (Robinson, 2003, p. 266). It is based on higher education material and how they can be successfully taught to high school students (Robinson, 2003). This program then began being administered in Canada, including Ontario. A problem for many high schools in United States was that challenging courses were not offered widely, especially for science and math (Morgan & Klaric, 2007).

The National Commission on the High School Senior Year recognized such a discrepancy and urged many of the states in the United States to also recognize that many high schools are not doing enough to prepare students for post-secondary studies and careers. Of the 70 percent of the students who graduate from high school and enroll in post-secondary studies, only half of those leave with a degree from a 4-year institution. This is because students were not well prepared for the hardship of post-secondary (Bailey, Hughes & Karp, 2002). A study done to compare AP to non-AP students, found that the rate of drop out in AP students in post-secondary is less than non-AP students (Santoli, 2002).

These types of proposals are not new to just the recent years but they do go way back to 1888 (Eliot, 1888). Educational reforms have shown to improve education. Reforms include changes to the educational system. In the United States, the AP program was imbedded in the College Board in 1955 to deal with these discrepancies. Between 1982 to 1994 the number of academically challenging courses increased from 14% to 52%. Achievement in science and math
increased as a result of these reforms. Student numbers tripled in AP courses. Scores in math and science also improved (Bailey et al., 2002).

However, with the variety of course levels being offered there is difficulty for employers, college admissions officers, educators, and parents to determine the quality of the courses. This refers to the meaning of a particular grade in the course and the standard the content meets. For example, grade inflation in many high schools is above 3.0 GPA for graduating high school seniors. There are also outliers that have above 4.0 GPA (Robinson, 2003). The number of students trying to attend post-secondary has been on the rise. An “A” grade used to be a great achievement to graduate but now that grade occurs more frequently. Some are even suggesting to use standard testing because of the grade inflation or as another option attend AP courses (Robinson, 2003). Recall the discussions from above, there are gaps in students that enroll in university and their persistence in continuing in the same program past first year university. AP program is a suggested option for students to overcome this gap by gaining experiencing in an environment that challenges them more academically than in the standard Academic curriculum (Robinson, 2003).

To achieve scientific proficiency, specialized programs (i.e. AP program) can provide some predictability in post-secondary success. AP courses have multiple advantages by remaining consistent in their standard content. Students take the same exam and the college admissions officers, teachers, and parents all know and accept the standard (Robinson, 2003). The College Board is directed in providing achievement of true and national standard through AP which is consistent over time. In the United States, the average SAT scores for AP graduates are 164 points higher than the combined national average scores. AP courses are taught by 100,000 teachers worldwide. The program is enriched by the teachers’ participation in the annual
AP Reading, summer institutes, and workshops where the AP teachers get together and score AP exams using guidelines (Robinson, 2003).

AP course descriptions are used by high school teachers to guide them in developing a course corresponding to the institution it will be applied. These course descriptions outline course content, curricular goals, and sample examination questions. The course covers the skills, assignments, and breadth of information found in the corresponding course. Even though the teachers have these course descriptions as sources of information to teach the course, the AP teachers have choice in determining the presentation of this content. The course overview that is written by an experienced AP teacher will have been published in the spring before the course is taught. Data has shown that most AP students pursue the same course of study in college (university) as they did in AP. This is particularly seen for students in biology, studio art, calculus, physics, and Spanish literature (Robinson, 2003).

2.3.1 Issues in the AP program. A major criticism of the AP program is its inaccessibility to students from disadvantaged backgrounds (i.e. lower income families) (Robinson, 2003). This is further explained as: Grouping is undemocratic in a way that it does not offer educational opportunities to fit different needs in children. For example, the fees associated with writing the entrance examination and other administrative procedures were prohibitive to some families. In the United States this led to complaints that resulted in a lawsuit to make it more accessible to students from disadvantaged backgrounds (Robinson, 2003).

On the other hand, proponents of the AP program argue that there should be times for high ability students to solely work and compete with one another (Johnson & Johnson, 1992). The results of a survey administered with 100 AP students from different schools revealed an
overwhelmingly positive opinion of the AP program and reported advantages such as having highly qualified teachers with specialized degrees. Because of the teacher hiring process in the AP program, AP teachers are likely to hold a major in the subject followed by a Master’s degree. AP teachers have been found to be more prepared and expectant in their students to reach for higher goals (Robinson, 2003).

Some post-secondary institutions like the University of Toronto and York University award students transfer credits upon completion of AP examinations with scores of 4 or 5 on a 1-5 scale. York University for example awards 5 full course credits. A school that has more students that receive university credits based on this criterion receives merit (Robinson, 2003; University of Toronto, 2011; York University, 2015). Thus, some schools use this information as a basis to encourage students to enroll in AP programs (Robinson, 2003).

A major consideration with this merit system is that it excludes students who come from schools and/or programs that do not offer AP if they want to pursue post-secondary studies (Robinson, 2003).

2.4 Relation of Motivation, Self-belief, Instructional Practices, and Extracurricular Activities

This section is concerned with how motivation, self-belief, instructional practices, and extracurricular activities drive scientific literacy in high school students. The world is rapidly changing such as seen by technology advancement, globalization inflation, science breakthroughs, economic competitiveness, and shifting workforce demands. These are some of the events that are redefining the type of skills that students need to acquire to be adequately involved and invest in today’s society (NSTA, 2011). To be a successful citizen in the 21st
Traditionally science achievement has been measured using cognitive factors like IQ (intelligence quotient). However, it has been shown that science achievement can be related to other domains like motivational characteristics in the individual (Areepattamannil, Freeman, & Klinger, 2011).

There are two types of motivation: extrinsic and intrinsic. Extrinsic refers to external influences that drive the individual to desired outcomes. Intrinsic refers to the drive within the individual for desired outcomes. Research shows that intrinsically motivated students are more creative and learn better because they devote time out of their heart and energy to complete their studies (Areepattamannil et al., 2011). This type of motivation has been associated with enjoyment of science and as important to the cognitive engagement, achievement, and learning of the student. This creates an emotional attachment between enjoying science and learning science. Therefore, the combination of self-regulation and interest facilitates learning of the competencies and skills required for a creative and productive future. On the other side, extrinsic motivation can be used to enhance student motivation and subsequent performance (Areepattamannil et al., 2011).

Furthermore, students with positive and strong self-beliefs are more likely to set challenging academic goals for themselves, feel confident in achievement tasks, take more challenging courses, have higher-level goals, enjoy studies, and persist longer on difficult tasks (Areepattamannil et al., 2011). If students gain experience in a setting that has challenging academic goals (i.e. face failures) it gives them a true sense of self-efficacy (belief about performing the task) and exposure to a more realistic setting (i.e. like in professional laboratories) (Almarode et al., 2014). Influence from teachers, parents, and friends also play a
role in the student’s attitude to face challenging academic goals (Almarode et al., 2014). These are also individuals who become positively influenced in science achievement. Nevertheless, instructional practices have been shown to be more influential in science achievements in students. (Areepattamannil et al., 2011).

Instructional practices in science education have been steering from teacher-driven to student-centered instruction. Student-centered instruction involves dialogic interactions, hands-on activities, and scientific inquiry to learn science. All these combined, lead to higher student achievement (Areepattamannil et al., 2011). For example, hands-on activities (i.e. labs which are often done in universities) support development and engagement of student academic skills (Wang & Degol, 2013). They lead to significantly higher scores than those that experience less of these activities (Areepattamannil et al., 2011).

Furthermore on activities, extracurricular activities could also be an indicator in student success. Certain extracurricular activities (mostly with sports) supplement adolescent development in a positive way (Feldman & Matjasko, 2005). Students have been linked to exhibit greater psychological adjustment, reduced feelings of social isolation, reduced rates of dropout, higher academic performance, higher self-esteem, and be less worried regarding the future. There are limitations to these studies because extracurricular activities are shaped by various factors and do not share the same characteristics (Feldman & Matjasko, 2005).

Overall, stronger science self-beliefs, student centered instruction, intrinsic motivations, and extracurricular activities are better predictors of student achievement (Areepattamannil et al., 2011; Feldman & Matjasko, 2005).

2.5 Conclusion
In this chapter, I presented scholarly research used in analyzing the data on SFP. Given the scarcity of the literature on SFP, I also made reference to the AP program because of its components in SFP. This literature serves as a way to better understand the broader aspect and engage with teacher interviews in my qualitative inquiry. To further explore the significance of this program in enriching and transferring students from high school science to university science. As previously mentioned, research illustrates a considerable gap in the bridging between high school and university science. High school students are finding that once they are in their first year of university their belief to graduate with a science major drops. Some of them switch or drop out of their program. The results of my research could inform the education community in utilizing SFP as a template for the development of the transferable scientific skills that students will need as they continue through their studies and careers.
Chapter 3: Research Methodology

3.0 Introduction: Chapter Overview

In this chapter, I describe the research methodology. The chapter is initiated by reviewing the general approach, procedures, and data collection instruments followed by elaborating on participant sampling and recruitment. Data analysis procedures and ethical considerations pertinent to my study are explained and reviewed, respectively. Furthermore, I identify a range of methodological limitations, but I also speak to the strengths of the methodology. Lastly, a brief recap of key methodological decisions and the reasons for these decisions based on the purpose and questions of the research, was used in concluding this chapter.

