PERCEPTIONS OF THE SOCIAL AND ECONOMIC FACTORS INFLUENCING ENGINEERING AND APPLIED SCIENCE STUDENTS' CHOICE OF DEGREE PROGRAM

by ©Amit Sundly

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Abstract

A career in science or engineering is not among the top choices of Canadian students. Although there is no current imbalance in demand and supply of engineers and scientists in Canada, it is also true that the global need for these skills is currently at its peak with substantial future growth opportunities. With competition from emerging economies like India and China, it is essential for government, schools and universities, and other agencies in the Canadian education system to understand the factors influencing Canadian students' participation in post-secondary degree in engineering. Review of the literature shows that there has been limited investigation of this phenomenon. Using a cross-sectional survey design, this study, set in the Newfoundland Labrador context, examines certain demographic, family, high school, societal, economic, and personal factors that play a role in students' academic decisions to pursue an undergraduate engineering degree. The findings show that participation in undergraduate engineering programs at Memorial University is associated with student's family background and gender. Students from lower socio-economic backgrounds and women are underrepresented in undergraduate engineering education in Newfoundland and Labrador. The results also reveal that engineering student represent their decisions to pursue engineering as influenced primarily by personal factors and only marginally by school-level factors. The study points to a number of implications for policy and practice. Among the policy actions that could increase the number of engineering students from underrepresented groups is reexamining and, where necessary substantially improving support programs for underrepresented populations – both at the secondary and post-secondary levels. At the school level, this might involve greater attention to engaging students in STEM-based experiential activities and programs, explicitly exposing students to information on careers in engineering and the applied sciences, and professional development for teachers and counselors. At the post-secondary level, financial support to students from underrepresented groups and continued research in the area of engineering education may increase participation in engineering and help create equitable educational opportunities in the field of engineering for students from lower socio-economic backgrounds.

Keywords: STEM education, engineering education, post-secondary decision-making, student perceptions

Acknowledgement

"Teacher and god both are here, to whom should I first bow. All glory be unto the teacher, path to god who bestow"- Kabir Das (Indian Poet)

These couplets were written to show respect to the teachers who impart knowledge and create a rational person. One of the first lessons I ever learned from my parents was to respect my teachers. I have no doubt in saying that whatever I am today is because of my teachers from kindergarten to University. So firstly, I would like to take the opportunity to thank every educator who taught me anywhere from early childhood to adulthood.

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List of Abbreviations

AAU	Association of Atlantic Universities
ACUDS	Atlantic Common University Data Set
GDP	Gross Domestic Product
ICEHR	Interdisciplinary Committee on Ethics in Human Research
OECD	Organization for Economic Cooperation and Development
NL	Newfoundland and Labrador
PISA	Programme for International Student Assessment
STEM	Science, Technology, Engineering, and Mathematics
YITS	Youth in Transition Survey

Chapter One- Introduction of the Study

1.1 Background

> "How many of Canada's young people do we need to embrace science?
> All of them." (AMGEN-Let's talk science, 2012, p.8)

This quote captures the sense of urgency expressed by some organizations about the need to refocus learning in ways that can help Canada prosper in a technology-driven world economy. It is a general understanding that our skilled society makes a critical contribution to Canada's prosperity, however, there remains uncertainty about precisely which skills are needed to thrive in tomorrow's economy. In a complex and uncertain global economy, human capacity in STEM (science, technology, engineering and mathematics) related fields is generally considered to be one of the major contributors to Canada's economic competitiveness and productivity (Dodge et al., 2015).

The AMGEN/ Let's Talk Science study states that there appears to be a severe detachment between Canadians' belief in the value of science to society and adolescents' desire to pursue a career in STEM (AMGEN-Let's talk science, 2014). According to Orpwood, Schmidt, and Hu (2012), although Canadian students do understand the significance of science and technology to Canada's future, the majority of them are not inclined to make career in those areas. The 2010 Angus Reid survey of Canadian students between 16 and 18 years of age, concluded that only a third of the participants were drawn towards taking a single science related course at the university level (AMGEN-Let's talk science, 2014). Canadian youths believe that, "people who work in science aren't cool" (QMI Agency, 2010).

Canada's capacity to fulfill labour market demand in STEM related fields and to promote innovation has been a matter of particular concern for governments, policy-makers, educators and businesses. In spite of the fact that Canada spends a higher percentage of its Gross Domestic Product (GDP) on education than the OECD (Organization for Economic Co-operation and Development) average, many other OECD countries are doing better in terms of motivating students to study STEM degrees (Statistics Canada, 2014; The Conference Board of Canada, 2014). The Conference board of Canada report suggests that, despite low numbers of science graduates, there is no shortage at the labour market level in Canada. However, a major concern for Canada as well as U.S., is the inability to keep up with emerging powers such as India and China, which are producing STEM graduates at an ever-increasing rate; this may have implications for innovation in the future. China and India give significant importance to STEM education, which helps them to develop the workforce, sufficient to fulfill domestic as well as global demands for these skills. Organization for Economic Co-operation and Development (2015) suggested that these countries could contribute more than 60% of the G20 workforce with STEM credentials by 2030.

In context of the U.S., multiple studies which explored the achievement disparities between the U.S. and higher-performing countries found that American students are disadvantaged on various aspects that affect mathematics and science achievement (Xie, Fang, & Shauman, 2015). These aspects include national cultural traditions related to math and science (Cogan & Schmidt, 2002; Fang, Grant, Xu, Stronge, & Ward, 2013; Stevenson & Stigler, 1992), family and school support to emphasizing math and science education (Fuchs & Wößmann, 2007; Sousa, Park, & Armor, 2012; Tsui, 2005), the educational system structure and national labour market conditions (Langen & Dekkers 2005), and cross-country disparities in curriculum and style of instruction (NCES, 2000, 2006; Schmidt, 2012).

Thus, it is important to explain and explore the factors that enable students to choose science and engineering as a career in Canada and the United States.

Even a quarter century ago there were calls for the education system in Canada to produce more scientists and engineers. Slemon, in his 1993 report addressed the future importance of engineering and science education in Canada:

> Canada's future prosperity and quality of life will depend in large measure on the incorporation of superior skill, intelligence and added value into its products and services while establishing a sound basis for a sustainable global environment. Professional engineers can play important roles in creating high-quality employment, establishing new enterprises, restructuring existing processes and developing new products and services. The basis for excellence in the engineering profession is excellence in the system of engineering education at undergraduate, graduate and career levels. It is imperative that this education system evolve effectively to meet these changing needs of Canadian society. (p. i)

Since 1993, the world has come a long way in terms of scientific discoveries and innovations. However, the need of engineering and applied science still exists more than ever. The Council of Canadian Academics (2014, p. xiii) articulates very well how science and technological innovation have helped transform the society in the last two decades:

> Science is a fundamental part of Canadian culture and society, affecting nearly every aspect of individual and social life. It is a driving force in the economy, catalyzing innovation and creating new goods, services, and industries. It has led to improvements in Canadians' physical health and well-being. It has made possible new forms of communication and learning, and changed how Canadians interact and relate to one another. It also provides opportunities for leisure and entertainment as Canadians visit science centres, pursue science-related hobbies, or tune in to such television programs as "The Nature of Things" or "Découverte". Science is also a systematic means of discovery and exploration that enriches our individual and collective understanding of the world and universe around us.

Some researchers argue that there is no evidence of a current imbalance between the demand and supply of engineers and physical scientists in the national labour market level in Canada (Dodge et. al., 2015); however, it is also true that immigrants hold more than half of all STEM-related credentials in Canada (Ferguson & Zhao, 2013). It is therefore important for Canadian educators and policymakers to understand how young Canadians choose to pursue an engineering degree and what influences them to do so.

There are numerous studies on how students make decisions to pursue higher education and the factors influencing them (Eidimtas & Juceviciene, 2014; Hanson & Litten, 1982; Hossler & Gallaghar, 1987; Jackson, 1982; Kotler & Keller, 2009; Schiffman & Kanuk, 2007)**.** These focus towards understanding students' buying behavior in higher education and how their decision to choose a specific college is influenced as a consumer. There still remains a gap in literature about investigating factors that influence students to pursue a degree in engineering and applied sciences. Xie et al. (2015), suggested that, "STEM education is distinctive because it is required for science or engineering employment. While it is possible, indeed common, for someone with STEM education to pursue a career outside of science and engineering, it is very difficult for someone without STEM education to pursue a career in STEM (p. 4).” There are valid reasons to consider that the societal determinants of the attraction to STEM education and to science and engineering careers may be different from those of education in general (Xie & Killewald, 2012; Xie & Shauman, 2003; Xie, 1989). Hence, there is a need for research to identify factors that promote student engagement and achievement in STEM areas (Xie et al., 2015). In the Canadian (Newfoundland and Labrador) context, my interests are to strengthen our knowledge base in this research area, those a study of the personal, social and economic factors that influence/motivate students to study engineering and applied science,

1.2 Purpose of the Study

The purpose of this thesis is to investigate specific factors that influence the decision-making process of undergraduate engineering students in Newfoundland and Labrador. In this study participants are undergraduate engineering students, and have already gone through the process of decision-making. They have made a choice to pursue a degree in engineering and applied sciences which means that they have already gone through the process described by Eidimtas and Juceviciene (2014) as ‘study choice’ and made a post-secondary program decision. Through descriptive survey-based research my intention is to determine students’ perceptions of the role of certain family, high-school, social, personal, economic factors (see Table 1 and Figure 2) on their decision to pursue a degree in engineering or applied science.

Table 1

Variables Under the Determinants of Decision-Making

Determinants	Factors
Family Determinants	Parental advice/encouragement to study engineering/sciences
	Parental pressure to study engineering/sciences
	Tradition of science/engineering occupations within family
	Parental pressure to be academically competitive
	High value of science/engineering education among family members
	Advice/pressure from extended family members
High-School Determinants	Teacher/Staff's advice/encouragement to study science/engineering
	Teacher/Staff's pressure to study science/engineering
	High-School level pressure to study engineering/science
	Career counselling advice received in high-school
	Academic focus on STEM in high-school
	High value of science/engineering among teachers/staff members
	Co-curricular school activities in engineering/science
Societal Determinants	General social pressure to study science/engineering
	General information/counselling available from other sources (social media, advertisements, news sources etc.)
	Career seminar/career fairs
	Friends and acquaintances
	Social pressure to be academically competitive
	High social value of career in engineering/science
Personal Determinants	Personal motivation to study engineering/science
	Aptitude for engineering/science subject matter
	Academic success in previous STEM related subject matter
	Personal desire to work as an engineer/scientist
Economic Determinants	Earning potential for a career in engineering/science

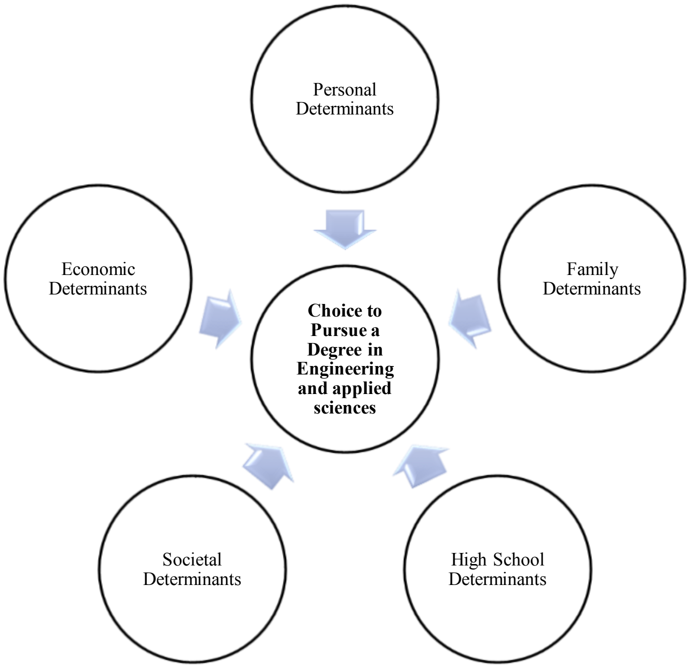

Figure 1: Determinants influencing choice of and engineering degree

1.3 Research Questions

Three research questions are posited in this study:

1. What are the perceptions of undergraduate engineering students about the influence of certain family, high-school, societal, personal, and economic factors on their decision to pursue a degree in engineering?

2. What influences do undergraduate engineering students perceive to be enabling factors for pursuing a degree in engineering?

3. What influences do undergraduate engineering students perceive to be limiting factors for pursuing a degree in engineering?

1.4 Significance of the Study

Although there have been multiple studies about the decision-making process among students and what factors influence the process, very few directly investigated the decision to pursue a degree in engineering and applied sciences in Canada. Even though this study will only focus on one university in Newfoundland and Labrador, it will provide useful context-specific information on the factors that students believe play a role in their decision to pursue a degree in engineering and applied sciences.

Some of the people and organizations that may benefit from the outcomes of this study are: Faculty of Engineering at Memorial University of Newfoundland; educators at secondary and post-secondary levels, researchers working in STEM education; educational policy-makers; school administrators and teachers; non-school education organizations; organizations promoting STEM literacy; and parents and family members.

1.5 Organization of the Study

This research study is organized into six successive chapters, a reference section, and appendix as follows:

Chapter One: Introduction of the Study: The aim of this chapter is to develop a background understanding of the topic and what I am trying to achieve by carrying out this study. This chapter also inform the readers about the research questions and significance of this study.