3.1 Research Approach and Procedures

There are various types of methods to conduct research: qualitative and quantitative (DiCicco-Bloom & Crabtree, 2006). This research project used qualitative research. A qualitative research approach is conducted using semi-structured, face-to-face interviews with 3 teachers, and a review of literature pertinent to the research questions and purpose of the study. Another known method is quantitative research which involves applying random selection methods and collecting large amounts of data (DiCicco-Bloom & Crabtree, 2006). Numerical data are used to derive conclusions. This method is considered reductionist because it is based on the context of numerical data (Marshall, 1996). Whereas, qualitative research, contributes to a body of knowledge that is theoretical and conceptual that draws from the life experiences of the interviewee. The goal of this method is to increase knowledge of the phenomena versus generalizing data to the population at large that is done by quantitative studies. Quantitative studies provide richly described research results to be applicable to other situations. The context
of the sample is described in enough detail for others to evaluate for use in their own situations (Marshall, 1996).

For this stage in the study, qualitative method was chosen partly because the sample pool was small and because the research questions required investigations done by face-to-face interviews to analyze teaching strategies in the SFP (Science Focused Program) classroom. SFP was used in place of the real name of the program to protect its privacy due to the ethics of the study. Future studies could be guided into a more quantitative research depending on the direction of the research in the field and the magnitude it grows. The qualitative strategy here could provide rich and insightful findings in this field which could be further explored in the future whether by quantitative or qualitative methods.

3.2 Instruments of Data Collection

Qualitative methods use interviews in different formats: unstructured, semi-structured, and structured (DiCicco-Bloom & Crabtree, 2006). Semi-structured interviews are used as the primary instrument for data collection in this study. Semi-structured interviews are organized around a set of predetermined open-ended questions that attend to the research focus, while leaving room for the interviewee to elaborate and potentially explore new questions brought up in the interview. The semi-structured interview can also be conducted in groups or individually (DiCicco-Bloom & Crabtree, 2006).

Individual, face-to-face semi-structured method was also used in this study. The individual in-depth interview, face-to-face, allows the interviewer to inquire further into the personal and social matters of the interviewee, whereas group interviews because of the public nature of the situation it could prevent delving deeply into the individual (DiCicco-Bloom &
Crabtree, 2006). Individual interviews establish a comfortable and safe environment for sharing personal attitudes and experiences. The many ‘truths’ obtained through interview research contributes to our knowledge of experience in humans (Warren & Karner, 2010).

Currently there are no research projects on SFP education as indicated by an online search (oise.library.utoronto.ca; scholar.google.ca) and according to the knowledge of the SFP department. Semi-structured interviews were used for the purpose of exploring something in the primary stages of research. Semi-structured interviews could unveil insights or new areas to explore on a bigger scale in the future. Open-ended questions for the semi-structured interviews were based on the literature review discussed in Chapter 2. Individual one-to-one interviews also provide that comfortable and safe environment for the teacher to share their answers and add a stronger validity to the data collected. My protocol (Appendix B) is organized into 5 sections: background information/teacher profile; student profile, teacher practices, teacher perspectives/beliefs, and challenges. Examples of questions include:

- What do you believe students can gain from attending a SFP curriculum compared to the regular Ontario science curriculum?
- What do you consider 21st century skills that will help students bridge to post-secondary studies (i.e. university) and careers in the scientific field?
- Have you faced any obstacles or challenges when teaching SFP?

3.3 Participants

In this section I review the sampling criteria I used for participant recruitment. I also review a range of possible avenue used in teacher recruitment. Furthermore, I present participant biographies.
### 3.3.1 Sampling criteria.
The following criteria was applied in recruiting teacher participants:

1. Teachers will have been working in the field of Ontario Secondary Education a minimum of 3 years full time.
2. Teachers will have been teaching in the SFP program a minimum of 2 years.
3. Teachers will have been teaching both in the Ontario Science curriculum and SFP.
4. Teachers will have been teaching science courses: physics, chemistry, biology or math.
5. There will be both male and female participants.

To address the main research question, teachers were selected based on having teaching experience in both the SFP program and the Ontario Academic Science curriculum. Ideally teachers will have been working in the field of Ontario Secondary Education for at least 3 years and in the SFP program at least 2 years. This is to allow teachers time to have explored their teaching experience in the Ontario Secondary Education system and to have knowledge of the way the SFP program functions. The focus of teachers selected was on those that teach science courses: physics, chemistry, biology or math to answer the main research question by exploring the emphasis placed in scientific skills and transferability to post-secondary. Both male and female participants were chosen to increase richness (Sutton & Austin, 2015) in the data obtained from this small sample.

### 3.3.2 Sampling procedures.
It is difficult to recruit enough participants if the phenomenon under study is extremely narrow (Marshall, 1996; Noy, 2008). Here, SFP program is focused to one school (I.G.1) and teachers were selected based on the subject they teach (science: biology, chemistry, physics, or math). At the time of this study, the number of teachers
that were teaching science in this program was around six, thus the choice in the sampling pool was quite small. Ideally a bigger pool gives the researcher the option of being more focused with the selection criteria of teachers. However, a smaller pool available also allows the researcher to get a more detailed overview of the characteristics of the program.

Sampling in qualitative study can be done using various approaches and the one used here was the ‘snowball’ sampling. ‘Snowball’ sampling is when a researcher accesses informants through contact with other informants (Noy, 2008). In other words, sampling through referencing within the SFP pool. This method is also a common strategy of sampling used in qualitative research across various disciplines in the social sciences. The selection of the 3 teachers was done through referral from the director of the program and other teachers within the program. These 3 teachers were recommended based on the sampling criteria.

3.3.3 Participant biographies. Three participants, referred to as Cathy, Holdon, and Mathew, contributed their knowledge and opinions through the interview portion of my research study. At the time of the interviews all three teachers have experience teaching in the SFP program and Ontario Academic Science curriculum. They have experience teaching in both programs at the same time and sometimes one or the other. They all hold a Bachelor of Science and a Bachelor of Education.

Cathy has taught various science courses like Grade 10-General Science Applied and Academic, Grade 11-Biology University, Grade 13-Chemistry University, and others in the Ontario Science curriculum. In the SFP program she has taught Grade 11-SFP Chemistry, Grade 10-SFP General Science, and others. She has been teaching for more than 15 years in Ontario public secondary schools and SFP program. Cathy received a Bachelor’s degree with honours in
science and the biotechnology option in an Ontario university.

Holdon has taught various science courses like Grade 11, 12, 12 AP (Advanced Placement) – Physics, Grade 10-General Science, Grade 12 - Earth and Space Science, various math courses, and others. In the SFP program Holdon has taught Grade 10-SFP Math, Grade 11-Physics, and others. Holdon has been teaching for more than 15 years in the SFP program and the Ontario Science curriculum. Holdon received a Bachelor’s degree with honours in science in an Ontario university. His degree specializes in astronomy, math, and physics.

Mathew has taught various science courses like: different math courses from Grade 9 to 12, Grade 11- Chemistry, Grade 11, 12 - Biology, and others. In the SFP program Mathew has taught Grade 9 - SFP Math, Grade 12 - SFP Linear Algebra, and others. Mathew has been teaching for more than 15 years in the SFP program and the Ontario Science curriculum. Mathew received a Bachelor’s degree in an Ontario university. His degree specializes in Molecular Biology.

3.4 Data Analysis

Qualitative research is like putting one self in another person’s shoes and viewing the world through the insights of that person. It is important to remain true to the participant’s voice in data analysis and management. The researcher’s duty is to listen, interpret and report the data for others to read and learn from (Sutton & Austin, 2015). Before data analysis began, data collection was done through audio-recording and was transcribed verbatim. Additionally, I kept field notes to note for environmental contexts, nonverbal cues, and behaviours that otherwise might not have been captured through audio-recording. This helps in adding more context to the transcription of audio-recording that could contribute to the validity of the data and avoid
memory bias (Sutton & Austin, 2015).

Once interviews were transcribed, coding was completed where I identified differences, similarities, issues, and topics that were revealed through this process and then interpreted. This allows the researcher to view the world from the perspective of the participant (Sutton & Austin, 2015). Codes are words, phrases or narratives. Codes drawn together from transcripts formed themes that were used to do data synthesis as they relate to my research questions and purpose. The three themes used in data analysis were student motivation and extracurricular activities, SFP teachers, and differentiation between SFP and Academic curriculum: classroom.

3.5 Ethical Review Procedures

Research ethics are regulated by the Ethical Conduct for Research Involving Humans. Research ethics is regulated to ensure that the rights and interests of the participants are protected. The trust of the public or participants in the researchers is delicate and as such it must be cautiously nurtured by the ones involved. Therefore, researchers must be aware of the appropriate ethical principles (Loewen, 2014). Ethical issues that could rise as participating in the interview have been identified by (DiCicco-Bloom & Crabtree, 2006): lessen the risk of unforeseen damage, secure the interviewees’ information, interviewee is effectively informed on the context of the research and lessen the risk of exploitation.

There were no known risks in participating in the study of SFP, however unforeseen emotional response could have risen in response to a research question that could have left the interviewee to feel fragile. To minimize such chances, the questions were provided ahead of time to the interviewee. Also, the interviewee was made aware that they may refuse to answer questions or refuse to continue with the interview at any point. The interviewee also had the
possibility to re-comment on a question for clarification or re-tract before data analysis. This further build on the trust between the researcher and interviewee. Furthermore, the interviewee anonymity is protected by assigning random names to the teachers (i.e. Cathy, Mathew, and Holdon). The original name of the program was replaced with SFP in this study and its location with I.G.1. If this information becomes compromised, it could lead to jeopardising the individual’s position in the system. As such, all data is stored in a computer and/or USB key that is password protected and will be erased after 5 years.