Chapter Two: Review of Literature: In this chapter I highlight research undertaken in the area of post-secondary academic decision-making process and factors influencing the process. It also identifies specific gaps in the literature, one of which this study seeks to fill.

Chapter Three: Methodology and Data Collection: This chapter presents the research methodology used in this study. I discuss the reasons behind my choice of a specific research method, what instrument was used to collect data, what kind of data were collected, who were the participants, and data handling procedures.

Chapter Four: Results: This chapter provides a description of the data collected and presents them in tabular form.

Chapter Five: Discussion, Conclusions, Implications and Recommendations: In this chapter I discuss the findings in broader context of the extant literature in this field and the warrant for the research. I also draw conclusions from the study followed by recommendations for further research. I also suggest possible implications of this study for various stakeholders in education.

1.6 Summary of Chapter One

This chapter introduces the reader to the research topic and background/warrant for the study. It also defines the purpose of the research, introduces the research questions, and provides a foundation for the research. In the next chapter, I will review the relevant literature around the research topic.

Chapter Two- Literature Review

There is limited literature directly addressing the factors influencing students' choice to pursue a degree in engineering and applied science, but the overall decision-making in higher education has been studied for decades by many researchers in social sciences (Eidimtas & Juceviciene, 2014; Hanson & Litten, 1982; Hossler & Gallaghar, 1987; Jackson, 1982; Kotler & Keller, 2009; Schiffman & Kanuk, 2007). My journey of writing this literature review was dynamic, which included multiple stages and going back and forth throughout my thesis timeline. My major sources of information were Memorial University of Newfoundland's physical and online library database, Google scholar, and grey literature such as Engineers Canada, Let's Talk Science, and Statistics Canada reports. I started with an internet search using the search phrases, 'decision-making and higher education', and 'academic decision-making process'. I read abstracts of peer reviewed research papers that came up on the search and downloaded the ones that were relevant for my study. Review of literature papers and references section of relevant peer reviewed papers provided an important list of further readings that helped me to develop my understanding about the previous research work done in the area of academic decision-making. Further, keyword searches like 'factors influencing decision-making in higher education', 'parental factors and academic choice', 'school factors influencing academic choice', 'factors affecting post-secondary academic choice', yielded results about the influencing factors and I examined relevant studies that came up. Grey literature in form of reports by Statistics Canada, Engineers Canada, Let's Talk Science, even though were contextually limited, provided empirical data to develop an objective picture of the literature in Canadian and provincial context. Also because of the lack of studies in Canada, studied from United States were also reviewed.

On the basis on the literature collected, I divided this literature review into six sections. First, I introduce the status of higher education in Newfoundland and Labrador. Then, I examine key elements in the post-secondary decision-making process and review the general literature around factors and influences associated with a school leaver's decision to pursue higher education. Next, I examine literature around determinants of decision-making in higher education. In the fourth section I highlight the results of two recent studies by Engineers Canada that provided empirical data around postsecondary decision making in context of engineering and applied science. In the fifth section, I situate the research in overall context, and then finally conclude the literature review with a brief summary.

2.1. Higher-Education in Newfoundland and Labrador and the Status of STEM Education Across Canada

Although post-secondary education is highly desired amongst schoolchildren, with 50 to 60 percent aspiring to one or more university degrees, only about 30 per cent actually apply to universities in Canada (Junor & Usher, 2004). The government of Newfoundland and Labrador (NL) in its labor market outlook for next ten years predicted a decline in the number of graduates (Department of Human Resources, Labour and Employment, 2011). In Newfoundland and Labrador, undergraduate enrollments have been declining for more than a decade. As of October 2016, there were 12,227 students enrolled in undergraduate studies in Newfoundland and Labrador, an 8.24% decline from 1st October 2006 (13,325). Undergraduate enrollments in other Atlantic universities have fallen since 2012 with declines of 2.1%, 13.26%, and 3.5%, for Nova Scotia, New Brunswick, and Prince Edward Island respectively (Association of Atlantic Universities, 2016). Of those students opting to pursue university programs a very small percentage of degrees are awarded in engineering and applied sciences (The Conference Board of Canada, 2014). In Newfoundland and Labrador, the undergraduate enrollment in engineering has declined by 5.5% since 2013 (Atlantic Common University Data Set, 2013; T. Coley, Student Engagement and Retention Project Coordinator-Faculty of Engineering, Memorial University of Newfoundland, personal communication, January 17, 2017). In the final report of the panel on status of public education in Newfoundland and Labrador, the dean in the Faculty of Engineering at Memorial University of Newfoundland predicted a shortage of engineers in Canada by 2020 (Sheppard & Anderson, 2016).

Some organizations have taken the position that a lack of interest in engineering and applied sciences at university level can be traced to perceptions of STEM subjects among intermediate-secondary students. In a recent survey among 818 Canadian students between the age of 13 and 17, results show that more than two third think that science is fun and STEM is important for adult life. Similarly, 78% think that STEM offers many career options, however, when it comes to pursuing science as a career, only one in five students express major interest in pursuing science in post-secondary level and only one in ten was extremely interested in working in science related areas (AMGEN-Let's Talk Science, 2014). A 2014 report by The Conference Board of Canada states that there is a relationship between the number of STEM graduates and future Canadian economic prosperity. Despite a decade of innovation agendas and prosperity reports, Canada was graded an overall D in the percentage of engineering graduates and six provinces were graded D-. Nova Scotia and Newfoundland and Labrador were the top two performing provinces with C grades (The Conference Board of Canada, 2014).

2.2. Decision-Making in Higher Education

There are a multitude of variables affecting a student's decision to pursue postsecondary education and to choose a specific field of study after completing high school which include the interaction of values and attitudes that are shaped by individual’s environment, family and peers (Cheung, 2007). There is a wealth of literature centered on student decision making as it relates to higher education. Many of these studies frame career decision making as a complex and multi-phase process (Băcilă, Dorel, & Alexandra-Maria, 2009; Brennan, 2001; Hossler, Schmit, & Vesper, 1999; Kusumawati, Yanamandram, & Perera, 2010; Shankle, 2009). Students’ decisions are seen to be based on their past experiences, how they have constructed their belief systems and worldviews about the value of higher education generally, and their chosen field of study, specifically.

To understand the stages of decision-making that students go through, Hossler and Gallagher’s framework of college choice is a useful starting point. Hossler and Gallagher (1987) developed a model of the process of college choice that theorized the college-choice process as taking place in three stages: predisposition, search, and choice. This model does not exclusively focus upon the attributes of students. It also considers the nature of post-secondary education choices and some organizational elements at the pre-college and college levels. Within this model, predisposition is defined as the stage after graduating high school when students create a plan for higher education attainment. Within this developmental stage, the emphasis is upon the decision to do something, that is, to go to college. The search stage deals with looking for and evaluating colleges/universities in which a student potentially might enroll. Within this stage students formulate a list of colleges and universities that they may find suitable.

Some scholars distinguish between two types of career information search processes undertaken by youth decision makers, namely internal and external searches (Barber, Dodd, & Kolyesnikova, 2009; Yamamoto, 2006). They define internal search as a process that is based upon students' personal experiences and involve no interference from any other individual or institution. If internal search doesn't offer a clear understanding during the decision-making process, student seeks information from external sources that may involve: personal sources- like friends, family, extended family, career planning counselors, reference groups and public opinion leaders; and independent sources – such as user groups, governmental institutions and the mass media (Al-Yousef, 2009; Perna, 2006; Strauss, 1998). Finally, in the choice stage students make a choice of college**.**

These stages are important to get a general sense of decision making process among students. It is important to note, however, that this study does not seek to analyze how students decide whether to attend college, but what factors they believe influenced their decision to pursue an engineering degree. Eidimtas and Juceviciene (2014) reviewed the literature around various college choice frameworks and concluded that school leaver's choice of studies is a result of four successive stages which are: need identification, information search, evaluation of alternatives, and choice (Hossler & Gallagher, 1987; Kotler, 2000; Moogan & Baron, 2003). At each of these stages, school-leavers are influenced by multiple factors. These factors were divided into four major categories: educational factors, information factors, economic factors and other factors.

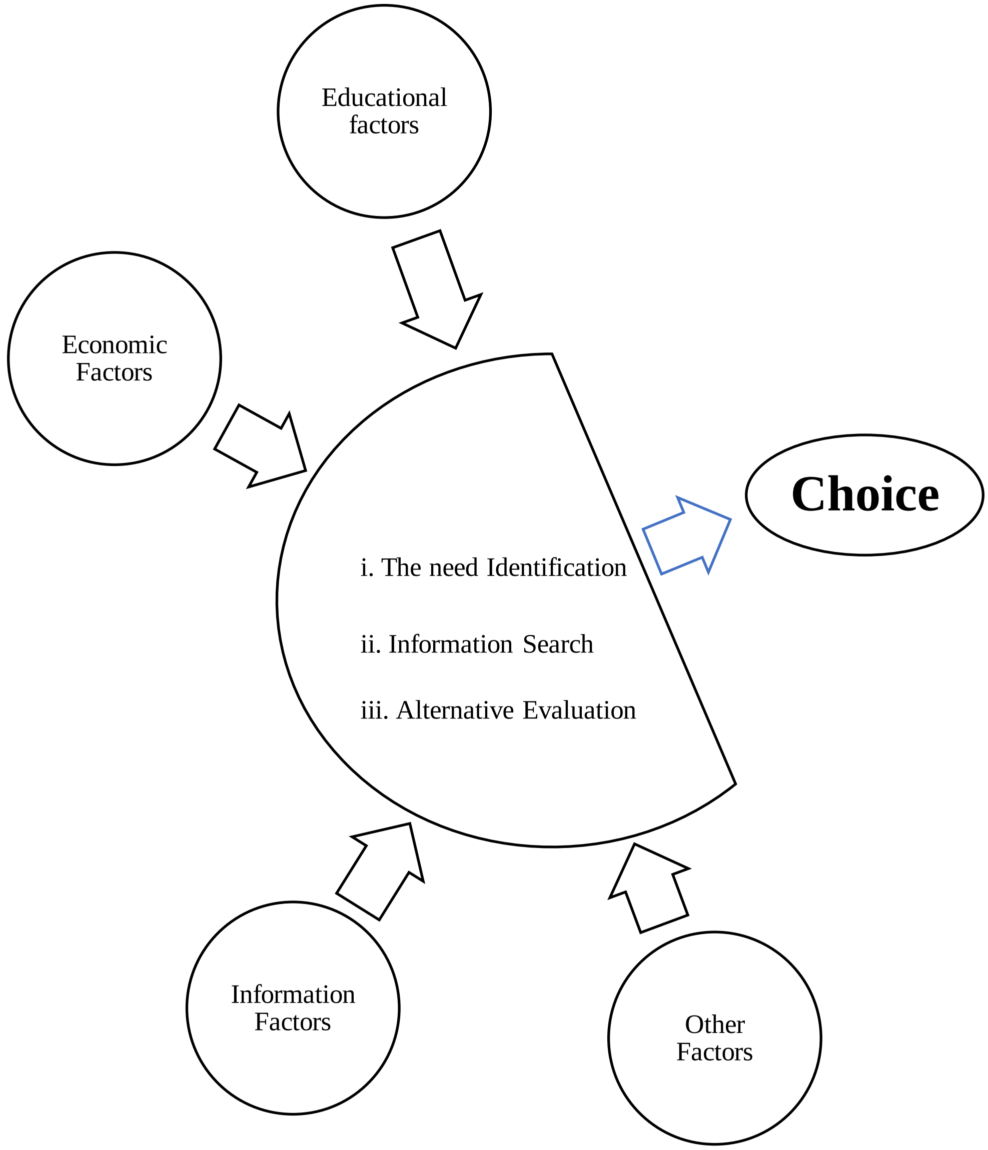

Figure 2: Study choice model. Adapted from Eidimtas and Juceviciene (2014)

Within this process of study choice model (Figure 2), the need identification is the state where the school leaver realises that secondary school is not sufficient and he/she develops a thought about the need to pursue higher education. During the information search stage, school-leavers start considering various possibilities of post-secondary education institutions. This may include creating a list of colleges and accumulating relevant information. The information gathered in this stage is used in the next step. During the evaluation of alternatives stage, depending on personal abilities, the student determines whether each alternative conforms to purposes and consequences of the decision (Hossler et al., 1999). Finally, in the choice stage, the student decides to make a selection of the program and the institution.

The process of student choice is biased by certain factor that construct student's perspectives. According to Eidimtas and Juceviciene (2014, p. 3986),

> Educational factors manifest in course of education that takes place in the family or school (formation of values, education, discussion and conversations, after-school activities, particular subjects); information factors reach the school-leaver from internal and external sources. Search and processing of specific information requires acquired skills; economic factors encompass actual subsistence of a future student, directly affect low income families; other factors that influence the school-leaver's decision depend on his/her peers, professions of parents, social class etc.

2.3 Determinants of Decision Making in Choice of Higher Education

2.3.1 Family Determinants

Parental influence has a substantial overall effect on postsecondary education aspirations (desire to go to university), participation (enrolling into a university program) and persistence (finishing the university program) and this influence has been affirmed consistently across several studies. Bers and Galowich (2002) observed that parental discussions in families encourages children to pursue higher levels of education and its impact gets stronger in senior years. According to Cheung (2007, p.24), "inherited intellectual capital influences individuals' abilities to access and succeed in post-secondary education, while their parents' occupation experience (in addition to their education), also influences their children's educational achievements." Galotti et al. (2006) suggested that adolescents with greater levels of educational encouragement by parents have greater faith in the information provided by parents whereas children with lesser educational encouragement by the parents primarily trust in-school resources like their schoolteachers and guidance counselors.

Horn and Chen (1998) showed that the educational role of parents has a stronger positive effect on the postsecondary educational prospects of students than the socio-economic status of the family or the personal skills and attributes of the individual. Similarly, Paulsen (1990) and Human Resources and Skills Development Canada (2004) found that parental encouragement is a more significant factor than socioeconomic status or academic aptitude. Davies and Kandel (1981) suggested that adolescent's perceptions of the parental aspirations of their attending university are more influential than peer or teacher aspirations.

To understand how career decisions are made and what elements inspire the process of decision-making is vital for policymakers. To address this issue the Canadian longitudinal Youth in Transition Survey (YITS) survey, included the question, "What kind of job or occupation you will be interested in having when you are about 30 years old?" (Statistics Canada, 2015). The data were collected every two years from the same participants starting at the age of 15 and later at 17, 21, 23, and 25. In terms of parental influence, the YITS revealed that the post-secondary participation of students depends upon two factors: parental value of post-secondary studies and socio-economic status.

Data from Cycles 1 through 6 (2000-2006) revealed a relationship between consistency in career decision-making and the value that parents placed on their youngsters acquiring higher education (Statistics Canada, 2015). Other results of this survey showed that:

> Youth were more likely to demonstrate consistency in their career expectations when their parents placed a high value on postsecondary education. Early demonstration of consistency in career expectations was also associated with higher levels of educational attainment at age 25. Conversely, late demonstration of consistency in career expectations, and particularly career indecision at age 25, were associated with lower educational attainment at age 25. (Statistics Canada, 2015, p. 6-10)

Beyond parental encouragement and level of education, Statistics Canada's data also reveals that earlier stability in career expectation is linked with higher socio-economic status of parents. Consistency was associated with the probability of enrolling into a post-secondary program within 15 months of graduating secondary school. Canadian students with at least one university educated parent are approximately three times more likely to pursue university education as compared to youth with parents without high school qualifications (De Broucker & Lavallée, 1998; Finnie, Lascelles, & Laporte, 2004). In all Canadian provinces, students whose parents had a university education are more likely to introduce the prospect of postsecondary education option for their children in comparison to those students whose parents lack a university education (Cheung, 2007). Moreover, students with at least one university educated parent are considerably more likely to be provided with a wide range of postsecondary education options while in high school, and to attend university. Parents who have post-secondary credentials tend to foster greater levels of parental involvement, increased expectations, attitudes and values for academic success and increased familiarity with the post-secondary process and experience (Cheung, 2007).

The parental role in impacting their children's academic achievement was also investigated through the Programme for International Student Assessment (PISA) questionnaire. This questionnaire probed accessibility of learning resources such as: dictionaries; study room; educationally appropriate cultural possessions at home like classic literature, poetry books, works of art; and frequency of discussions or activities that may enhance cultural knowledge (cultural communication), or an expression of parental interest in their children's lives (social communication). The results showed a positive association between achievement and the quantity of household cultural possessions and the educational ambitions of parents, more so for boys than girls. Children belonging to families with higher socio-economic status were more likely to have open post-secondary choices than those from lower socio-economic background (Human Resources and Skills Development Canada, 2004).

Higher parental income in Canada is also positively associated with higher educational achievement among youth, although parental income is less robust as a predictor of a child's educational accomplishments than parental education (Drolet, 2005; Finnie et al., 2004). Youth who live in high-income households are much more likely to attend postsecondary institutions that those from families with lower incomes, the income gap being much more prominent among university attendees (Drolet, 2005).

Children raised in single-parent families typically have lower average levels of mental well-being and socio-economic success than those raised by two biological parents (Amato, 2005; Coleman, 1988; Massey, 2008). Astone and McLanahan (1991) and Heard (2007), suggested that children living in single-parent families are less likely to attend college. In the Canadian context, Finnie and Laporte (2003) found that children who come from two-parent families were more likely to participate in some form of post-secondary education than from those who came from other types of family. Similarly, Lambert, Zeman, Allen, and Bussière (2004), based upon Statistics Canada's data suggested that students who live with two parents while in high school are more likely to pursue post-secondary education and less likely to leave their postsecondary education as compared to youth who lived with one parent or in alternate living arrangements. However, trends seems to have changed with time. Cheung (2007) and Seabrook (2013), found that family structure (two parents versus single parent families) exerts little effect on educational aspirations and status attainment. Based upon a Statistics Canada census of 2011, McMullen (2011) suggested that underrepresented minority youth from single-parent or other non-two parent family types were 10.8 percent points less likely, on average, to attend university than those coming from two-parent families. In terms of family size, Bishop (1977) found that the likelihood of college attendance is inversely associated to the number of siblings a potential student has.

2.3.2 High-School Determinants

School is the only institution other than family where students spend the majority of their time. In a recent national survey by Engineers Canada, two out of three students reported that they made their decision to pursue engineering in or before high school (2016). Negative experiences in high school are associated with decreased desire to pursue higher education in Canada (Human Resource and Skills Development Canada, 2004). This report also concluded that participation in extracurricular activities, attachment to school, academic self-confidence, and bending or breaking rules in the home or the school, have less effect on youth plans to pursue post-secondary education.

Hossler et al. (1999) and Moogan and Baron (2003) suggested that a school leaver’s need for further education is formed by school culture and climate, as well as by what they call internal sources (parents and siblings). Greene, Miller, Crowson, Duke, and Akey (2004) suggest that it is easier for teachers to make students understand that their future success depends upon present learning. Similarly, students are inclined towards pursuing educational paths that Canadian teachers and counselors assert to be desirable (Human Resources and Skills Development Canada, 2004).

High school career counselors are expected to play a role is shaping an individual’s interest in a specific area of study. Boyer (1987) was highly critical of the negligible impact of high school guidance counselors in preparing high school students to make the transition from secondary to postsecondary education. Hossler et al. (1999) claims that there is no significant relationship between students’ educational aspirations and their interaction with teachers or counselors. In two related studies McDonough (1994, 1997) reported that teachers and counselors at private high schools do have a strong influence on decisions about post-secondary institutions because of low student-to-counselor or student-to-teacher ratios. Some scholars have suggested that a stronger understanding of the college decision-making process and better information about college options in high school might help high school guidance counselors provide more effective service to students and their families (Hossler, et al., 1999; Orfield & Paul, 1994). Hossler et al. (1999, Kindle Book-Conclusion Chapter, Implications and Recommendations Section, Para 7) in their longitudinal study articulated the role of teachers and counselors in post-secondary career decisions by saying:

> Teachers and counselors help form students’ consideration sets. We submit that it is advantageous for students to consider a wide range of schools, but teachers and

> counselors are limited by their own experience in helping students enlarge these sets. Further, many high school guidance counselors have had little training in college counseling and need professional development opportunities to learn more about college counseling. We lack empirical data, but it is our impression that teachers and counselors often cannot help students understand the differences among various types of college. Students with extensive sources of external information, including teachers and counselors, are more likely to actualize their college plans.

According to Cheung (2007), participation in extracurricular activities is viewed as way in which individuals can increase their social capital, networking capacity and, relationships with other people. Participation in extracurricular activities is also positively associated with post-secondary attainment. Similarly, high education aspirations are positively associated with participation in extra-curricular activities. Other research confirms that students who are involved in more activities during high school are more likely to have higher educational aspirations (Hossler & Stage, 1992; Stage & Hossler, 1989).

Munro and Elsom (2000) conducted a mixed method research in Cambridge, England and found that science teachers appeared to have a major influence on students' motivation toward science subjects and careers in science. They also concluded that students have to make crucial subject choices at the time of their lives when they are losing interest in science subjects. This lack of motivation reduces the likelihood of seeking objective information for themselves. It is thought that schools can help students by good teaching, improving science classroom experiences, school-based extracurricular activities, and career education and guidance. Other outside influences -parents and family, perceptions of science subjects, perceptions of careers in science and engineering, labour market history gender, and the media – were all considered to be motivating factors.

High-school determinants have a significant effect on students' career decision making however as suggested before, the broad decision-making is an outcome of multiple factors. The report of the National Research Council (2003, p. 120) in the United States mention that:

> In some respects, it makes little sense to discuss what schools can do to engage students in learning without considering the settings in which both schools and students live. Ideally, schools would build on the knowledge and interests youth develop at home and in the community and create opportunities for students to extend and apply school learned skills in contexts outside of school. They would take advantage of resources and supports for learning in the community and be a positive force in the community for developing an environment that supports positive youth development.

2.3.3 Societal and Economic Determinants

Schools alone cannot achieve the high levels of engagement and standards, and students need many sources of support and consistency in messages from significant people in their lives (National Research Council, 2003). Graham (1995, p.22) suggests:

> The battleship, the school, cannot do this alone. The rest of the educational flotilla must assist: families, communities, government, higher education, and the business community. Only then will all of our children be able to achieve that which by birthright should be theirs: enthusiasm for and accomplishment in learning.

Humans have social dispositions and hence their interactions in their social environment influence their behaviours. Schools are not the only educating institution; According to Cremin

(1976) there are multiple institutions in the communities such as religious institutions, workplaces, youth organizations, radio and television, and many such organizations or groups influence career decisions.

In the context of STEM education, Xie et al. (2015) provide a social perspective of STEM education. Xie (1989) and Xie and Killewald (2012) view STEM education as a medium for individual social mobility that allows socially underprivileged people to be successful through objectively measured criteria that are acknowledged by STEM educators and scientists. Some sociological theorists consider education as an mechanism through which families transmit social advantages or disadvantages to following generations (Blau & Duncan, 1967; Bourdieu, 1986; Raftery & Hout, 1993; Sewell, Haller, & Portes, 1969), and contemplate how the built-in cultural customs in social class background influence educational experiences and attainment (Boudon 1974; Bowles & Gintis, 1976; Brand & Xie, 2010; Xie et al., 2015).

Some literature in the field of economics discusses education as a system of human capital that produces significant economic returns (Mincer, 1974) and the highly educated section of society especially takes advantage of this opportunity (Autor, Katz & Kearney, 2008). Science is a high-status occupation that rewards its incumbents with comparatively high individual income and social reputation (Rothwell, 2013; Xie & Killewald, 2012). Although, remuneration for people working as basic scientists in the United States have stagnated in recent decades (Xie & Killewald, 2012), education in the area of STEM in particular carries a premium in the overall labour market (Rothwell, 2013). Hossler (1982) suggested that students choose to go to university if the perceived economic benefit of attending college or university are greater. In the Canadian context as well, perceptions of job relevance to education has positive association with higher educational aspirations. Educational aspirations and attainments still remain a function of demography and are higher for youths living in urban rather than rural areas (Cheung, 2007).

Gibson and Hutton (2017) carried out a national study on public perceptions of engineers and engineering. The results of this study showed relatively low familiarity among respondents with only about two in five being familiar with engineers and the engineering profession. However, in the majority of instances, the levels of overall impression, trust, and respect for engineers and the engineering profession increased with increased familiarity – 82% held favorable impressions of the engineering profession, 83% trusted the engineering profession, and 85% respected the engineering profession across Canada.

Technology constitutes a greater part of the lives of people in twenty first century. Students make use of internet search and social media for networking and communicating. Latest news, podcasts, Ted Talks, and other audio-visual material about technological discoveries and advancements is frequently viewed by students. Such things may indirectly advertise specific fields of study and influence one’s interest in it. Frequent use of information technology for the purpose of education have been related to higher educational aspirations (Human Resource and Skills Development Canada, 2004).

Friends can sway the decision (Franklin, 1995; Fuller, Manski, & Wise, 1982; Riggs & Lewis, 1980). Friends and acquaintances are an important influence on students’ academic achievement. Past research indicates that friendship is positively associated with academic outcomes, while students without friends had lower academic outcomes (Wentzel, Barry & Caldwell, 2004; Wentzel & Caldwell, 1997). Coleman (1966); Falsey & Heyns (1984); Russell (1980); and Tillery (1973) reported that students are positively influenced by social interaction with other students with college plans. The more students get to interact with other students who have college plans, the more likely they are to consider attending college. Similarly, negative peer influences have negative associated with post-secondary educational aspirations (Cheung, 2007).

2.3.4 Personal Determinants

Even though there are individuals and factors that develop a positive perception of higher education among school-leavers, the final decision that students make is based upon their own perceived advantages of higher education (Eidimtas & Juceviciene, 2014). Cheung (2007), after her analysis of Statistics Canada data suggests that the most important factor which determines educational aspiration is academic performance and accounts for 29.9% variation and explain 80% of the gender difference in Canada. Academic self-confidence and beliefs about the relevance of education to one’s jobs and careers has strong influences on educational aspirations (Cheung, 2007). Bishop (1977); Hossler et al. (1999); Jackson (1978); Sharp, Johnson, Kurotsuchi, and Waltman (1996); Tuttle, (1981) suggest that student achievement is one of the best predictors of higher education aspirations. Hossler et al. (1999); McDonough (1997); and Weis (1990) suggest that, high performing students are encouraged more, to pursue higher education by their parents, teachers, friends, and extended family members. Academic performance, and program of study have noticeable effects on youth plans, as does academic effort (Human Resource and Skills Development Canada, 2004).

2.4 Post-Secondary Decision Making in Context of Engineering and Applied Science Education in Canada and Newfoundland and Labrador

There is limited research available around the factors that influence students' choice of engineering degree in Canada. 'Engineers Canada' acknowledged the need, and recently started collecting data about 'undergraduate program motivations and experiences' in which final year undergraduate engineering students report factors that influenced them to pursue a degree in engineering. The results from the two latest studies (2015 and 2016) were similar and provide a national picture of certain factors that influenced students to pursue engineering.