Next, the interviewees were asked to sign a consent letter as outlined in Appendix A, to consent to being audio-recorded and interviewed. The consent letter outlines an overview of the study, specifies participation expectations (semi-structured interview about 60 minutes in length), and addressed possible ethical implications. Interviewee was made aware of the context of the research before the interview. It was also pointed out to the interviewee that the data for this project was unknown at the early stages of the study and it may uncover unknown results once analyzed.

By reducing such possible ethical issues, it ensured trust between the researcher and the interviewee to “truthfully” answer the questions. Thus, it further contributed to the validity of the data. Along this process their anonymity, emotional response, and communication has been treated with care and sensitivity.

3.6 Methodological Limitations and Strengths

In qualitative research, there are no statistical tests that can be used to check validity and reliability of the data and analysis. Therefore, the qualitative research relies on the interpretation and representation of the interviews by the researcher (Sutton & Austin, 2015). Otherwise, in
quantitative research there are software and statistical tests to overcome this limitation. There are other ways to overcome such a limitation in qualitative research and that is done by “trustworthiness” confidence: dependability (demonstrate that the findings are consistent and repeatable), transferability (demonstrate that the results can be applied in other contexts), credibility (the findings are confidently supported through “truth”), and confirmability (the length to which the results are shaped by the respondents and not through bias by the researcher) (Sutton & Austin, 2015).

Overall, the interviews allowed for in-depth insights and it created an opportunity for teachers to express of what matters most to them with regards to the research topic. Thus, it validated teacher voice and experience, and provided an opportunity for them to make meaning from their own lived experiences.

3.7 Conclusion: Brief Overview and Preview of What is Next

In this chapter, I explained the research methodology. It began with a discussion of the research approach and procedures by explaining the significance of qualitative research while comparing to quantitative research. This was followed by the instruments of data collection where I explained the choice of semi-structure individual face-to-face interviews and spoke to some of its benefits compared to other types of interviews. The participants interviewed were recruited by ‘snowball’ sampling while following a sampling criteria and were introduced in the participant bios. Subsequently, I described data analysis approaches by investigating interviews through coding and themes. This research project was carried out using ethical review procedures by considering ethical issues and ways to minimize it. Lastly, I discussed methodological limitations and strengths to the study by looking at data validity and teacher
expression. In the next chapter, I report the research findings.
Chapter 4: Research Analysis

4.0 Introduction

The following chapter describes the findings of a qualitative study to learn about the characteristics of a secondary education program, Science Focused Program (SFP), and how this program contributes in reducing the gap of student transition from secondary to post-secondary level education. An enrichment program with an emphasis in the sciences. The name of the program has been changed to SFP to conform to the ethical requirements of this research study. The findings come from three 1-hour, separately conducted interviews with educators. Each interview was initially coded into individual pieces of data and then used to synthesize them into larger themes (Sutton & Austin, 2015). Then the findings were organized based on the research questions, which they best related to. The participants in this study go by the pseudonyms: Mathew, Cathy, and Holdon to respect their confidentiality. All three teachers have taught various science courses in SFP and Ontario Academic Science curriculum. They all have more than 15 years in the profession and in the programs. Cathy is mainly a Chemistry teacher, Holdon mainly a Physics teacher, and Mathew mainly a Math teacher in the latter years of their careers. Holdon also teaches AP Physics. They all have a Bachelor of Science and Bachelor of Education. Participants were recruited through personal contacts who got me in touch with potential participants which fit the research requirements, as outlined in Appendix A and section 3.3.1.

When I analyzed the data, three themes emerged that directly relate to the sub-questions of the research topic. The three themes are: student motivation and extracurricular activities, SFP teachers, and differentiation between SFP and Academic curriculum: classroom. These three
themes all together aim to answer the two main research questions: How does SFP differ from Ontario Academic Science curriculum? What benefits can SFP bring to the Ontario Academic Science curriculum for preparation of students for post-secondary science studies?

The first theme relates to the sub-question: what is the student profile in SFP based on teacher perspectives? The first theme breaks down into three subsections: motivation in SFP students, motivation in Academic students, and their extracurricular involvement. Overall it explores differences between SFP and Academic students’ motivation and their extracurricular involvement at the secondary level (high school). Then this was analyzed to determine how they are linked to student academic success and pursuing science at the post-secondary level (university).

The second theme relates to the sub-questions: What is the interviewed teacher’s profile in SFP? What training do these teachers receive? What background do these teachers bring to SFP? The second theme breaks down into two subsections that explores teacher “training” and teacher background. Overall this theme explores how teacher backgrounds and assistance they receive enriches the program.

The third theme relates to the sub-question: What methods do teachers use to teach SFP? This theme breaks down into three subsections that will explore: curriculum design, SFP Push Factor and more instructional practices that are used to prepare students to overcome academic challenges in post-secondary education.

Finally, the findings were analyzed to determine how a specialized science program, like SFP, can help in transitioning students smoothly into post-secondary studies and to pursue science. All the above are presented below.
4.1 Student Motivation and Extracurricular Activities

The following sections discuss motivational differences between SFP and Academic stream students and their extracurricular involvement at the secondary level (high school). These were also investigated to determine how they affect a student’s future in continuing science studies at the post-secondary level (i.e. university). I present the analysis based on teacher observations and the knowledge they have of their students. This information was collected through their interviews. All three teachers have been teaching at the SFP and Academic stream level for more than 15 years which makes them familiar with the school community. According to them, SFP students are known for “majority” getting into university and pursuing sciences.

4.1.1 Motivation in SFP students. The analysis results of this study indicate that motivation plays a role in SFP students in achieving academic success to possibly pursue and complete post-secondary science studies. Intrinsic motivation appears to be more commonly observed among SFP students than extrinsic motivation.

In line with this analysis, research has shown that students with higher levels of motivation (specifically intrinsic motivation) are better learners in science (Areepattamannil, Freeman, & Klinger, 2011). Motivation has the potential to facilitate students’ need for productive and creative futures (Areepattamannil et al., 2011).

Previous research has also shown that major reforms in science education are partially the result of increased motivation, both intrinsic and extrinsic motivation, in students to study science (Areepattamannil et al., 2011). Intrinsic motivation refers to the drive within the individual for desired outcomes. In contrast, extrinsic motivation refers to external influences to drive the individual to desired outcomes. Extrinsic motivation can be used to enhance student
motivation and subsequent performance (Areepattamannil et al., 2011).

Intrinsically motivated students have been described as efficient learners and more creative because they choose out of desire to dedicate time and efforts to their studies. Intrinsic motivation to learn science foreshadows student cognitive engagement, achievement and learning. In addition, students who have an interest in science topics and enjoy learning about it, likely become emotionally attached in learning science and identify it as a worthwhile activity (Areepattamannil et al., 2011). In other words, the presence of high interest reduces students’ need to effortfully and consciously persevere in a task. Thus, intrinsically motivated students are potentially capable of facilitating learning skills and competencies needed for creative and productive futures.

In this study, SFP students were described by Mathew as having

[…] a degree of motivation that is different [compared to non-SFP students] and with that they will work harder. And part of that is just that they know they want to go somewhere. […] It’s the willingness to put in that effort […]. I think SFP students are more motivated and that’s why you can get them to work more. […]. Most of it is internal.

Similar evidence was found in the analysis of Holden and Cathy’s interviews. Holden said that,

[…] the big difference between that individual [non-SFP student] and well at least at the beginning and SFP kids is their ability to do work. To go home and just shut down and do it. And that difference is quite obvious. […]. I know they [parents] want success. The kids are working hard being in the SFP program, most of them do. They got it figured
out, now just going to let them run out, let it play out.

Cathy said that,

Most of them [SFP] are also very curious. They will research things on their own, they want to learn, so a lot of them know the stuff before they get to class. […] a lot of them [SFP students] have it inside they want do really really well, some of them though it is parental pressure.

In addition, the teachers in this study have observed SFP students as being overly prepared before coming to class, curios and having an initiative in researching content beyond the classroom material. The analysis indicates the presence of a drive behaviour or motivation as playing a role in their SFP students’ academic achievement.

This study shows that there are indications of both extrinsic and intrinsic motivation in SFP students, but they do not appear to be at the same level. Analysis, based on teacher interviews, presents intrinsic motivation as more apparent than extrinsic motivation in SFP students. For example, in Cathy’s quote above there is indication that many of the SFP students show intrinsic motivation more than extrinsic, and many of the SFP students have it (i.e. drive) inside of them as they want to do well. Furthermore, Holden did not directly express observations of specifically intrinsic and extrinsic motivation but he did recognize that his students are hard workers in the program and if his students’ goals were to easily get marks just to get into university, then they would not be in the SFP program. Holden’s statement shows evidence of intrinsic motivation in his SFP students. Popular and reputational undergraduate programs are known for being competitive even for high GPA students (Robinson, 2003), regardless of the type of high-school education the students received. In other words, Holdon expressed that if the goal of these SFP students was just to get into these highly competitive
programs than they would not have enrolled in a program that challenges their GPA and is not accredited towards undergraduate credits. It enriches their learning for higher education. In short, two of the teachers directly stated that they recognized the presence of intrinsic motivation in their SFP students more than extrinsic motivation. The third teacher’s interview manifests a similar theme.

In addition, all teachers have witnessed parental influence in motivating their SFP students which is indicative of extrinsic motivation. The findings in this study also show that teachers play a role in contributing to external motivation. For example, one of the teachers stated that they have a role in the classroom to bring out student motivation in learning by inspiring them through their teaching through this quote:

[…] the main objective of motivation is to get them to try […] to get them to believe in themselves and to convey enthusiasm for the material, the subject that you are teaching […] We are motivating children in the fields and in a way I think is sublime, in a way just being who you are, being in the room, being representative of that field, having great stories to tell about it, and they can understand you with fascination.

Therefore, analysis shows that extrinsic motivation does exist in SFP students but based on the above findings less than intrinsic motivation.

As a result, the research findings from this study when compared to the previous literature research (stated above), suggest that intrinsic motivation is more frequently present than extrinsic motivation in SFP students. In line with previous research, intrinsic motivation shows a correlation to students’ academic success, as at the end of their secondary school diploma “almost everyone” gets into a science degree in university.
4.1.2 Motivation in Academic students. On the contrary to section 4.1.1, analysis here suggests that motivation in the students from the standard Academic Science stream is less apparent than that seen in SFP students. The analysis here has also revealed that this motivation is more of a reflection of extrinsic motivation.

For example, Cathy finds it difficult to motivate students in the Academic stream classes. The challenge she faces with them “is trying to convince students that they need to practice on a regular basis. I think that is my biggest challenge with the regular students.”

She also added that,

A lot of their [non-SFP students] families have come here [referring to the community nearby being mostly immigrants] so they can have a better life and so they are getting a lot of extrinsic […]. They also have it internally as well but there is a lot of external in our regular group [non-SFP students].

All three teachers indicate that extrinsic motivation is observed as having more of an influence in these students from the Academic Science curriculum. Analysis also indicates that there could be a lack of confidence to succeed in specific scientific tasks, science courses or science-related activities. Thus, these students could be relying more on extrinsic motivation than intrinsic motivation because of a lack of self-confidence in the sciences and as result this could affect their career path in the sciences.

4.1.3 Students and their extracurricular involvements. Students in the SFP program exhibit high involvement with extracurricular activities and based on literature certain extracurricular activities could supplement their adolescent development in a positive way (Feldman & Matjasko, 2005).
It is common for SFP students to be heavily involved in various activities outside the classroom whether it is science-specific or others. For example, the interviews support this by Mathew’s statement that “They are busier than most kids…with a lot of these students, you need 40 hours of community service to graduate, it is not uncommon for these kids to have thousands!”, Holdon’s statement “They are busy busy busy doing something meaningful.”, and Cathy statement “Lot of them are very very very involved, not all of them, but a lot of them are very involved.” Therefore, similar findings were observed in the analysis of all three teacher interviews. Some of the extracurricular activities that SFP students have been involved are musical (i.e. piano and violin), sports (i.e. swimming), and other school based clubs (i.e. SFP website team). Students also involve themselves in volunteering at hospitals to gain science-specific exposure. An example of that would be Sunnybrook Hospital. Within the SFP program it is also common for senior students to assist with SFP events like SFP Information Night for the Grade 8 students and parents, and the field trips for the junior grades in the SFP program.

These students not only become highly involved in attending extracurricular activities but they often time also excel (i.e. National Fencing Team and swimming trials in the Olympics) or assume leadership roles in these activities. Previous research suggests that there is evidence that indicates that being part of outside-classroom activities like extracurricular does affect adolescent development in a positive way. This is mostly seen with sports. These effects are linked to higher academic performance and attainment, reduced rates of dropout, greater psychological adjustment including less worry regarding the future, reduced feelings of social isolation, higher self-esteem and others. There are limitations to these studies because extracurricular activities are shaped by various factors and do not share the same characteristics (Feldman & Matjasko, 2005).
Similarly, the analysis of the interviews reflects SFP students as being high achievers, hard workers, and highly involved in extracurricular. As Cathy said, “So they are not only just participating [referring to extracurricular], they are excelling on that as well.” Similarly, Mathew said, “[…] they will work harder. Part of that is just that they know they want to go somewhere […]” This is a common appearance in all three interviews and the teachers did compare them to the non-SFP students stating that there is less of these characteristics in their non-SFP students. In line with the literature review in Chapter 2, these results demonstrate that their involvement in extracurricular could be another indicator of why SFP students are known to be more involved in pursuing science degrees.

4.2 SFP Teachers

In the following theme, I discuss the assistance teachers receive in the SFP program and background teachers bring to the program. In other specialized science programs, like Advancement Placement (AP), teacher background and training are taken into consideration in creating an enriched learning environment in sciences (Robinson, 2003; Santoli, 2002). Similarly, interviewed teachers present teacher assistance (“training”) and backgrounds that could further add to enriching SFP courses and students.

4.2.1 SFP teacher “training”. In my teacher education, I have been taught that a classroom is not only a mirror of its students but also of its teachers. In this study, I got insights into the assistance these teachers receive to help build the program’s reputation. In my analysis, I compare SFP teachers to those of other specialized science programs (i.e. AP). Like SFP, AP program was also developed to select “talented” students to motivate and challenge them for successful post-secondary work (SFP Program, 2016).
According to the interviews, all three teachers have been teaching for more than 15 years in their respective fields which are math, physics, biology, and chemistry. Simultaneously, they have been teaching in SFP more than 10 years. It is not uncommon for a SFP teacher to have that many years of teaching experience. However, currently there are no formal selection criteria or training to be a SFP teacher. To keep the program’s reputation, teachers who are selected receive support from other fellow colleagues in the program. For example, Cathy at the beginning of her career as a SFP teacher was given a resourceful binder full of working lab activities by two previous SFP teachers.

This was her statement,

I've always been lucky. People have always helped me along the way and I think that is the biggest resource is to have someone in the school who will be like: This is what we do […] when I came here they [SFP teachers] gave me the binder and I picked and chose what I wanted to do, but at least I knew that the labs that they gave me worked because they were using them and so there was less labs that I would have to find. That was probably the biggest resource.

When Holdon was asked about teacher training he responded as follows,

Nothing [training]. We did all on our own. […] We had a vision, we had done well enough, we knew what we felt needed to get done for university, and we just did it. […]. The only way you are going to get anything like this is if you get people with similar backgrounds [to them], spent two or three years with us, shadow, and work with us.

The benefit to that arrangement is also linked to the fact that the program is localized within a specific high school (I.G.1). SFP teachers are in proximity to each other and able to
communicate and share information constantly. Furthermore, to support consistency, Mathew plays a leading role in the program and oversees the SFP curriculum. He stated that if there are two teachers teaching the same course, he will evaluate that the material remains consistent between the two.

Unlike the SFP program, specialized science programs like AP offers its teachers formal professional development workshops and summer institutes. According to AP this keeps the program strengthened and standardized internationally as a result of a widespread AP teacher population in many different schools (Robinson, 2003).

SFP teachers also teach math and science courses in the Academic stream. In addition to these courses, Holden has taught for many years Grade 12 AP Physics. AP courses are open to all students in the school regardless if you are a SFP student or a non-SFP student. Majority of the students in the AP Physics are SFP students (SFP Program, 2016). There are also other AP based courses at the school like Grade 11 Calculus AP BC equivalent. Most of the senior level courses in the SFP program prepare students to write the AP exams (SFP Program, 2016). For the AP Physics courses, Holden goes through a formal process where he has to submit his course dossier and plans to the AP organization for international consistency of the course.

In summary, SFP teachers though they do not receive a formal training like AP teachers, they manage to enrich the program through close collaboration with each other giving the support needed.

4.2.2 Teacher background. In this study, I got insights of the work experience and educational backgrounds the interviewed SFP teachers bring to the program. This is considered to have possible link in further enriching the program, as described below. In my analysis, I
compared these SFP teacher backgrounds to AP teacher backgrounds.

In addition to their many years of teaching experience, two of these SFP teachers have been awarded prestigious awards on their teaching excellence including nationally recognized teaching awards in Canada. These awards were received after their involvement with SFP. Furthermore, one of these two teachers has also written parts of high school science textbooks. In terms of their academic backgrounds prior to teaching, they all have a Bachelor of Science and a Bachelor of Education. Moreover, they bring with them a research background (first teacher), honours degree in biotechnology (second teacher), and honours degree in science (third teacher). Their pseudonyms were not used in this section to respect the privacy settings of this study. As well, all three teachers assist with field trips. Especially Holdon, who is an outdoor enthusiast and hosts many of the outdoor field trips in the SFP program along with the assistance of other teachers in the school.

Mostly, teachers in specialized science programs, like AP, are more likely to hold a major in their subject like sciences and a Master’s degree. This is because teachers would have probably gained the necessary depth of science to teach these courses at a high academic level (Robinson, 2003). As previously mentioned in Chapter 2, research has shown that in a comparison of AP and non-AP students, the post-secondary drop-out rate in AP students is less than non-AP students (Santoli, 2002).

Holden is one of the few people in the AP program who teaches AP courses while having a Bachelor’s degree and not a Master’s. Similarly to the AP program, the other two teachers in this interview hold a major in their subject but instead just a Bachelor’s degree and not a Master’s. However, all these teachers have other valuable backgrounds that are supportive of a rich academic contribution to their teaching, like their teaching awards, lab research experience,
Biotechnology, Biology, Physics, and Honours degrees. Considering all this information, it is possible that these teachers bring a valuable background to their science students but a more in-depth study can follow to provide further insights.