Guiry and Howell (2015) conducted the national survey for Engineers Canada in 2014 with a sample of just over 2000 final year undergraduate engineering students across Canada. The results from the most recent study which was conducted using a similar survey with a sample of 2,222 final year undergraduate engineering students across Canada gives a macro understanding of certain factors that influenced their decision to study engineering (Engineers Canada, 2016). Among the respondents, majority (78%) were male and remaining were females. In terms of age, 90% were under 26, and remaining were 27 or over. The results of this study indicated that, two-third of students reported that choosing to pursue and engineering degree was a result of their own interest (65%) or reported application of science and math (62%) as a reason to pursue engineering. A little less than two-third reported practical, applied nature of engineering discipline (60%) as the influence. Less than half reported financial security (44%), job security (43%) or, reported challenge (44%) of engineering profession as the main influence to pursue an engineering degree. A third reported a feeling of positively influencing the world/community (36%) as the reason to pursue engineering. Only a quarter reported family (26%) as the influencing factor to pursue engineering degree, or reported taking related courses

(26%) and liking them as a reason to pursue engineering. Only a few reported a role model (14%), reported reaching another goal with the help of engineering degree (9%) or other (3%) as the influence.

There were 70 (4%) participants in 2015 and 62 (3%) participants in 2016 in these surveys from Newfoundland and Labrador. It would have been interesting to have data from Newfoundland and Labrador perspective however the responses about the factors influencing decision to pursue engineering were not tabulated by provinces.

In the final report of the panel on status of public education in Newfoundland and Labrador, the dean in the Faculty of Engineering at Memorial University of Newfoundland, proposed that schools should improve students' awareness of the work of engineers and how they contribute towards the society and refocus, "on depth of math, science, and computer literacy in senior years to address the lack of preparation for technical fields like engineering" (Sheppard & Anderson, 2016, p. 42).

2.5 Situating the Research

According to De Broucker and Lavallée (1998), educational accomplishment can be largely attributed to inherited intellectual capital, defined as "the experience and knowledge acquired by an individual or a group of individuals (such as the family) during the course of their lives that can be applied in the pursuit of economic and social goals" (p. 129). Educational accomplishment can be conceptualized as an outcome of sequence of 'decisions' that a student makes during and immediately after finishing high school. Although there is significant research available around academic decision making in higher education and choice of college/university, there is limited work on student perceptions of social and economic factors that play a role in their choice to study engineering and applied science in Newfoundland and Labrador or in Canada as a whole. This study seeks to contribute to this gap by examining student perceptions of the influences that impact their decision making in context of post-secondary education in engineering and applied science.

2.6 Summary of Chapter Two

In this chapter I develop a historical and academic understanding of the topics under study. I began by reviewing the literature on decision-making in higher education and followed this with a review of various elements that influence this process in the light of decision to pursue engineering education.

In the next chapter, I will discuss the research methodology used in this study. This chapter will also discuss the data collection, data analysis, instrument, limitations and delimitations, and ethical considerations in this study.

Chapter Three- Methodology and Data Collection

This chapter outlines the research methodology and data collection procedures adopted in this study and is divided into 10 sections. It starts with my positioning as a researcher followed by commentary on quantitative research methodology. The survey instrument, pilot test, validity and reliability, participants, recruitment, data analysis, limitations and delimitations, and ethical considerations construct the remaining body of this chapter.

3.1 Positioning as a Researcher

Justification of our methodology and methods is something that reaches into the assumptions about reality that we bring to our work (Crotty, 1998). I approached this study with a belief in syllogism-which is based upon the assumption that, through a sequence of formal steps of logic, from general to the particular, a valid conclusion can be deduced from valid premise (Cohen, Manion, & Morrison, 2007). Quantitative researchers in general carry an objectivist stance, which is an epistemological viewpoint that, “things exist as meaningful entities independently of consciousness and experience, that they have truth and meaning residing in them as objects (‘objective’ truth and meaning), and that careful (scientific) research can attain the objective truth and meaning” (Crotty, 1998, p. 5-6). I am positioned as a survey researcher in the epistemological spirit of post-positivism; a paradigm where researchers seek to generate knowledge (such as the identification of factors that influence students’ decision to pursue a degree in engineering) by accumulating and analysing numerical data using scientific methods.

3.2 Quantitative Research Methodology

The goal of undertaking this research is to develop a statistical profile and measure influence of factors that influence students' choice to pursue a degree in engineering or applied science. Therefore, a quantitative research method was used. According to Creswell (2012), the rationale of using quantitative data is to provide a general picture of the research problem. Since there is not enough literature available around the choice of engineering degree and social and economic factors influencing this decision, the objective of this study is to create a general understanding of what influences students to choose engineering program in post-secondary education. According to Cohen, Manion, and Morrison (2007), the purpose of a survey is to gather large scale data in order to make generalizations by measuring the responses from the participants. "Survey researchers often correlate variables, but their focus is directed more towards learning about the population and less on relating variables or predicting outcomes" (Creswell, 2012, p. 376).

Kruger, Shirey, Morrel-Samuels, Skorcz, and Brady (2009), expressed the significance of survey data as being to satisfy the needs of policy actors, and proposed that modification of a survey to target specific areas and demographics can result in better quality of data. Greener (2011) critiques the use of surveys and suggests that ambiguous wording, low/poor response rate, and response bias, may hinder the survey from measuring what it is intended to. However, surveys remain the most effective tool for quick and comprehensive assessments of behaviours, values, and attitudes.

Since this research aims at collecting data and providing information in a short amount of time, a cross-sectional survey design was best suited for the study. A cross-sectional survey design has the advantage of measuring attitudes or practices efficiently (Creswell, 2012).

3.3 Survey Instrument

Data were gathered using a self-developed survey instrument (Appendix 1). Fowler (1988) suggests that a prerequisite to designing a good instrument is deciding what is to be measured. A structured questionnaire was designed for the survey. Based upon a review of literature, the following four sections were developed to constitute the body of the instrument:

Section one contained the informed consent form for the participants.

Section two consisted of a set of demographic questions that included, residency status, gender, age, language spoken, current program of study, family type, parental household income, main source of funding for their education, highest level of education, parental education, and family size.

Section three asked students to rate their level of agreement on a five point Likert scale (1-Strongly Disagree to 5-Strongly Agree) about the role of a series of potential determinants:

(1) Parental Determinants (parental advice/encouragement, parental pressure, tradition of science and engineering occupations in their family, parental pressure to be academically competitive, high value of science/engineering education among family members, and advice/pressure from extended family member);

(2) High School Determinants (advice/encouragement to study science/engineering by a teacher or other staff member in high school, high school level pressure to study science/engineering, career counselling advice received in high school, academic focus on STEM in high school, teacher or other staff member's pressure to be academically competitive, co-curricular school activities in science and engineering, and high value of science/engineering among teachers and other staff members);

(3) Social Determinants (general social pressure to study science/engineering, general information and/or counselling from other sources, career seminar and career fairs etc., friends and acquaintances, societal pressure to be academically competitive, and social value/status of career in science/engineering);

(4) Personal Determinants (personal motivation, aptitude for science/engineering subject matter, academic success in previous STEM related subject matter, and personal desire to work as a scientist or engineer), and;

(5) Economic Determinants (earning potential of a career in science/engineering) on their choice of engineering degree program. Participants had to respond to a statement that said, 'My decision to study an engineering degree was influenced by…', by rating each variable on the Likert scale.

The Likert scale is a psychometric response scale primarily used in questionnaires to obtain participant's preferences or degree of agreement with a statement or set of statements. In the Likert scale, respondents are asked to indicate for each topic whether they strongly agree, agree, are undecided, disagree, or strongly disagree (Ary, Jacob, & Razavieh, 2002). I have used a five point Likert scale as opposed to three or seven points because some studies suggest that it increases response rate as well as reduces the frustration level of respondents (Babakus & Mangold, 1992; Sachdev & Verma, 2004).

Originally my ethics proposal included a plan to conduct focus group interviews and participants who wished to be part of further study had the option to provide identifying information for future communication in section four. As the study evolved and increased in scope the qualitative component was not conducted and the data collected in section 4 were not used. The participants who submitted their contact details were notified that the further study would not take place but they might be contacted in future. Any further intervention will follow ICEHR (Interdisciplinary Committee on Ethics in Human Research) guidelines.

The survey instrument was developed on Google Forms on the google mail platform.

3.4 Pilot Test

Since the survey instrument was self-developed it was tested prior to implementation. As Fowler (1988) suggests, “the closer the final instrument is to perfection, the better the research process” (p. 103). Pilot testing is a procedure to find out if the survey instrument will work in the real world. The purpose of pilot testing was to ensure that all participants not only understand the questions, but understand them in the same way. Testing can also discover any questions that respondents feel uncomfortable with. Finally, it can also gauge the approximate time frame required to complete the survey. I carried out the pilot test with 15 engineering graduates who were not part of Memorial University of Newfoundland. They were sent a link by e-mail to a duplicate copy of the survey to complete. After they had completed the survey, they were asked for their feedback. Based on this feedback there were some minor changes made to the survey instrument (Appendix 2). The approximate time reported to complete the survey was 10-15 minutes. To test the reliability of the pilot instrument, Cronbach's alpha was calculated and was found to be 0.910. The revised instrument was sent to ICEHR for approval and was approved without any issue. The design introduced in this study is the final version of the instrument.

3.5 Validity and Reliability

According to Kerlinger (1973), validity refers to a question that, are we measuring what we think we are measuring? I validated the survey questionnaire by consulting with the experts (my supervisor and some PhD students), doing an extensive literature review and carrying out pilot testing. I requested my supervisor to review my questionnaire for readability, clarity, and comprehensiveness, which helped me to validate the content.

Reliability: To test the reliability of the final instrument Cronbach's Alpha was calculated and was found to be 0.837. This level of reliability is considered to be good.

3.6 Participants and Sample Size

The participant group for the study was the current undergraduate student population of engineering students at university level in the province of Newfoundland and Labrador. Memorial University of Newfoundland is the only university in Newfoundland and Labrador and hence the current undergraduate students enrolled in the Faculty of Engineering and Applied Science constituted this population.

Based on data received from the faculty, there were 1032 undergraduate students enrolled in the the Faculty of Engineering and Applied Science at Memorial University of Newfoundland in the winter semester of 2016. Of these, 535 were on a work term and the remaining 497 were on campus. There was access only to students on campus in the study. Out of the 497 students, 136 were female and 361 were male. In addition, data were collected from 83 students from the Faculty of Science; these students had indicated a desire to switch to engineering and were taking required courses. Finally, there were total 151 students who responded to the survey.

The number of responses were more than the desired sample size. Desired sample size (145) was calculated using Z-value (for 95% confidence interval) of 1.96, proportion ratio of .5. 10% margin of error and 50% response rate (calculated using the pilot test). The following formulae was used to calculate the desired sample size:

$n = \text{Z-value}^2\,[p(1-p)]/d^2$ OR $n = 1.96^2\,[.5(1-.5)]/.1^2$ $n=96.4$

Desired sample size= n + 50*n/100 OR Desired sample size= 96.4 + .5*96.4= 144.6 (145)

3.7 Recruitment

The survey instrument was made available in electronic as well as paper form. The electronic survey instrument was developed in Google Forms. A web link to the electronic copy of the survey gave participants the option to complete it at their convenience. In addition, I provided the option to complete the surveys on paper copies to potentially increase response rates (Cook, Heath & Thompson, 2000; Hohwu, et al., 2013; Nulty, 2008). However, all students chose to complete it online.

There were three strategies used to recruit participants:

1. Post-Class Recruitment: I contacted faculty members in the Faculty of Engineering and Applied Science who agreed to permit me to distribute survey

instruments to undergraduate engineering students at the end of regularly scheduled classes. After the approval from ICEHR, a formal request was made to the Faculty of Engineering and Applied Science to allow the data collection process. I was provided post-class access to three classes (EN1010, EN1020, and EN8152) with three different faculty members; this gave access to all the students in the faculty at the time of data collection.

2. Faculty of Engineering and Applied Science Listserv: I also coordinated with the Faculty of Engineering and Applied Science to distribute the research advertisement and electronic survey instrument among their members through their listserv. A formal email with the link to complete the survey was sent to all the students by the faculty administration office. This email was sent every week for two months in an effort to generate a high response rate.

3. Sharing the Advertisement on Social Media: The advertisement and the link to the survey was made available on Memorial University's Learning Management System (D2L) by the Faculty of Engineering and Applied Science. This gave access to all the registered undergraduate students in the faculty of engineering.

3.8 Data Analysis

The majority of descriptive analysis was automatically available on Google Forms. To study the responses on the five point Likert scale, "strongly disagree" and "disagree" were combined together, "neither disagree nor agree" was left as it was, and "agree' and "strongly agree" were again combined together. Thus, the five-point scale was simplified to three "disagree", "neutral", and "agree".

Table 2

Scale Collapsing Scheme to Generate Trichotomized Response data

Original five Point	1 (Strongly Disagree)	2 (Disagree)	3 (Neither Agree nor Disagree)	4 (Agree)	5 (Strongly Agree)
Trichotomized	1	(Disagree)	2 (Neither Agree nor Disagree)	3	(Agree)

3.9 Limitations and Delimitations

Limitations- A problem with survey research is that participants might misinterpret questions and respond based upon their understanding rather than the what the researcher wants to know. To control this, pilot testing was conducted and appropriate changes were made on the survey instrument. Moreover, I provided my contact details for them to clarify any issues with understanding or concerns about the survey instrument. Sometimes, the responses may be biased by socially desirable responses. It was assumed that all the participants would be honest in their responses.

Delimitations- There were multiple recruitment strategies used to increase the responses. At the conclusion of data collection 151 responses were received. Low response rates can result in response bias and as Creswell (2012) suggests, “the responses do not accurately reflect the views of the sample and the population” (p. 403). There can be a number of reasons for this that may include:

1. Time of data collection: Data collection was scheduled only during the winter semester of 2016-2017 based upon availability of resources.

2. Reduced sample size due to work terms: Of 1032 total students, 535 were on their work term and it is likely that they were not attending to their university email. Even if they received the email, their work schedule would have hindered them from completing the survey. There was no opportunity to promote the research in-class to these students.

3. Unregistered email accounts: The email communication was sent through listserv, however, students who didn’t register their email accounts would have not received the email.

4. No Incentive: Due to lack of financial resources I was not able to offer incentives for completing the study. This may have contributed to the low response rate. Usually incentives increase the response rate as there is monetary or non-monetary reward available in return for the time of respondents.

5. Absenteeism: During the post-class recruitment, students who were absent that specific day did not get a chance to know more about the study.

The sample size and low response rate may limit the generalizability. The participation from Newfoundland and Labrador (N=151) in this study is twice that of the sample studied by Engineers Canada in 2015 (N=70) and 2016 (N=62). This may mean that the results of this study might be more generalizable than those from previous studies.

3.10 Ethical Considerations

This research project received an ethical review from Memorial University of Newfoundland's Interdisciplinary Committee on Ethics in Human Research (ICEHR) prior to start. The approval is attached in Appendix 3.

3.11 Summary of Chapter Three

This chapter addresses the methods adopted in this study. It started with an introduction about the chapter followed by defining the methodology and introducing the instrument used to collect data necessary to respond to the research questions. It also defines the population and sample used in this study and the ways in which data collection was carried out. Limitations and delimitations of this study were presented followed by steps that were taken to make sure that this research study progresses within the ethical boundaries.

The next chapter will be highlighting the results obtained from the collected data in tabular and textual form.

Chapter Four- Results

This chapter presents the results obtained from the data collected. The results are presented in the same order as the items appeared on the survey instrument. This chapter is organised in six sections which include, demographic profile of participants, followed by family determinants, high-school determinants, societal determinants, personal determinants, and economic determinants in context of students' decision to pursue a degree in engineering.

4.1 Demographic Profile of the Participants

This section describes the responses recorded in demographic section of the survey instrument. There are total of 151 participants in this study. The majority of participants (91.3%) came from English speaking families, with a few (5.4%) who were bilingual (English and French). The remaining spoke another language at home. The participants were from different departments within the Faculty of Engineering and Applied Science.

Only a very few participants intentionally or unintentionally skipped a few questions in the survey. The total number of responses for each variable (n) are presented in respective tables under the frequency tab. The results for each variable are presented in table format.

4.1.1 Residency Status

Table three presents the residency status of the participants. More two third of participants identified themselves as Canadian citizens who are also residents of Newfoundland and Labrador. Half of the remaining participants were Canadian citizens from other provinces and the rest were non-Canadians.

Table 3

Residency Status of the Participants

Residency Status	Canadian Citizen (NL Resident)	Canadian Citizen (Another Province)	Non- Citizen
Frequency (N=150)	77.3% (116)	12% (18)	10.7% (16)

4.1.2 Gender

Consistent with the national trends in engineering education and representation of women, females were under represented in undergraduate engineering education at Memorial University with only a third of respondents identifying themselves as females (see Table four). That said, Newfoundland and Labrador ranks first in comparison with other Canadian provinces with 26% females in engineering programs, (Wlotzki, 2015). The remaining two-third of the participants were males. Only one participant was identified as non-binary.

Table 4

Gender

Gender	Male	Female	Non-Binary
Frequency (N=151)	66.9% (101)	32.5% (49)	.7% (1)

4.1.3 Age

Table five presents the participants by age. The majority of respondents were under the age of 20. A third were between 20 and 25, and remaining were older than 25 years of age. This reflects that the majority of students in Newfoundland and Labrador choose to study engineering right after finishing high-school. These results were consistent with Guiry & Howell (2015) and Engineers Canada (2016) in which almost 90% respondents were 26 years of age or younger.

Table 5

Age

Age	Under 20	21-25	26-30	30+
Frequency (N=151)	60.3% (91)	35.1% (53)	4% (6)	.7% (1)

4.1.4 Family Type

Table six presents the type of family the respondents came from. The vast majority of participants reported coming from a two-parent family where, mother and father lived in the same household. Within the remaining participants, more than half reported having a single parent (mother), which was more than double the number of participants who reported coming from a single parent (father) family type. There were very few participants who reported other as their family type.

Table 6

Family Type

Family Type	Mother & Father live in the same household	Single Parent (Mother)	Single Parent (Father)	Other
Frequency (150)	82.7% (124)	8.7% (13)	3.3% (5)	5.3% (8)

4.1.5 Parental Household Income

Table seven presents the reported parental household income of the participants. There was wide variation in annual family income levels with almost half of the participants (47.7%), reporting parental household income to be greater than $100,000. A third of participants reported income to be between $50,001 and $100,000. Just over 10% of participants reported parental household income of less that $50,000, which shows that there is a very small representation of students from lower income families in engineering and applied science programs at Memorial University. About 13% of participants reported not knowing their parental household income.

Table 7

Parental Household Income

Parental Annual Household Income	Less than $50,000	$50,001-$100,000	$100,001-$150,000	$150,001-$200,000	More than $200,000	*Don't Know*
Frequency (N=151)	10.6% (16)	29.1% (44)	25.2% (38)	15.2% (23)	7.3% (11)	12.6% (19)

4.1.6 Main Source of Funding for Student's Education

Almost two-third of the participants stated that their education was funded either by their parents/relatives or through scholarships and funding. Only a third of the participants self-funded their education either through employment or bank loans. Table eight illustrates the response summary within this variable.

Table 8

Main Source of Funding for Education

Main Source of Funding for Your Education	Self-Funded (Work)	Self-Funded (Student Loans, Bank Loans etc.)	Funded by Parents Relatives	Scholarships and Awards	Other
Frequency (N=150)	22% (33)	12% (18)	52% (78)	12.7% (19)	1.3% (2)

4.1.7 Parental Education

Table nine presents the parental education of the participants as reported in the survey. More than 80% of the participants' mother had earned at least a post-secondary certificate or diploma, and more than half were university graduates. A quarter of the participants reported that their mothers had a graduate university degree. The pattern was similar for fathers of undergraduate engineering students in Newfoundland and Labrador.

Table 9

Parental Education

Parent	Level of Education	Frequency	Total (N)
Mother's Highest Level of Education	Less than High School Diploma	1.4% (2)	149
	High School Diploma	15.4% (23)	
	Post-Secondary Certificate or Diploma	28.2% (42)	
	Undergraduate Degree	30.9% (46)	
	Graduate Degree	21.5% (32)	
	Doctorate Degree	2.7% (4)	
Father's Highest Level of Education	Less than High School Diploma	4% (6)	148
	High School Diploma	17.6% (26)	
	Post-Secondary Certificate or Diploma	30.4 (45)	
	Undergraduate Degree	27.7% (41)	
	Graduate Degree	16.9% (25)	
	Doctorate Degree	3.4% (5)	

4.1.8 Family Size

Table 10 presents the number of siblings reported by the participants. Majority of the participants had one (53%) or two (27.8%) siblings which also mean that they came from a family consisting of less than five members. This aligns with Bishop (1977) who suggested that small family size is related to a greater chance of college/university attendance.

Table 10

Family Size

Family Size (No. of Siblings)	0	1	2	3	4
Frequency (N=151)	6.6% (10)	53% (80)	27.8% (42)	9.9% (15)	2.6% (4)

4.1.9 Profile of Undergraduate Engineering Students

A typical undergraduate engineering student in Newfoundland and Labrador is male under 26 years of age, has parents with at least a post-secondary degree or diploma, and comes from a traditional family (mother and father living together) with less than five members. One interesting finding is that the vast majority of respondents reported living in a traditional two parent household. This is a very interesting fact because none of the previous studies reviewed in the literature reported any relationship between family type and higher education aspirations in the area of engineering and the applied sciences.

4.2 Family Determinants and the Decision to Pursue a Degree in Engineering

Participants were asked to state their level of agreement on a five-point Likert scale (trichotomized for the purpose of analysis) with a series of statements intended to examine family determinants on program decisions. There were six variables studied within the family determinants construct which include: parental advice/encouragement, parental pressure to study science or engineering, tradition of science and engineering occupations in family, parental pressure to be academically competitive, high value of science and engineering education within family members and advise/pressure from extended family member.

Table 11

Family Determinants and Decision to Pursue a Degree in Engineering

Influence	Disagree	Neutral	Agree	Responses (N)
Parental Advice or Encouragement	15.2% (23)	29.1% (44)	55.6% (84)	151
Parental Pressure to Study Science or Engineering	52.3% (79)	23.2% (35)	24.5% (37)	151
Tradition of Science or Engineering Occupations in Family	66.2% (100)	11.9% (18)	21.8% (33)	151
Parental Pressure to Be Academically Competitive	26.5% (40)	13.9% (21)	59.6% (90)	151
High Value of Science and Engineering Education among Family Members	37.4% (56)	15.3% (23)	47.3% (71)	150
Advice/Pressure from Extended Family Member	63.6% (96)	18.5%(28)	17.9% (27)	151

More than half of the participants agreed that their decision to pursue a degree in engineering was influenced by parental advice/encouragement (55.6%) and parental pressure to be academically competitive (59.6%). Results also indicate that a tradition of science and engineering occupations in the family or advice/pressure from extended family member both had minimal influence on participants' decisions to pursue engineering, and almost two-third of the participants reported negatively in response to this option. Almost half of the participants reported that value of science and engineering education among family members influenced their decision to pursue engineering however, about a third also disagreed that it was an influence.

Overall, parental advice/encouragement, parental pressure to be academically competitive, and high value of science and engineering education among family members seem to be enabling influences for almost half of the respondents in the study.

4.3 High-School Determinants and the Decision to Pursue a Degree in Engineering

The participants were also asked questions about advice, encouragement, pressure, and value in the context of in-school factors and their decision to pursue an engineering degree. There were seven variables studies under the high school determinants construct which were: advice/encouragement by teacher or other staff member, high-school level pressure, career counselling advice, academic focus on science/engineering, teacher or other staff member's pressure to be academically competitive, high value of science/engineering among teachers and other staff members, and science/engineering related co-curricular activities. The results are shown in Table 12.

Table 12

High School Determinants and Decision to Pursue a Degree in Engineering

Influence	Disagree	Neutral	Agree	Total Responses (N)
Advice/Encouragement by Teacher or Other Staff Member to Study Science/Engineering	36.4% (55)	24.5% (37)	39.1% (59)	151
High School-Level Pressure to Study Science/Engineering	45% (68)	23.8% (36)	31.1% (47)	151
Career Counselling Advice Received in High School	59% (89)	17.2% (26)	23.9% (36)	151
Academic Focus on Science/Engineering in High School	28% (42)	19.3% (29)	52.7% (79)	150
Teacher or Other Staff Member's Pressure to be Academically Competitive	40% (60)	18% (27)	42% (63)	150
High Value of Science/Engineering among Teachers and Other Staff Members in My High School	34.4% (52)	26.5% (40)	39.1% (59)	151
Co-Curricular School Activities in Science/ Engineering	51.3% (77)	22.7% (34)	26% (39)	150

Results show that participants were not particularly influenced by teachers or counselors; only one third agreed that encouragement or advice from a teacher or other staff member played a role in formulating their decision to pursue engineering. More than half (59%) of participants stated that their decision to pursue engineering wasn't influenced by career counselling advice received in high school. More than half of the respondents (52.7%) stated that school level academic focus around science/engineering was an influence in pursuing a degree in engineering, while a similar number (51.3%) indicated that co-curricular activities in science/engineering didn't had an influence. The findings also suggest that decisions about post-secondary studies in the field of engineering are relatively independent of the advice and encouragement provided by teachers and/or counselors.

4.4 Societal Determinants and the Decision to Pursue a Degree in Engineering

The societal determinants construct consisted of six variables which were used to gauge the influence they had on participants' decision to pursue a degree in engineering. The variables studied were: general social pressure to study science/engineering, general information/counselling, career seminars/career fairs, friends and acquaintances, social pressure to be academically competitive, and social value of science/engineering career. The results are shown in Table 13.

Table 13

Societal Determinants and Decision to Pursue a Degree in Engineering

Influence	Disagree	Neutral	Agree	Total Responses (N)
General Social Pressure to Study Science/Engineering	47.4% (71)	19.3% (29)	33.4% (50)	150
General Information or Counselling from other Sources (Social Media, Advertisement, News etc.)	46.3% (69)	26.8% (40)	26.8% (40)	149
Career Seminar, Career Fairs, etc.	50.3% (76)	25.2% (38)	24.5% (37)	151
Friends and Acquaintances	32.5% (49)	21.2% (32)	46.3% (70)	151
Social Pressure to be Academically Competitive	35.1% (53)	21.9% (33)	43% (65)	151
Social Value/Status of a Career in Science/Engineering	17.2% (26)	16.6% (25)	66.2% (100)	151

Results indicate that the social value of a career in science/engineering, is an important determinant of students' decision to pursue a degree in engineering, with agreement from two-thirds (66.2%) of respondents. Fewer than half of the participants agreed that general social pressure to study science/engineering or general career information and/or career seminars/fairs were influential in helping them choosing a career in engineering. Social pressure to be academically competitive was a stronger determinant of students' decision to pursue a degree in engineering than social pressure to study engineering/science. Interestingly, almost half (46.3%)

of the participants agreed that peer influence played a role in formulating their decision to pursue a degree in engineering.