4.3 Differentiation Between SFP and Academic Curriculum: Classroom

Enrolment numbers in undergraduate level programs in Canada has nearly doubled in the last 30 years because many careers require university education as a prerequisite (Parkin & Baldwin, 2009). Many students that do pursue a science degree program enter optimistically only to realize that there is a likely chance that they will not be able to graduate in the field (Stinebrickner & Stinebrickner, 2014). As much as 52.1 percent university students graduate from their initial enrolled program of choice within five years of starting it. This leaves 47.9% students unable to graduate in that period in their initial enrolled program (Finnie & Qiu, 2008). That is too high of a number and indicates that preparation is lacking at the secondary level. Here I explore the SFP curriculum design, Push Factor and other instructional practices that are used to prepare students to overcome such facts. Analysis of all three teacher interviews suggest that most students that do go through SFP do not encounter such a problem as will be discussed below.

4.3.1 Curriculum design. SFP teachers have developed their own unique curriculum while at the same time SFP curriculum fulfills the requirements for students to get an Ontario Secondary School Diploma. Their goal in the SFP program is to provide an enriching education in sciences to their SFP students to transfer to post-secondary education. This is also stated on the SFP website (SFP Program, 2016).

First of all, content traditionally taught at higher grade courses in the Ontario Academic
Science curriculum, is introduced in lower grade courses in SFP. Thus, students in SFP become exposed earlier to material traditionally taught later in the Ontario Academic Science curriculum. For example, in SFP students learn Organic Chemistry in Grade 11 where in Ontario Science curriculum students learn it in Grade 12.

This can be seen in Cathy’s statement,

I do a lot more labs with the SFP students. That is where I put my emphasis with Grade 11. I will give them a lot more harder questions, and usually in each unit there is one thing, one extra thing that I teach them that is not in the curriculum [Ontario Science Academic curriculum]. I also in Grade 11 teach Organic Chemistry, so that when they get to Grade 12 they already know the basis for organic, and so they are able to do a lot more organic in the Grade 12 course.

Next, this flexibility in the curriculum has allowed them to develop courses that they consider as equal or higher level than AP courses, by using various resources and their experiences. AP level courses are known for developing student skills at a higher level than those in regular curriculums. Furthermore, AP students have a lower drop-out rate in post-secondary (Santoli, 2002).

In addition, Mathew says that he is not familiar with the AP curriculum but SFP science courses do prepare students to write AP exams. Students that do write AP examinations have a chance of qualifying for University credits (undergraduate science course credit) if they meet the score requirements. For example, a score of 4 or 5 on an AP scale of 1 to 5, accredits a student the equivalent of 5 full course credits at York University (York University, 2015).

Some of the resources that teachers have used in developing these SFP courses are from
AP resources as described by Holden. Furthermore, Cathy says that SFP courses use textbooks like those found in the AP curriculum because teachers wanted more of a university or AP level feel to their SFP courses. This was not something available to them through the Ontario Academic curriculum. In other words, students in these courses are exposed to rich resources beyond the classroom to help them build their academic level.

On the contrary, interviewed teachers consider the textbooks in the Ontario Academic curriculum as not providing the in-depth material they want to present to their SFP students. Teachers in the Ontario Academic curriculum are limited to using these approved textbooks therefore cannot seek resources beyond the approved list. School funding also places a limit on the amount of resources that can be acquired for classroom use. The SFP programs have their own Enrichment Funding if they are not able to get support through the school. Although, according to an interviewed teacher it is “not much” but sufficient.

For example, Mathew uses a Calculus textbook in his SFP Calculus classes that is not approved from the Ontario Academic curriculum. While he does use such textbooks he does make sure to at least cover the Ontario curriculum requirements for students to receive their Ontario Secondary School Diploma.

He did point out that there is flexibility of when that occurs during the length of the students’ four years at the school,

The Ontario curriculum you really have to follow these rules that would be an obstacle because that's not right for these kids [SFP students]. Because they end up learning the Ontario curriculum anyway just maybe not when it's based on their courses.

All the collected evidence based on these interviews could suggest that SFP teachers
develop SFP courses with the aim of reflecting the goal of the program. The goal of the program is to provide an enriched education to its students that widens the students’ skills and knowledge by “greatly” exceeding the Ontario Academic curriculum (SFP Program, 2016). A more in depth analysis in future research like looking at lesson plans would provide more insights into this.

4.3.2 SFP Push Factor. Here, I discuss the SFP Push Factor which I consider a strong academic force SFP students receive from their teachers, followed by ready support from the faculty to help them get through academic barriers. The analysis suggests that this approach builds students’ academic success to smoothly transfer to post-secondary studies. This is in relevance to literature that indicates many students that enter post-secondary education feel an academic stress, as they realize they lack the background and “learn that their grade performance in STEM majors will be worse than expected” (Stinebrickner & Stinebrickner, 2014, p. 429).

Mathew described the experience of students from Ontario Academic stream as follows:

I think academic students, I think it’s too easy for them […] because no one wants students to fail because that makes them feel bad and hurts their self-esteem and that’s all true. But it doesn’t help them by cuddling them because then what happens? Then non-SFP students if they have never been made to work, they might think they have worked but they haven’t really. When they go off to university […] they just get blown out of the water. I just think that is so unfair.

Based on this quotation and other similar evidence (as follows) throughout all three interviews teachers pointed out that non-SFP students at the school need more academic challenging material to match the academic demands of university.

Mathew continued to add that “non-SFP students have an artificially high sense of self-
esteem […]” because of the academic environment they face during high school.

Holdon commented on the Academic Science program and its students that,

It’s about lack of preparation […], they [i.e. educators] think that a kid that walks into first year is going to remember everything that they learned in Grade 12 and beyond. […] What you need to do is over train them so when they come in there is an adjustment phase in university, where they largely get it, they get used to independent environment, they get used to type of examinations. The transition is far more seamless. It's cruel right now and it has been for years.

The current Academic environment based on these interviews is not a reflection of the rigours of secondary studies. This leads them to face struggles during their transition from secondary to post-secondary by making transition less smooth. These findings are in line with research findings where students realize that once they get into university they lack the necessary preparation and fear their grades will drop if they continue to pursue it (Stinebrickner & Stinebrickner, 2014).

Students from one stream are not considered as being more “smart” than the students from the other stream. Interviewed teachers did point out that if their non-SFP students (i.e. Academic stream) are challenged similarly like SFP students from earlier on in their education, there would be little difference between the two streams. For example, students up to Grade 9 can apply to enroll in SFP. A Grade 9 student can apply to enroll in Grade 10 of SFP. Similarly in literature it is suggested that if we need more science graduates, policies at younger ages lead to better prepared post-secondary science students. Policies include institutional rules related to major choice, elective courses, flexibility in the timing of major declaration, and others
According to the interviewed teachers’ knowledge of their students and the program, SFP students typically do not face the issues mentioned above. Typically, these issues are likely to be seen in Academic stream students. According to interviewed teachers, most SFP students get into university and pursue sciences. In general, SFP students are academically pushed more than students from the Ontario Academic stream. SFP program does this by providing similar academic challenges that students from the Academic stream would typically face during their transition to university. By doing this for the SFP students while in high school, teachers can keep a close eye on them and provide the necessary support and guidance to reach academic achievement. As a result, students get to challenge their knowledge and build the mindset to overcome it. This is what I call the Push Factor.

Similarly, literature research has shown that positive interpersonal relationships with teachers have been associated with high grade point averages (Wang & Degol, 2013). However, at the university level this kind of link between student and professor is not common and as a result students do not get that support from university faculty. This could be a further indicator of the drop out rate in students in post-secondary science education (Stinebrickner et al., 2014) who do not have a background in facing academic challenges at the university level.

Thus, the combination of teacher support and academic push (Push Factor) in SFP students during secondary school helps them become better prepared to face similar challenges when they get to post-secondary studies. This is because they have built a science background and mindset that reflects the realistic expectations of post-secondary school. In other words, the SFP Push factor could play a role in benefiting SFP students when they are transitioning into post-secondary studies.
4.3.3 More instructional practices: Hands-on activities. Throughout the interviews it is evident that teachers differentiate the SFP and Academic Science streams in various ways to achieve the goals of each stream, such as through hands-on activities. Overall the materials in SFP are perceived as being more enriching to a student and in developing similar scientific skills they will face in post-secondary education. Hands-on activities have been demonstrated to support development and engagement of student academic skills (Wang & Degol, 2013).

Teachers take a different approach to the hands-on activities that students are exposed to in the classroom, between SFP and Ontario Academic curriculum. SFP teachers have mentioned that in SFP science courses students “do a lot of labs” compared to science courses in the Academic Science curriculum.

SFP students also attend many trips offered through the SFP program. For example, this can be seen in Cathy’s statement:

We usually have Grade 9, and second week of school we go to an outdoor centre for the YMCA and Pinecrest. The kids are coming from all over the city and they don’t know each other. So this is kind of a place where they get to meet each other, they have to work as teams, they learn all the different thing we want them to have as they go though the program. In Grade 10 it’s the big science one. In the beginning of May we go to Algonquin park for 4 days and they are hiking and doing science experiments though the entire park. And they come home and do a massive presentation about what they found and, they are usually very specific. So some of them will be just looking at the pH of the entire park and they will be analyzing the information that we have not only for this year but all the other years.
To summarize the findings, SFP students have more exposure to multiple trips and group work throughout their four years in high school compared to Academics. For example, in Grade 9 they are taken on a social field trip to develop friendships. Then in Grade 10 they go on a four-day trip to the Algonquin Park which is organized by Holden. This gives them the exposure to apply their knowledge in the real world and get a feel of real world scientific studies. This amount of hands-on activities is partly possible because of a SFP fund. This is also possible because these students have built the knowledge to carry out these activities starting from earlier on in high school. This is also why the program stops intaking students after Grade 9 from the standard Ontario curriculum. Research has indicated that exposure to frequent hands-on activities lead to significantly higher academic scores than those that experience less of these activities (Areepattamannil et al., 2011). This is another evidence that gives SFP students an advantage in achieving academic success for a smooth transfer to post-secondary studies.