Among all the variables studied under societal determinants, social value of career in engineering/sciences is the strongest determinant of students' decision to pursue a degree in engineering in Newfoundland and Labrador.

4.5 Personal Determinants and Decision to Pursue a Degree in Engineering

Under personal determinants there were four variables which were: personal motivation, aptitude in science/math subject matter, academic success in previous STEM related subject matter, and personal desire to work as a scientist or engineer. The results from responses to items related to this construct are shown in Table 14.

Table 14

Personal Determinants and Decision to Pursue a Degree in Engineering

Influence	Disagree	Neutral	Agree	Total Responses (N)
Personal Motivation	2% (3)	7.9% (12)	90% (136)	151
Aptitude for Science/Engineering Subject Matter	3.3% (5)	6.6% (10)	90.1% (136)	151
Academic Success in Previous STEM Related Subject Matter	7.3% (11)	17.2% (26)	75.5% (114)	151
Personal Desire to Work as a Scientist or Engineer	5.9% (9)	8.6% (13)	85.4% (129)	151

The data suggest that all four of the variables within this section are strong influences on the decision about whether to pursue a degree in engineering. Academic success in STEM based subjects in high-school appears to be positively related to choosing an engineering degree, but personal motivation, aptitude for science and engineering subject matter and personal desire to work as an engineer or scientist were the most noteworthy factors under the personal determinants construct.

4.6 Economic Determinants and the Decision to Pursue a Degree in Engineering

The economic determinants construct consisted of only two variables which were: earning potential of a career in engineering/science and main source of funding for students' education. Results of both these variables are presented in Table 15

Table 15

Economic Determinants (Earning Potential) and Decision to Pursue a Degree in Engineering

Influence	Disagree	Neutral	Agree	Total Responses (N)
Earning Potential of a Career in Science/Engineering	6% (9)	9.9% (15)	84.1% (127)	151

The majority of the participants (84.1%) perceive future economic benefit/earning potential of pursuing a degree in engineering as a determinant of their decision to pursue an engineering degree.

4.7 Summary of Chapter Four

This chapter presented the results derived from the survey data. Parental socio-economic status and similarities emerge as important factors that characterizes the traits of an undergraduate engineering student. The typical engineering student is a male Canadian citizen, under 26 years of age, from a financially sound, highly educated two-parent family with the means to support him/her financially during her/his academic program. His/her decision to pursue a degree in engineering is for the most part influenced by:

- Personal motivation and desire to work as an engineer
- Aptitude and academic success in previous STEM subjects
- Financial benefits of the engineering profession
- Social value of a career in science/engineering
- Parental advice/encouragement and,
- To some extent parental, social, and high-school pressure to be academically competitive

Results also indicate underrepresentation from women, students who come from single-parent family and have lower levels of education and income. The influence of high school factors is perceived to have limiting effect on student outcome (choice to pursue an engineering degree).

In the next chapter I will synthesise the findings in broader context while discussing the results in context of arguments from literature.

Chapter Five- Discussions, Conclusions, Implications and Recommendations

The purpose of this thesis is to investigate specific influences that contribute to the education decision-making process of undergraduate engineering students in Newfoundland and Labrador. The three research questions posited in this study are:

1. What are the perceptions of undergraduate engineering students about the influence of certain family, high-school, societal, personal, and economic factors on their decision to pursue a degree in engineering?

2. What influences do undergraduate engineering students perceive to be enabling factors for pursuing a degree in engineering?

3. What influences do undergraduate engineering students perceive to be limiting factors for pursuing a degree in engineering?

The data directly address the first research question and indirectly address the second and third research questions. In this chapter I discuss the findings, specifically how they are situated in the context of the existing literature, interpret the findings and present section-specific and overall recommendations for the policymakers and practitioners. Finally, in the implications section I will examine its implications for various stakeholders. This chapter will follow the same sequence (demographic, parental, high-school, societal, personal and economic variables in) that has been previously followed in the study.

5.1 Demographic Factors That Enable or Limit the Students to Pursue a Degree in Engineering and Applied Science

The findings from this study reveal that demographic factors matter. Students coming from certain segments of the society have an advantage over others when it comes to pursuing an undergraduate engineering degree in Newfoundland and Labrador. These advantages or disadvantages can be categorized by gender, family type (two-parent versus single-parent family), socio-economic status of parents, parental income, parental level of education, parental financial support during post-secondary education, and family size.

5.1.1 Gender

The findings from this study show that gender is associated with the decision to pursue an undergraduate engineering program. Two third of respondents identified themselves as males, the remaining identified themselves as females with the exception of one, who identified as non-binary. Historically girls' academic performance has been better than boys around the world (Voyer & Voyer, 2014). Canadian data suggest that women do better than boys both in the K-12 school system and during post-secondary studies (Turcotte, 2011); however, their representation in engineering is significantly lower than that of men (Hango, 2013). Various studies have previously discussed the underrepresentation of women in the field of engineering **(**Chubin, May, & Babco, 2005; Engineers Canada, 2017; Hango, 2013; Sadker & Sadker, 1995). In Newfoundland and Labrador, the female to male ratio in engineering is greater than other Canadian provinces (Engineers Canada, 2015), however there is still plenty of scope to increase the representation of females in engineering education. It will be worthwhile to invest knowledge and effort in understanding the determinants specific to female students that influence them or act as barriers to becoming an engineer. Since girls do better than boys in the K-12 school system in Newfoundland and Labrador, greater efforts to create opportunities for and awareness of engineering as a valuable career choice for girls would seem warranted. Some options could include (1) identifying girls with an aptitude for math and physics and providing them with opportunities to develop these skills. (2) deliberate efforts by science teachers and counselors to encourage girls to pursue engineering related careers (3) providing opportunities for women in science and engineering to talk about career options in these fields, and (4) creating opportunities for schools and school districts to liaise with organizations such as Engineers Canada, which are involved in promoting engineering education. At the government level, girls can be attracted towards engineering degrees by providing more scholarships and bursary opportunities. Financial incentive programs for girls with high academic achievement who choose to pursue engineering degree may be another monetary motivation. These programs may include, for example, tuition fee remission and/or financial help for books and resources for women choosing to pursue undergraduate engineering degrees.

Various initiatives that encourage women to participate in undergraduate engineering degree may reduce the gender disparity in engineering fields. A joint effort by the government, schools, and communities seem warranted to motivate girls to study science and math in high school, and study engineering at university.

5.1.2 Family Composition

Overall, family type, specifically coming from two-parent family is strongly associated with post-secondary participation in the field of undergraduate engineering education. Almost 83% of participants reported coming from a two-parent family. These results were consistent with several other studies reviewed in the literature. Astone and McLanahan (1991) and Heard (2007), emphasized that children coming from single parent families are less likely to pursue post-secondary studies. Similar arguments were made by Finnie & Laporte (2003), and Lambert et al. (2004), who argued that children coming from two-parent families are more likely to attend post-secondary education in Canada. It should be noted, however, that the arguments made by these researchers were in the context of higher education and not specific to engineering education. The findings from this study are also inconsistent with the arguments made by Cheung (2007) and Seabrook (2013) who have suggested that family structure exerts little effect on higher educational aspirations generally; I was unable to find literature specific to engineering education.

Possible reasons for these findings are not evident in literature specific to post-secondary education in engineering, nor does this analysis tell us why students from two-parent families engage in post-secondary education in engineering. However, it is possible that this finding is more reflective of income level than family type. The data show that the majority of engineering students in this study funded their education through resources provided by their parents.

In Canada, children living in single-parent households are three times more likely to live in low-income circumstances as compared to those living in two-parent families (Statistics Canada, 2017). Furthermore, children living with a single mother had a greater low-income rate than those living with single father (Statistics Canada, 2017). Overall, we may say that traditional (two-parent) families act as an enabling factor towards choosing a career in engineering and applied science. Given that two-parent families are likely to be better positioned financially to support their children's attendance at university, family type may simply be a proxy for income level. However, based upon the results we can also say that children from single-parent families are underrepresented in undergraduate engineering education. This relationship between type of family and choice of pursuing a degree in engineering should be further explored.

5.1.3 Family Size

The results show that more than half of students had no more than one sibling. This indicates that in addition to other demographic factors, family size seems to be be associated with an individual's decision to pursue a degree in engineering. Again, however, family size may be related to financial means; generally, it would be expected that smaller families would have proportionally more disposable income from which to financially support their children. Conversely, from a financial perspective, it might be expected that children from larger families are disadvantaged from becoming an engineer. Statistics Canada (2017) has shown that the likelihood of a child in low income families increase as the number of minor children in the household increases.

5.1.4 Parental Income

Almost half of the participants in this study reported annual family income of more than $100,000. This was consistent with Drolet (2005) and Finnie et al. (2004) who suggested that higher parental income was positively correlated with their children's decision to pursue post-secondary education. In addition, results of the Youth in Transition Survey (YITS), showed that students with parents from higher-socio-economic backgrounds reported consistent career choice throughout this longitudinal study. Their response to the question: What kind of job or occupation you would be interested in having when you are 30 years old? was same at 17, 21, 23, and 25 years of age (Statistics Canada, 2015). Only 10.6% of participants reported household income less than $50,000, which shows that very few students from lower income families are represented within the ranks of those pursuing engineering and applied science degrees. Hence lower parental income seems to be limiting factor that acts as a barrier to students entering the engineering and applied science fields.

This analysis does not explain the reasoning for this disparity but it is reasonable to assume that parents with greater financial means are better able to support their children to study university programs such as engineering. Conversely, children from lower income families are likely to encounter financial barriers to the pursuit of engineering and applied science programs. One suggested explanation for higher post-secondary participation among students belonging to families of higher financial means may be that their parents are able to afford the rising cost of education (Finnie & Laporte, 2003).

Based on the findings from this study, we may say that low parental income is limiting factor to post-secondary participation in the field of engineering. Although this topic needs to be further studied to explore ways to increase participation from students coming from lower socio-economic backgrounds, certain immediate efforts could lessen this barrier. Some possible actions at the school district/school level might include (1) inviting engineering professionals to deliver talks about the career in engineering. (2) liaising with organizations like Engineers Canada and the faculties of Engineering/applied sciences, which are involved in promoting engineering education among students and, (3) investment in professional development opportunities for teachers and counselors to keep them up to date with future market demands and growth opportunities. Teachers and counselors may further use this knowledge and educate students and their parents about what fields of studies may lead to a successful career. Knowledge sharing and partnership among these organizations may foster evidence based practices and policies to foster greater interest in the benefits of engineering occupations.

Other actions could involve targeting students with an aptitude for math and physics from underrepresented groups (low income families) for opportunities to develop on these skills, such as participation in STEM based experiential learning. Career counselors might consider ways to encourage students from low-income families to pursue engineering as a career such as undertaking sessions on the practical and financial benefits of engineering careers. Since money is a prime barrier for such students, government might consider introducing means-tested scholarships and funding opportunities for children from low-income households who choose to pursue an engineering degree. Financial incentive programs like tuition waivers for high achieving students (from low-income households) may be another monetary motivation. Financial support to buy study material (books, laptops etc.) may help engineering students from low income families while they are in undergraduate engineering programs. Engineering firms could be encouraged to sponsor university engineering education for students from low income households as part of their corporate social responsibility.

At the community level, more not-for-profit organizations that promote and fund engineering education for children from low-income families could be examined. Print and digital media coverage of the topic of career in engineering and writing articles about its role in social mobility may help families and children know and understand the long-term payoff of a career in engineering.

5.1.5 Parental Education Level

A majority of the students who participated came from families where their parents had at least a post-secondary degree, diploma, or certificate. More than 80% of participants reported that both their parents had at least some post-secondary education and more than 50% reported that their parents had a minimum of an undergraduate degree. These results align with those of Cheung (2007) who suggests that parents with post-secondary educational credentials (1) seem to foster higher levels of involvement in post-secondary academic decision-making, (2) tend to have higher educational expectations for their children and (3) transmit attitudes and values for academic success. The work of Cheung (2007), De Broucker and Lavallee (1998) and Finnie et al. (2004) supports the claim that parental education increases their children's likelihood of pursuing higher education. The findings from this research is consistent with this earlier work. From the perspective of choice to study engineering and applied science, students whose parents have earned post-secondary credentials have an advantage over those whose parents are less educated.

Social reproduction theorists have long recognized the positive impact of higher parental education on children's educational attainment levels (e.g., Bourdieu, 1986). Multiple studies have analysed the direct and indirect associations among parental education, income, and child development and found that parents' parenting behaviours and academic expectations from their children are a function of their personal educational experiences and awareness (Davis-Kean, 2005; Eccles, 2005). Similarly, Dubow, Boxer, and Huesmann (2009) studied the long-term effects of parental education and children's occupational success and found a positive association between the two variables. They also found that parental education influences the child's perception of his/her own educational aspirations.

It is a very complex phenomenon how parents knowingly or unknowingly transmit certain social advantages to their children. Some theorists see education as a means through which families transmit social advantages or disadvantages to the next generation (Blau & Duncan, 1967; Raftery & Hout, 1993; Sewell et al. 1969). We may say that this cycle continues as children mature and become parents transmit similar advantages or disadvantages to the next generations.

Finnie and Laporte (2003) suggested that parental education may explain the disparity in post-secondary participation between students coming from high and low-income families. Students whose parents have limited education may need more support to understand and pursue post-secondary programs that have the potential to increase social and economic prospects and interrupt patterns of social reproduction. This is a substantial social problem that is situated at the centre of what many educators, reconstruction theorists, and policy decision-makers see as fundamental to poverty reduction strategies. Opportunities to convey the value of higher education and the provision of special financial support to pursue a degree may benefit children whose parents are less educated. Since engineering degrees have substantial economic benefits, initiatives to foster math and physics in high school, creating awareness about engineering degrees and financial support to pursue one, may not only help increase number of engineers but also act as poverty reduction strategy that is based upon the principle of equity.

The role of media cannot be neglected because it can play an important role in disseminating information to the general public. A recent survey of people's perceptions about careers in engineering highlighted the lack of knowledge about engineering and the engineering profession. Only two out of five respondents in this survey reported being familiar with engineering and the engineering profession (Gibson & Hutton, 2017). Steps can be taken to make families aware about importance of a career in engineering and the engineering profession. This may be done through programs at school level, by organizations involved in promoting engineering education, during community events and through the mainstream media.

This issue can be addressed at strategic level by implementing public financial support programs for students from lower socio-economic backgrounds. Programs that provide financial assistance, in various forms, for potential engineering students from low-income households would seem to be central to increasing the number of engineering students from disadvantaged groups. This in turn would give the underrepresented population an opportunity to choose a career in engineering and become a part of the workforce that foster economic productivity of the province and country.

5.1.6 Financial Support

Almost two-third of participants in this study stated that their education was funded either by their parents/relatives or through scholarships and awards. Results in the previous section showed that parental annual income for almost half of the participants was more than $100,000. As Davis-Kean (2005) suggests, parenting behavior is a function of a parent’s own academic experience. Financial support to children may also be a result of parents’ own experiences of dealing with education loans and the difficulties associated with them. External financial support for post-secondary studies mainly from parents and relatives clearly emerges as an important mean through which engineering students fund their education. The majority of respondents in this study were raised by educated parents in smaller, two-parent families with good incomes. Collectively they constitute the ideal conditions to establish strong ‘means of support’.

Students belonging to larger families and those whose parents have lower levels of education and income are underrepresented among the engineering students who participated in this study. Students who overcome these barriers and manage enter the engineering program, are likely to be at higher risk of attrition because of financial reasons. They may have to work extended hours to pay for their living cost and education. Although this is speculative, this may also influence educational outcomes in terms of performance and career prospects. This is an avenue for further study.

Overall, financial support can be seen as a predictor of participation in undergraduate engineering education. However, a further analysis of this variable and a comparison with other fields of study will help determine if financial support from parents is more evident in engineering education than in other sectors.

5.2 Role of Family Determinants of Decision-Making in Post-Secondary Choice of Undergraduate Engineering Degree in Newfoundland and Labrador

The findings from this study show that parental advice/encouragement, parental pressure to be academically competitive, and high value of science and engineering education among family members are perceived as enabling influences by almost half of the respondents in the study. This is consistent with the previous research by Bers and Galowich, 2002; Cheung, 2007; Galotti, 2006; Paulsen, 1990, and a study published by Human Resources and Skills Development Canada, 2004. These studies underscore a substantial role for parents in encouraging their children to pursue higher education. The data from the present research shows that the educational role of parents in academic press, encouragement, advice and value for science and engineering education were contributing factors, in addition to the other supports they received from their parents. Bers and Galowich (2002), suggested that discussions within families can influence students to pursue higher education. These discussions may also strengthen the value of post-secondary education among children. Galotti et al. (2006), found that children with higher levels of educational encouragement from their parents tend to believe the information provided by them. Since a majority of participants' parents were university educated, participants may have perceived the advice they received as valid. As a follow-up to this study, it would be useful to investigate, through qualitative inquiry, the particular types of discussions that foster student's aspiration to engage specifically in undergraduate engineering education and the ways in which students respond to such conversations.

Previous literature is consistent with the results from this study in demonstrating that socio-economic status and parental education are positive influences on a child's post-secondary educational choices. However, the educational role of parents (e.g., example, encouragement and value for education) tends to be a stronger determinant of post-secondary education prospects than socio-economic status and parental education (Horn & Chen, 1998; Human Resources and Skills Development Canada, 2004; Paulsen, 1990). The majority of engineering students in the study indicated that parent's value for education, academic press, parental advice and encouragement were all determinants in the decision to pursue an engineering degree.

The most disadvantaged are the families belonging to lower socio-economic sections of the society and hence for most part, programs should be focused on them. Interventions at the government and school level may be able to change people's perceptions about education. For the most part, teachers are seen as valuable source of knowledge for both children and parents. Schools may be able to identify children who may have the ability and aptitude to study engineering, but, for economic or other reasons are unlikely to advance to engineering programs at university and focus on educating their parents on the importance of education and how this may impact their children's future well-being. Programming can be introduced in specific schools located in low income zones within the province. A more robust level of communication with parents may not only strengthen the relationship between school and parents, but also help educate the disadvantaged parents about importance of education (more specifically engineering) and available financial assistance. At the government level, the Department of Children, Seniors, and Social Development and Eastern Health in Newfoundland and Labrador works with the families at various level. Early childhood development and parenting are part of programming at these government organizations. Information sharing around importance of education among families seeking services from these organizations may be considered as an additional option.

Family determinants in decision about post-secondary program choices should be explored further to understand current perceptions among parents about careers in STEM fields. Knowledge about the impact of family determinants can help policy communities plan ways to engage parents in supporting their children to choose a career in engineering. Saying that, higher parental education, income, and type of family still remain the strongest determinants of choice of an engineering degree.

5.3 Role of the High School in Post-Secondary Choice of Undergraduate Engineering Degree in Newfoundland and Labrador

The findings from this study raise questions about the impact of high schools on student choice to pursue an engineering degree. While generally schools motivate students to pursue higher education through various means, from classroom instruction and experiential learning to counselling, school based determinants were not strongly associated with the decision of participants to study engineering. The findings from this research support the argument made by Hossler et al. (1999) that there is no substantial relationship between students' educational aspirations and their interaction with their teachers or guidance counselors. Moreover counselling/career information, and career seminars and fairs were not widely reported as being influential in career decision-making. It is possible that teachers and counselors are not providing sufficient advice/encouragement with respect to STEM as a career, or high schools may lack sufficient capacity to provide appropriate career advice. Hossler et al. (1999) advocate for more related professional development opportunities for teachers and counselors while arguing that teachers and counselors have limited knowledge around college decision-making process, which hinders them from offering valuable advice to students and their parents.

The results from this research raise questions about the effectiveness of career counselling and career seminars/fairs programs and/or events in Newfoundland and Labrador. Cheung (2007) states that a positive correlation exists between participation in extra-curricular activities and post-secondary educational aspirations. She claims that participation in extra-curricular activities is positively correlated with post-secondary educational aspirations. Similarly, Hossler and Stage (1992) and Stage and Hossler (1989) claim that students who are involved in extra-curricular activities during high school are more likely to have higher educational aspirations. However, with respect to undergraduate engineering education in Newfoundland and Labrador, the results are not consistent with these claims, as only about a quarter of the participants report that co-curricular activities influenced their decision to pursue a degree in engineering. So, in terms of extra-curricular activities in school, either they are inconsequential in terms of availability or, they are not very influential in piquing student interest in engineering or applied science careers. The data suggest that students don't see 'co-curricular activities in science/engineering' as a characteristic of 'academic focus in science/engineering' or building blocks towards careers in engineering.

This study highlights a need to strengthen capacity among teachers (particularly science teachers) and career counselors in high-schools. Better school based experiences to attract students and more relevant information may increase students' interest in STEM subjects. Further research in this area might assist schools to provide adequate guidance and encouragement to students in context of higher education in engineering or other STEM areas. With respect to extra-curricular activities, further research may be able to discuss the forms of extra-curricular activities that may be effective in stimulating interest in STEM fields. We know that students from lower socio-economic background are underrepresented in engineering education, and they may not have access to high-quality career advice at home. Teachers and counselors have a pivotal role to play and can inspire such children to attain higher-education.

5.4 Role of Society in Post-Secondary Choice of Undergraduate Engineering Degree in Newfoundland and Labrador

Results indicate that the social value of a career in science/engineering is a determinant of students' decision to pursue a degree in engineering. These results support the findings of Gibson and Hutton (2017), who suggest that even though the familiarity about engineers and engineering profession was relatively lower in Canada than in some other professions, the overall impression, trust, and respect for engineers and engineering profession increased with increased familiarity. The findings from this study validate findings from studies in other jurisdictions that illustrate the social value of the engineering and science professions.

Only about a third of participants cited general social pressure to choose engineering as an influencing factor in their program decision. Social pressure to be academically competitive was shown to be a stronger determinant of students' decision to pursue a degree in engineering than social pressure to study engineering/science. Interestingly, less than half (46.3%) of the participants indicated that peer influence played a role in formulating their decision to pursue a degree in engineering.

Other than social value for a career in engineering, none of the other factors under social determinants (i.e. general social pressure to study engineering, availability of information/counselling in society, career fair and seminars, peer pressure and social pressure to be academically competitive) seems to influence students to pursue a career in engineering. Students disagreed that general information about engineering careers or counselling or career seminars, was an influence. Again, this may be question of quality or quantity of such events. Additional research on societal determinants might help address the question about lack of quality or mode of information sessions, counselling, and career seminars.

5.5 Role of Personal Factors in Post-Secondary Choice of Undergraduate Engineering Degree in Newfoundland and Labrador

The results show that personal factors were perceived as playing the strongest role in decision to pursue an engineering degree. The variables under personal determinants registered the highest level of agreement in terms of their impact on the decision to pursue an undergraduate degree in engineering. Results about aptitude for science/engineering and academic success in previous STEM coursework aligned with the literature that student achievement is one of the best predictors of higher education aspirations (Bishop, 1977; Hossler et al., 1999; Jackson, 1978; Sharp et al., 1996; Tuttle, 1981). In Canada, academic self-confidence and beliefs about the relevance of education to job and career has also been shown to have a strong influence on educational aspirations (Cheung, 2007).

The participants in this study seem to be motivated mainly by personal desire, previous academic performance, aptitude, and perceived economic benefit of higher education in the area of engineering. Around 90% of the respondents indicated personal motivation and 85% indicated personal desire to work as an engineer the reason to pursue an engineering degree. Both desire and motivation to work as an engineer are a function of awareness about the engineering profession. Students belonging to highly educated parents earning high incomes are likely to be subjected to conditions that foster the awareness of various professional fields earlier in their lives. Around 90% of participants attributed their aptitude for engineering subject matter as a factor in their choice to pursue a degree in engineering and more than 75% indicated academic success in previous STEM subjects to be a factor.

Even though personal factors were perceived as the strongest determinant, it is fair to say that the ‘person’ in personal factors is a product of cumulative advantages that student received during the progression of life while being part of a family in a higher socio-economic group. Parental education, income, stable family environment, and financial support, all contributed in developing this ‘person’. Similarly, this ‘person’ can also be called a product of a school’s culture and climate, educational resources and quality of instruction. This individualistic orientation has been studied by Hofstede (1986) who considers Canada as a ‘loosely-knit society’ where self-image is defined in terms of ‘I’ rather than ‘we’. He further states that people in individualistic societies consider education as a medium through which one can improve his/her social and economic worth. Further study could be directed towards questions about what students perceive as the building blocks for their academic success and aptitude in STEM subjects.

5.6 Role of Economic Factors in Post-Secondary Choice of Undergraduate Engineering Degree in Newfoundland and Labrador

The majority (84.1%) of the participants perceive future economic benefit/earning potential of a career in engineering as a principal determinant of their decision to pursue an engineering degree. This is consistent with the general understanding that engineers earn impressive salaries and this is borne out in the literature. STEM career areas, in particular, carry a premium in overall job market (Rothwell, 2013). Since the majority of participants belong to higher socio-economic backgrounds they are likely to have been exposed to such knowledge and the expectation that they will become high earners, either through their immediate family members or by people they interact with in daily life. This also mean that students understand the importance of and implications associated with financial security. This may be a driving force behind choosing to pursue a degree in engineering. From an economic standpoint, being exposed to the life choices of their own parents (who generally belong to higher socio-economic stratum) may also be a factor that influences the desire to become an engineer. Educated parents with high-income may transmit the importance of economic benefits of degrees such as engineering that tend to prepare students for high-earning jobs.

On the other hand, the barriers outlined earlier in Chapter 5 may hinder an individual’s aspiration to pursue a degree in engineering. Students who come from low-income families may not be exposed to such information. Their decision to pursue or not to pursue and engineering degree may be based upon different family experiences and expectations, patterns of non-attendance or other circumstances, such as financial limitations.

Bourdieu (1986) argues that social advantages or disadvantages (social capital) are passed on from one generation to another. Many of the so-called enabling factors discussed in previous sections may act in concert to develop a student's understanding of the economic and social value of higher education, in this instance, an engineering degree. This can be thought of as a cycle, where an individual's level of education determines the kind of job he/she is qualified for, his/her income level, and subsequent social and professional network. A person's social and professional network will then expose the individual to other people with similar characteristics, that is, people with higher education will, for most part, network with people who have similar values, levels of education and stations in life. This builds and perpetuates forms of social capital within certain families that may transmit these same social values and dispositions to their children, which builds their children's social capital. Their children, during their school years, may develop more comprehensive understanding of the importance of education and its relevance to their future. Such families also have the means to provide financial support for higher education for their children. Higher education will help get them earn the credentials to enter the workforce in a high-paying job and the cycle repeats.