Overall, in this section the analysis suggests that a combination of instructional strategies such as hands-on activities also contribute to SFP students being more prepared about what science and post-secondary studies include.

4.4 Chapter Conclusion

Science specialized programs like SFP seemingly provides an advantage to its students to transfer into science post-secondary studies and to continue in it. These findings inform the main research questions: How does SFP differ from Ontario Academic Science curriculum? What benefits can SFP bring to the Ontario Academic Science curriculum for preparation of students for post-secondary science studies? The discussion of the findings began by looking at student motivation and involvement in extracurricular activities. There was a correlation between
students who exhibited intrinsic motivation and participated in extracurricular activities. Most SFP students exhibited these traits which are known to help them advance in academics. Then the analysis continued by looking at the opportunities that SFP offers through its SFP courses, out in the field activities, Push Factor, and others. The findings suggested that SFP students have an enriching exposure while being in the SFP program by gaining science skills, the necessary background for a smooth transition into post-secondary education, and most students continuing in a similar field. Their colleagues in the Academic Science curriculum unfortunately do not get the same exposure and as a result might have a less smooth transition into post-secondary education or even be able to continue sciences. In Chapter 5, I further elaborate on these findings through implications to the educational community, and to my professional identity and practice. I also discuss recommendations and areas of future exploration in this science education research field.
Chapter 5: Conclusion

5.0 Introduction

This chapter concludes my research study which investigated a science program at the secondary level, Science Focused Program (SFP) in comparison to the Ontario Academic Science curriculum. It aims to answer the main research questions: How does SFP differ from Ontario Academic Science curriculum? What benefits can SFP bring to the Ontario Academic Science curriculum for preparation of students for post-secondary science studies? In this study there is evidence that SFP provides an enriching environment that could help students transfer to post-secondary science with ease. This may in turn lead students to pursue further education and even careers in sciences. Furthermore, this chapter discusses the significance of the key findings and their implications to the educational community, and to my professional identity and practice. Then this is followed by recommendations which addresses the implications of this research study. Lastly I present areas for further exploration in this research field, science education.

5.1 Overview of Key Findings and Their Significance

The research findings of this study, presented in Chapter 4, are important to understand the gap students face in transferring from secondary to post-secondary science education. Overall, the findings suggest that most SFP students have an enriched student experience in the SFP program by gaining necessary science skills and background. This provides a smoother transition into post-secondary education compared to their peers in the standard Ontario Academic Science curriculum program. In chapter 4, the key research findings were organized into three themes: student motivation and extracurricular activities, teacher “training”, and lastly
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differentiation between SFP and Academic curriculum: classroom.

For the first theme, student motivation and extracurricular activities, the key findings suggested motivational differences between SFP and Ontario Academic Science curriculum students. The majority of SFP students express intrinsic motivation whereas the majority of non-SFP students express extrinsic motivation, according to teacher’s observations. Additionally, students in the SFP program are typically involved in various extracurricular activities where they dedicate many hours of their time. In this theme, intrinsic motivation and extracurricular activities, describe characteristics found mostly in SFP students which promote student success (Areekattamani, Freeman, & Klinger, 2011; Feldman & Matjasko, 2005) and possibly help with transferring to post-secondary.

For the next theme, teacher “training” (assistance) and background, the key findings suggest that teacher collaboration plays the role of an informal SFP training for richer pedagogy. Furthermore interviewed teachers bring educational backgrounds that contribute to a richer pedagogy. In terms of collaborations, SFP teachers are in proximity and share rich resources to help them build their lessons. These SFP teachers also have a background in lab research, Honours degree, and others. All this in return could expose students to a enriched academic environment.

In the last theme, differentiation between SFP and Academic Science curriculum, the key findings here indicate that SFP teachers use curriculum flexibility, the Push Factor and other instructional practices to support their students. This supports students by helping with transitioning to post-secondary studies. SFP curriculum flexibility has allowed teachers to design courses by enriching content while fulfilling the requirements for the Ontario Secondary School Diploma. For example, they are able to use resources (i.e. textbooks) outside the Ontario
Academic Science curriculum. Furthermore, they are able to modify (shift) the Ontario Academic Science curriculum component in SFP courses. This exposes their students to material that closely resemble post-secondary content. This further helps with the transfer to post-secondary. Next, teachers provide academic push (Push Factor) to create academic challenges for students to build a real sense of self-perception before going into post-secondary science studies. Along the way, teachers provide support to help them get through the challenges. Non-SFP students would likely experience such a thing independently when they enter post-secondary, without much support from professors. This could lead to a greater possibility for these students to change their minds about their initially enrolled degree. Additionally, teachers use more instructional practices like hands-on activities to expose students to real-life science and help students predict their outcomes in the field. In return, all these factors could possibly contribute to a smoother transfer of SFP students in the post-secondary science studies.

5.2 Implications

Based on the key research findings presented above, in this section I present the implications for the educational community, and my professional identity and practice as an educator. For the educational community I discuss implications in reference to students, curriculum, and pedagogy. For my professional identity and practice, I discuss implications in reference to the characteristics of the SFP program that I learned through this research study. Here, I further discuss how these characteristics like student attitude (motivation), pedagogy, and curriculum influence my thinking and practice as an educator.

5.2.1 The educational community. The educational community is a broad term and encompasses a variety of stakeholders. In this section, I focus on three facets for the educational
community: students, curriculum, and pedagogy. Scholarly research addressing the secondary to post-secondary gap indicates that students who are initially open to majoring in science, few of these students graduate with a science major (Stinebrickner & Stinebrickner, 2014).

This is seen,

Specifically, while the proportion of students who begin school believing that a degree in science is their most likely outcome (0.20) is higher than the proportion for any other major […], only 0.07 of students complete a degree in science (Stinebrickner & Stinebrickner, 2014, p. 428).

This observation could be because students have unrealistic expectations about the demands of post-secondary studies once they get there, which leads the majority to change pathways and not graduate with a science degree (Stinebrickner & Stinebrickner, 2014). Therefore, it is necessary to reduce this gap by equipping students with the necessary skills and knowledge, to have a smoother transfer from secondary to post-secondary education.

5.2.1.1 Implications for students. First of all, in reference to implications for students, I discuss this based on SFP’s enriching environment and then expand to student motivation.

Based on teacher interviews, SFP could provide an enriching environment for its students to study science and possibly help them have a smoother transfer to post-secondary. This is in comparison to their peers in the Ontario Academic Science curriculum, within the same school. Overall, interview analysis suggests that SFP provides an enriching educational environment. SFP builds students’ skills and knowledge of science through its resources (i.e. research field trips), teaching strategies (i.e. Push factor), curriculum (i.e. textbooks), and others. Likewise in scholarly articles, it is discussed that the experience students derive from challenging coursework (similar to Push Factor in SFP) and opportunities to engage in science (similar to research in real
world settings assignments in SFP) offer exposure similar to those experienced in professional laboratories (Almarode et al., 2014; Areepattamannil et al., 2011). Consequently, this provides students with realistic knowledge and skills of what lies ahead, if they are to pursue science studies and careers. Thus, the implication for students suggests that learning about SFP’s enriching environment could reduce the gap between secondary and post-secondary education. If the characteristics of SFP can be applied to the Ontario Academic Science curriculum, it could help students gain the necessary skills and knowledge for transferring to post-secondary.

Moreover in implications for students, according to interviewed teachers, motivation differs between SFP and non-SFP students. SFP students express more intrinsic than extrinsic motivation which could have a role in students achieving academic success, and to possibly pursue and complete post-secondary science education. This is in comparison to non-SFP students who are observed by the teachers as having more of the extrinsic than intrinsic motivation. Based on literature, intrinsic motivation can boost student cognitive engagement, enjoyment with science, and help students be more efficient learners than extrinsically motivated students. To promote enjoying and cognitive challenging environments to students, teachers can use various strategies like student-centred instruction using hands-on approaches (Areepattamannil et al., 2011). In this study, the interconnection between curriculum content (like those discussed in 5.2.1.2), pedagogical approaches (like those discussed in 5.2.1.3), and student attitude (i.e. work ethic skills) could be nurturing intrinsic motivation within these students. For example, pedagogical approaches like hands-on approaches are often used in SFP classes. I find that a combination of these factors could bring enjoyment and facilitate student cognitive development. Unlike their SFP peers, non-SFP students do not receive this level of exposure in the Ontario Academic Science curriculum. This could be affecting their motivational
differences. Therefore, implications for students suggest that intrinsic motivation build through enriched curriculum content, pedagogy, and student attitude can facilitate their learning of the competencies and skills required for a creative and productive future (Areepattamannil et al., 2011).

5.2.1.2 Implications for curriculum. In reference to implications for curriculum, SFP takes a different approach to its curriculum compared to the Ontario Academic Science curriculum. Certain content in the SFP program is taught earlier than what is normally done in the Ontario Academic Science curriculum (curriculum shifting). As well SFP has flexibility in selecting textbooks beyond the Ontario Academic Science curriculum.

First of all, content traditionally taught at higher grade courses in the Ontario Academic Science curriculum, is introduced in lower grade courses in SFP. In other words, there is a curriculum shift in SFP compared to when the content is traditionally taught in the Ontario Academic Science curriculum. For example, Organic Chemistry is taught in Grade 12 in the Ontario Academic Science curriculum but in SFP it begins in Grade 11. To ensure that all SFP students build on the prerequisites earlier on to advance to SFP senior classes, Ontario Academic Science curriculum students cannot apply to enroll in SFP after Grade 9. Another difference between the two curriculums is textbook options. Based on teacher interviews, textbooks used in SFP resemble those that are used in AP (Advanced Placement) courses or university courses. This provides students with a more accurate representation of the material they will see in post-secondary science. All these characteristics of the SFP curriculum give students a more accurate perception of post-secondary. The implication for curriculum suggest that if these SFP characteristics are applied to update the Ontario Academic Science curriculum, it could lead to reducing the gap between the two education levels.
5.2.1.3 Implications for pedagogy. Lastly, I discuss implications for pedagogy. SFP distinguishes itself in its pedagogical approaches. This can be seen through the time teachers invest in pedagogy, their attitude toward students (i.e. Push Factor), and the hands-on approaches teachers use.

Firstly, as described by Mathew, SFP teachers often go beyond job hours to prepare for classes. This kind of commitment leads to an enriching environment for SFP students. For example, Holdon many times will keep his lab open after school for students to finish their experiments. The implications for pedagogy here suggest that to achieve the kind of standard used in SFP classes, teachers require more time for pedagogy. This is important because providing adequate time to pedagogy could further reduce the gap between secondary and post-secondary science.

Furthermore, SFP teachers in their pedagogy apply the Push Factor (academic push) to help students be prepared for the challenges they will face in post-secondary. The literature review in Chapter 2, indicates that students that enter post-secondary education feel an academic stress as they realize they lack academic background and cannot get through it (Stinebrickner & Stinebrickner, 2014). Students that experience this phenomenon, initially during post-secondary have a higher chance of switching or dropping out of their current post-secondary program: science (Stinebrickner & Stinebrickner, 2014). If students are exposed to these kind of challenges (i.e. failures), it builds their true sense of self-efficacy (belief about performing the task). The attitude in facing those challenges will depend on the influence from teachers, parents, and friends have on the students (Almarode et al., 2014). Similarly, the teachers in these interviews believe that by giving academic push to their students in high school, students can face and navigate their challenges earlier on while having the close support of their teachers. On
the contrary, their non-SFP peers potentially face these challenges after entering post-secondary, where there is more independence as a student and thus less support from professors. This in return could lead them to possibly rethink their program of choice. The divergence in pedagogy between SFP and Ontario Academic Science curriculum, points to gaps in teaching practices and attitudes between them. It also points to the degree that students are prepared for post-secondary studies in the sciences. Another implication for pedagogy suggests that if teachers in the Ontario Academic Science curriculum consider this approach (student academic push or as I call it Push Factor) it can be a learning opportunity for students. This in return could help students grow into well rounded individuals to face those challenges with ease once they get to post-secondary. Thus, this could further contribute to the reduction of the gap between secondary and post-secondary science.

Next, interviewed teachers frequently use hands-on approaches in their pedagogy. Hands-on activities have the possibility to enhance students’ procedural and conceptual understanding, their intellectual and practical skills, and their understanding of the nature of science (Areepattamannil et al., 2011). To point out, these teachers bring backgrounds like field-related experiences, which all add to a teacher background that is reflective of enriching pedagogy. Their backgrounds could be a precursor to their pedagogy approaches, in that they often apply hands-on approaches in the classroom. For example, Mathew has lab experience and Holdon brings outdoor knowledge. Teachers use hands-on approaches in SFP to bring real-life practicality to their students. For example, students in the program attend social and academic field trips. For one of the academic field trips, students attend a camping trip in Algonquin Park, collect data out in the field, analyse, and present these data. This in return builds a database history of the park and helps students get a feel for science, research, and being a scientist. The
teachers say that this is not a common occurrence outside SFP due to administrative obligations (i.e. paperwork) and resources (i.e. skilled teachers and finances). Therefore, the implication for pedagogy here suggests that these approaches to pedagogy, if applied in the Ontario Academic Science curriculum through professional development of teachers, it could resemble the outcomes of SFP’ enriching environment which is reflective of the hands-on requirements of science. This in return could further contribute in reducing the gap between secondary and post-secondary.

5.2.1.4 Summary of implications. Overall the implications for the educational community in reference to students, curriculum and pedagogy suggest that a combination of these characteristics from the SFP program, if applied to the Ontario Academic Science curriculum could help its students transfer to post-secondary with greater ease. This could lead to reduction in the current gap between the two education levels (secondary and post-secondary). Therefore, students will have a more comprehensible view of the expectations of post-secondary science to predict their outcomes in the field.

5.2.2 My professional identity and practice. Regarding implications for my professional identity and practice, I present my goal as an educator and what I learned through this study (secondary to post-secondary gap, motivation in students, pedagogical strategy, and connecting the curriculum to real-life practicality).

In my teaching career, I aim to teach students the reality of science when it comes to education and careers. This is because of my personal experience with the field. Growing up in the same high school that SFP runs, I witnessed most of my SFP peers go through a different education than those in Academic Science curriculum, as described in 5.2.1. I also witnessed
many of my colleagues that work in the scientific field, express dissatisfaction with the way high school prepared them for the realities of post-secondary and science careers. This is what drove me to conduct such a study and to learn more about how to improve student transfer from secondary to post-secondary, by providing an enriching environment that portrays a more realistic picture of science.

Throughout this study I learned new knowledge and reinforced current knowledge that has influenced my thinking and practice. Some of these are discussed below.

First, this study reinforces my professional judgement that students in the Ontario Academic Science curriculum may lack necessary skills to transfer smoothly to post-secondary. By investigating the SFP program at various levels (pedagogy, curriculum, and students) I learned that understanding these levels can possibly help students overcome that transfer issue. As an educator, I am now more informed on these levels and I will consider applying this knowledge to my pedagogy to improve the current situation.

Next, I learned how curriculum, pedagogy, and student attitude interconnect, which I can then use those to apply related strategies and help facilitate intrinsic motivation in students. As a teacher, I feel that intrinsic motivation is an important characteristic that can boost student success and it is one of the predictors for student achievement (Areepattamannil et al., 2011). This is something that I am interested in bringing out in my students. To do this I could start by creating a fun learning environment in science classes that inspire creativity and are reflective of post-secondary work, through resources like hands-on applications. However, because I would be in the role of a teacher my contribution would mostly be on pedagogy and student attitude. As mentioned earlier, for this to take full effect there needs to be interconnection between all three levels. This would require the help of other people that hold different roles in relation to the three
levels, for example curriculum designers and administrators. All the stakeholders combined would be able to provide support in fulfilling curriculum, pedagogy, and student attitude.

Moreover, I learned that teachers use Push Factor as a pedagogical strategy by helping students learn to face challenges they will encounter after entering post-secondary. In doing so, teachers provide support to students to overcome their challenges and ensuring their well-being. This prepares them for the realistic expectations of post-secondary. On the contrary, non-SFP students probably lack this experience when they get to post-secondary. I thought this was an interesting way to approach pedagogy. I am interested in applying this in my teaching practice to help students build the necessary skills to transfer smoothly to post-secondary.

Lastly, I will keep up to date with jobs in the science-related field because I recognize the disconnect between theory and practice, and the need for teachers to connect the curriculum to the high and changing demands of the science career world. I will do this through my professional contacts in the science-related field and reach out to science-related professional through cold calls or programs.

Among the various knowledge I learned through this study which have influenced my professional identity and practice, these are the ones that stood out to me the most: secondary to post-secondary gap, motivation in students, pedagogical strategy, and connecting the curriculum to real-life practicality.

5.3 Recommendations

The educational community can learn from the SFP program by exploring its characteristics (i.e. Push Factor) to improve the quality of education (i.e. Ontario Academic Science curriculum) and to reflect the demands of the fast changing scientific field. By learning about these characteristics, we can explore into transferring that knowledge into the Ontario
Academic Science curriculum for all students. I will focus on four recommendations in my upcoming career as a teacher: student motivation, updating curriculum, updating pedagogical approaches, and keeping in touch with science-related fields.

To help students bring out their intrinsic motivation I recommend that applications resembling science in a real-life setting be used as a foundation to begin changing the mindsets of students. This may potentially encourage intrinsic motivation in students. As discussed earlier in 5.2, there needs to be a combination of support at all three levels of pedagogy, student attitude, and curriculum for this to be more successful. However, this is just a starting point in helping students find their intrinsic motivation.

My next recommendation is related to the curriculum. Science is fast-changing and constantly updating, and with that said I recommend that the curriculum to be often updated to match those changes. SFP has already changed its curriculum to better reflect post-secondary requirements. These types of steps help students in SFP to better understand the material in first year post-secondary school. Another recommendation to curriculum is regarding textbooks. Textbooks need to be updated simultaneously with the fast-changing science world. For the textbooks, I also recommend that we try different formats like electronic versions to keep up with the fast changes of science.

Next in terms of pedagogy, I recommend application of Push Factor, changes to teacher preparation periods/time and teacher professional development. To begin with, I suggest to teachers to challenge their students using Push Factor as seen with the SFP teachers. As indicated in this research, this helps students face academic challenges while in high school with the support of their teachers, and not in post-secondary where they are independent and potentially incurring financial and time losses. Additionally, I suggest teachers should be allocated more
time or an extra period for preparation within school hours to meet the demands of providing an enriching environment. Moreover, I suggest professional development for teachers. In professional development teachers can be trained on the latest technique trends. They will gain knowledge about the latest discoveries to use in the classroom and make students aware of what science looks like in the current time as well.

Finally, as a recommendation to my peers, new and experienced teachers, I recommend that they connect the curriculum to science-related careers and science post-secondary education. This is to construct a more realistic picture of the current situation in the field. Thus, students can be aware of what is current and coming. Science is always changing therefore it is necessary to keep up with those changes. Teachers can keep up with all the necessary updates by reaching out to scientists through cold calling or science promoting programs, attending career seminars/job fairs, and others.

In summary, the recommendations above (bringing out intrinsic motivation, updating curriculum, updating pedagogical approaches and keeping in touch with science-related jobs) are some of the recommendations that I suggest to the education community. This is based on my research and professional education in order to reduce the gap between secondary post-secondary science studies for students in the Ontario Academic Science curriculum.

5.4 Areas for Further Research

For areas for further research, I have three propositions as follows to help with understanding the gap between secondary and post-secondary science: lesson plan analysis, student longitudinal study, and intrinsic motivation study. These are extensions of my research based on the context of my qualitative study as the Master of Teaching program allowed me to complete my qualitative research within a limited time and capacity. Furthermore, this research
followed the ethical parameters placed by University of Toronto which indicated that I was not allowed to observe or interact with students.

Firstly, I suggest a larger scale document analysis of lesson plans for teaching pedagogy. I am making this proposal based on my findings that SFP and the Ontario Academic Science curriculum differ in curriculum and pedagogy. This is to further understand the content used in the SFP program for the possibility of transferring its characteristics to the Ontario Academic Science curriculum. This analysis can be done through qualitative methods like teacher interviews, lesson plan analysis, and others.

Next, I propose a long-term study that follows SFP and non-SFP students before and after entering post-secondary school like university. I am making this proposal based on my findings that students from SFP and the Ontario Academic Science curriculum differ in the backgrounds they bring to handle challenges in post-secondary. This is to further learn longitudinal student experience with science education based on the backgrounds they bring forward. This can be done using mixed methods through student interviews, surveys, and collection of their academic performances (i.e. transcripts).

Lastly, I propose a qualitative study to research intrinsic motivation in SFP and the Ontario Academic Science curriculum students, how to bring that out in students, and the approaches teachers can use to do that. I am making this proposal based on my findings that students in SFP display more intrinsic than extrinsic motivation. This qualitative study can be done through observations of student interactions in the classroom, and interviews with students and teachers.

In summary, these three study proposals (lesson plan analysis, student longitudinal study, and intrinsic motivation study) are what I suggest as areas for further research and as an
extension to this research study. These discussed areas for further research could help shed light into new knowledge to reduce the gap between secondary and post-secondary science education, to better prepare students for sciences.

5.5 Concluding Comments

In this chapter I have provided the conclusions derived from my research study which investigated SFP in comparison to the Ontario Academic Science curriculum to help bridge the gap between secondary and post-secondary science education for students. First, I presented an overview of the key findings and their significance. The three themes discussed here were student motivation and extracurricular activities, teacher background and curriculum, and lastly curriculum differentiation. Next I discussed the implications for the educational community and for my professional identity and practice. The implications for the educational community suggest that a combination of student, curriculum and pedagogical characteristics could further support in bridging the gap. This research also taught me various things like the pedagogical strategies that have influenced my professional identity and practices, which I will consider applying in my future teaching to help students be successful. Furthermore, I provided numerous recommendations to the educational community to further investigate into SFP as a way to learn more about its benefits toward influencing student learning and reducing the gap. Lastly, I outlined three areas for further research based on the findings of this study and its limitations from the Master of Teaching program. Such studies include lesson plan analysis, student longitudinal study, and intrinsic motivation study.

This research study is important to educators interested in reducing the gap between science secondary and post-secondary education, and helping students succeed in the field. This study has identified current working applications and the things that remain to be completed.
This study has also identified possible ways for the educational community firstly to bridge the gap and secondly to ease student transfer, between science secondary and post-secondary educations. Overall this study has identified possible characteristics from SFP that can be explored in the Ontario Academic Science Curriculum to potentially enhance student success in transferring to post-secondary.
References


SFP Program. (2016). *Welcome to the* (name removed) program. Retrieved from (link removed) (note: original reference was modified to follow privacy ethics of this study).


Appendix A: Consent Letter

Date:
Dear _______________________________,

My Name is Albana Kume and I am a student in the Master of Teaching program at the Ontario Institute for Studies in Education at the University of Toronto (OISE/UT). A component of this degree program involves conducting a small-scale qualitative research study. My research will focus on exploring the SFP program and the benefits to its students for science skills in application to post-secondary transition and career focused. I am interested in interviewing teachers who are teaching science courses in SFP for at least 2 years and have been teaching full time in the Ontario education system for at least 3 years. I think that your knowledge and experience will provide insights into this topic.

Your participation in this research will involve one 45-60 minute interview, which will be transcribed and audio-recorded. I would be grateful if you would allow me to interview you at a place and time convenient for you, outside of school time. The contents of this interview will be used for my research project, which will include a final paper, as well as informal presentations to my classmates. I may also present my research findings via conference presentations and/or through publication. You will be assigned a pseudonym to maintain your anonymity and I will not use your name or any other content that might identify you in my written work, oral presentations, or publications. This information will remain confidential. Any information that identifies your school or students will also be excluded. The interview data will be stored on my password-protected computer and/or USB key and the only person who will have access to the research data will be my course instructor. You are free to change your mind about your participation at any time, and to withdraw even after you have consented to participate. You may also choose to decline to answer any specific question during the interview. I will destroy the audio recording after the paper has been presented and/or published, which may take up to a maximum of five years after the data has been collected. There are no known risks to participation, and I will share a copy of the transcript with you shortly after the interview to ensure accuracy.

Please sign this consent form, if you agree to be interviewed. The second copy is for your records. I am very grateful for your participation.

Sincerely,

Albana Kume
E-mail: albana.kume@mail.utoronto.ca
Consent Form

I acknowledge that the topic of this interview has been explained to me and that any questions that I have asked have been answered to my satisfaction. I understand that I can withdraw from this research study at any time without penalty.

I have read the letter provided to me by Albana Kume and agree to participate in an interview for the purposes described. I agree to have the interview audio-recorded.

Signature: ______________________________________

Name: (printed) _______________________________________________

Date: ______________________________________
Appendix B: Interview Protocol/Questions

Introductory Script: Thank you for agreeing to participate in this research study, and for making time to be interviewed today. This research study aims to learn how SFP program benefits its students for the purpose of providing insights to the education community. This interview will last approximately 45-60 minutes, and I will ask you a series of questions focused on background information/teacher profile, student profile, teacher practices and challenges. I want to remind you that you may refrain from answering any question, and you have the right to withdraw your participation from the study at any time. As I explained in the consent letter, this interview will be audio-recorded. Do you have any questions before we begin?

NOTE: Italics text in the question list below refers to further clarification to the questions if the interviewee misses.

Background Information/Teacher Profile
1. How long have you been teaching in Ontario secondary public schools?
2. What courses have you been teaching as a full time teacher in Ontario public schools?
3. How long have you been teaching in the SFP program and what courses?
4. What degrees do you have, other additional qualifications and teaching awards? (Did these occur prior to you teaching SFP?)

Student Profile
5. What characteristics do you observe among your students in your recent classroom/s? (If you have any insights into this, what is their life like outside the classroom in terms of extracurricular, clubs, science related activities, etc.?)
   a. What do you believe students can gain from attending a SFP curriculum compared to the regular Ontario Science curriculum? (For example in the long-term or even the short-term).
   b. I realize SFP students attend multiple excursions, how has that influenced academic achievement or performance in your students? (Can you give me an example? Is this something that you see applied on the same level in the regular academic curriculum?)

Teacher Practices
6. How did you become involved with SFP? (What training did you receive and what did it look like in becoming a SFP teacher?)
   a. What resources or opportunities do you have available to you as a SFP teacher that a regular academic program may not have?

7. How do you differentiate between teaching a SFP and a regular academic program?
   a. There are different types of instruction like: teacher-centered and/or student-centered. What is your approach in a SFP classroom versus a regular academic classroom? (Can you provide some examples?)
   b. What other teaching methods do you use, starting with the one you rely with the most?
      i. How is AP content incorporated in your SFP course/s?

Teacher Perspectives/Beliefs

8. What do you consider 21st century skills that will help students bridge to post-secondary studies (i.e. university) and careers in the science field? (How do you teach that to your SFP students? What about academic students?)

9. How has your students’ (SFP and academics) academic confidence grown through the time you got to know them? (Do you have an example?)

10. How does motivation play a role in your student academic achievement (extrinsic vs. intrinsic; SFP vs. academics)?
    a. How does SFP make a difference in gaining admission to post-secondary education like university? (drop out rate, confirmation of science career path)
       i. What do you think is the role SFP has on students in completing their science degree programs?

Challenges and Supports

11. Have you faced any obstacles or challenges when teaching SFP?
    a. What about when compared to your academic students?

12. What supports would you like to have for a more successful teaching practice?

13. What is your advice for incorporating some of the SFP strategies or opportunities for students in Academic (or even Applied) science courses?