5.7 Conclusions

Increasing the number of engineering and applied science students is an important strategic priority for the Canadian labour market, but there has been very limited research that investigates the social and economic processes that influence Canadian youngsters to pursue careers in engineering. We still don't fully understand why so few Canadian students choose to pursue a STEM related career. Xie et al. (2015) blames national cultural traditions and ‘disadvantages’ that students face across various facets of life and recommends for more research in this area. Recent U.S. studies suggest a need to identify factors that casually promote student engagement and achievement in STEM areas (Xie et al., 2015; Xie & Killewald, 2012). In the Canadian context, the present study is one step forward in that direction. Using quantitative inquiry that includes a cross-sectional survey, this research focused on profiling and describing the enabling and limiting factors that influence students to pursue undergraduate engineering education. The findings present a snapshot of the demographic characteristics (which includes gender, family type, parental education, parental income, family size etc.) that are associated with a students’ decision to pursue a degree in engineering in Newfoundland and Labrador. The findings also reveal the extent to which certain, school based, social, economic, and personal influences are associated with the decision to pursue a degree in engineering and applied science. Perception of higher economic value of studying engineering and personal factors like aptitude for STEM subject matter and previous success in them, play a major role in the decision to pursue engineering degree.

One of the important findings of this research is the demonstration of an apparent imbalance in the socio-economic profile of engineering students, where students from lower income families are underrepresented. Previous research suggests that students belonging to lower income families are underrepresented not only in engineering but in any form of higher-education. Efforts to increase opportunities for underrepresented groups (including girls) to make engineering studies and preparation for other STEM-based occupations more accessible will improve the number of Canadian engineers and applied scientists At the policy level, efforts should be focused on funding opportunities to access higher education.

Schools can play a significant role in framing an individual's future. Teachers and counselors need to be well equipped with knowledge around the future economic global demands through professional development opportunities made available to them. STEM educators specifically should be trained in such was way that they view a degree in sciences as a means for social mobility. Since STEM related extra-curricular activities are not perceived as a major influence in an individual's decision to study engineering, further study could help determine how such activities could be better designed and implemented.

5.8 Implications for Practice

This study will help policy makers and practitioners develop a better understanding of post-secondary decision-making in Newfoundland and Labrador, specifically in the context of engineering studies at Memorial University. The findings presented here will be useful to institutions, agencies and government departments in developing programs and other strategies towards developing students' interest in and ability to pursue engineering as a field of study.

Specifically, government departments such as the Provincial Department of Education and Early Childhood Development and the Department of Advanced Studies may wish to use this research towards building capacity among teachers and counselors in liaison with Faculty of Engineering and Applied Sciences to develop or improve science related extra-curricular and experiential learning activities to benefit students. Educational agencies should especially look to develop targeted financial assistance programs that will strengthen the supports for low-income students. With a combined effort from universities, schools, and government, our capacity in engineering and STEM-related occupations will increase and contribute to Canada's prosperity, and economic competitiveness. Further research, including longitudinal research to study how such programs may benefit targeted population would also be beneficial.

Some other countries, notably India and China, have developed their societies in a such a way that they promote STEM education through many social processes. For example, from my own experience growing up in India, the students who do well are well recognized in national and local media, which motivates others to do well. Student success stories and their narratives are profiled on news channels and newspapers. The role of family in student success is recognized and it is an integral part of prime-time news on major national TV channels. Individuals and organizations working in education promotion may use this study to develop programs for children. This research points to an opportunity to establish social enterprises in field of engineering education, similar to the educational enterprises in India and China that inspire and empower middle and lower middle class students to climb the economic ladder. An international comparative study with these two Asian countries that fulfill global skills demand can give rise to new knowledge in the field of STEM education. Since India and China are producing STEM graduates at a very higher rate, data from these two countries can be a point of reference to make comparisons and identify what (as a society) is motivating a large number of students to pursue careers in engineering there.

5.9 Recommendations

There are two major findings of this study, (1) students from certain sections of the society and demographic characteristics are disadvantaged in the journey to become engineers, and; (2) the decision to pursue an engineering degree is largely motivated by personal factors; there is no apparent relationship between students' educational aspirations and their formal career advice or supports ate the school level.

The key to overcome these barriers is financial support at two levels. First, in the Newfoundland and Labrador context, there is an apparent need, for funding and program development at the intermediate and high school levels focused on the development and delivery of training programs for STEM subject teachers and guidance counselors. These programs might be concentrated on promoting engineering education and encouraging female students and those from low-income households to pursue careers in engineering fields. Second, individual financial support should be targeted towards students (scholarships, awards, incentives etc.) from low-income families and female students.

The training programs will provide professional development opportunities for teachers/counselors to offer extended support and knowledge (for example, knowledge about engineering field, social benefits of earning an engineering degree, basic requirements for enrollment in university to study engineering, economic value of engineering degree, financial supports available etc.) to students and families underrepresented in engineering fields. This support will create an awareness and desire of pursuing post-secondary engineering degree among students and those with aptitude in math and physics may participate in university engineering programs with the help of level two financial support programs.

5.10 Summary of Chapter Five

In this chapter I highlight the enabling or limiting factors students perceive to influence their decision to pursue a degree in engineering. I also discuss the key findings, conclusions and implications from the study, and suggest recommendations for policy decision-makers.

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Appendix 1- Survey Instrument

Perceptions of the social and economic factors influencing engineering and applied science students' choice of degree program

Informed Consent Form (Survey)

Title: Perceptions of the social and economic factors influencing engineering and applied science students' choice of degree program.

Researcher(s): Amit Sundly, Graduate Student, Faculty of Education
Tel: 709-763-8888, Email: as0887@mun.ca
Supervisor(s): Dr. Gerald Galway, Faculty of Education
Tel: 709-864-2522, Email: ggalway@mun.ca.

You are invited to take part in a research project entitled "Perceptions of the social and economic factors influencing engineering and applied science students' choice of degree program."

This form is part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. It also describes your right to withdraw from the study. In order to decide whether you wish to participate in this research study, you should understand enough about its risks and benefits to be able to make an informed decision. This is the informed consent process. Take time to read this carefully and to understand the information given to you. Please contact the researcher, Amit Sundly, if you have any questions about the study or would like more information before you consent.

It is entirely up to you to decide whether to take part in this research. If you choose not to take part in this research or if you decide to withdraw from the research once it has started, there will be no negative consequences for you, now or in the future.

Introduction:
I am a graduate student in the Faculty of Education at Memorial University of Newfoundland. As part of my master's thesis, I am conducting research on the social and economic factors influencing engineering and applied science students' choice of degree program.
This form is part of the process of informed consent. In order to make an informed decision about whether you wish to participate in this research study, you should understand the risks and benefits. This form describes the research and what your participation will involve. It also describes your right to withdraw from the study. Please take the time to read this carefully and to understand the information given to you. If you wish to learn more about the study or would like more information before you consent, please refer your questions to the researcher.

Purpose of study:
The purpose of this study is to explore your perceptions of how various factors (school, family, etc.) influenced your decision to pursue a degree in engineering. The overall goal of the research is to better understand what motivates enter the fields of engineering and the applied sciences in Newfoundland and Labrador.

What you will do in this study:
You will help me explain and explore the research topic in more detail and improve my understanding about how some of your life experiences played a role in developing your interest in engineering and sciences.
If you consent to participate, you will complete this online questionnaire (A paper questionnaire is also available). The questionnaire body consists of the informed consent form and three other sections.

Section A will have a set of demographic questions. Section B will ask you to signify your level of agreement with each of a series of statements about the influence of certain factors on your decision to pursue a degree in Engineering. And, in Section C, you will be informed that the option to withdraw will not be available once the responses have been submitted.
After submitting the response, you will have an opportunity to fill in your contact details using the link or a separate sheet of paper to be part of a discussion group in future.

Length of time:
Time commitment for completing the survey: 10-15 minutes.

Withdrawal from the study:
Printed Questionnaire:

- You may withdraw by not completing the survey at all.
- You may withdraw any time before you submit your response in the sealed collection box.
- It will be impossible to determine which survey response belongs to whom once the survey is complete. Thus, after completion, the right to withdrawal will be unavailable.
- You can choose to skip any question you do not wish to answer.
- There is no penalty for withdrawal.

Online Questionnaire:

- You may withdraw by not completing the survey at all.
- You may withdraw if you don't agree to any the part of this informed consent by simply closing the web browser.
- It will be impossible to determine which survey response belongs to whom once the survey is complete. Thus, after completion, the right to withdrawal will be unavailable.
- You can choose to skip any question you do not wish to answer.
- There is no penalty for withdrawal.

Possible Benefits:
As a participant in this research you will contribute to building an understanding about factors that motivate students to choose a career in engineering and applied sciences. This research will help to fill the gaps in scholarly research around STEM-related higher education. Your participation will help to identify social and economic influences on students' decisions to study engineering and applied sciences that might not otherwise be understood or known. Additionally, your involvement will help improve labour market information about the STEM workforce in Canada.

Possible Risks:
The demographic questions on the survey questionnaire consist of three questions related to family composition, income and educational funding. You may consider these to be personal. In the case of the question on income, I chose to use broad categories rather than asking for more precise information. You are assured that your responses are private and confidential and I will make every possible effort to safeguard your identity.

Confidentiality:
The ethical duty of confidentiality includes safeguarding your identity, personal information, and data from unauthorized access, use, or disclosure. Data will only be accessible to my research supervisor and will be stored on my Google Drive, which requires a password-protected login. Other relevant information will be stored in my computer and will be maintained in a password-protected folder (in addition to the password required to gain entry to the personal computer).
Anonymity:
Your participation will be anonymous in nature and no personally identifiable information will be collected unless you voluntarily enter contact details to participate in group discussions. You will not be identified in the reporting of research findings and information will be bound to confidentiality. The data will be reported in aggregate form and hence it will not be possible to identify individuals.

Storage of Data:
Data will be only accessible by me and my research supervisor. Any information that is stored on my computer will be maintained in a password-protected folder (in addition to the password required to

gain entry to the personal computer). Any information that is printed will be stored in a locked cabinet in my supervisor's locked office. The survey responses will be destroyed by shredding the paper copies and permanently deleting the electronic copies on my computer, in conjunction with the Memorial University's policy.
As per University policy, data will be kept for a minimum of five years, as required by Memorial University's policy on Integrity in Scholarly Research. Data will not be retained beyond the minimum 5-year period.
Archival Value: The data will have no archival value.
Reporting of Results:
I anticipate publishing the results in a scholarly journal, conducting a presentation in the Faculty of Education that will be open to member of the university community. I will provide a summary of the research to the Faculties of Engineering and Applied Science and Education, should they wish to profile the research on their web pages. The thesis will also be publically available at the QEII library. Results will be reported in aggregated form, so that it is not possible to identify individuals. Graphs, tables and direct quotations will also be used however no personal identifiable information with will be shared. Pseudonyms will be used in direct quotes.

Sharing of Results with Participants:
I will make best efforts to provide access to the findings to You, Dean-Faculty of Engineering and Applied Science, Director of First Year Admissions, the cooperating professors and the leaders of the various student associations in the faculty of Engineering and Applied Science. I also anticipate publishing the results in a scholarly journal, conducting a presentation in the Faculty of Education that will be open to member of the university community. I will provide a summary of the research to the Faculty of Engineering and Applied Science and Education, should they wish to profile the research on their web pages.

Questions:
You are welcome to ask questions at any time before, during, or after your participation in this research. If you would like more information about this study, please contact: Amit Sundly (Email: as0887@mun.ca, Ph.: 709-763-8888) or Dr. Gerald Galway (Email: ggalway@mun.ca. Ph.: 709-864-2522)

Note: The proposal for this research has been reviewed by the Interdisciplinary Committee on Ethics in Human Research and found to be in compliance with Memorial University's ethics policy. If you have ethical concerns about the research, such as the way you have been treated or your rights as a participant, you may contact the Chairperson of the ICEHR at icehr@mun.ca or by telephone at 709-864-2861.

Consent:
By Completing this survey you agree that:
- You have read the information about the research.
- You have been able to ask questions about this study.
- You are satisfied with the answers to all your questions.
- You understand what the study is about and what you will be doing.
- You understand that you are free to withdraw participation in the study without having to give a reason, and that doing so will not affect you now or in the future.

You understand that if you choose to end participation during data collection, any data collected from you up to that point will not be retained. You also understand that once response has been submitted, it will be impossible to removed the data.

By completing the survey, you do not give up your legal rights and do not release the researchers from their professional responsibilities.

Note: A copy of this consent form will be made available to you for your records.

* Required

1. **Informed Consent** *
   Check all that apply.
   - [ ] I have read the informed consent and agree to participate in this study

Section A

Demographics: Please check the appropriate response.

2. **Residency status in Canada**
   Mark only one oval.
   - Canadian Citizen (NL Resident)
   - Canadian Citizen (Other Province)
   - Permanent Resident (You or your parents immigrated to Canada)
   - Other: __________

3. **Gender**
   Mark only one oval.
   - Male
   - Female
   - Non-Binary

4. **Age**
   Mark only one oval.
   - Under 20
   - 21-25
   - 26-30
   - 31-35
   - 36-40
   - 40 or Older

5. **Language spoken at home**
   Mark only one oval.
   - English
   - French
   - English & French
   - Other: __________

6. **What is your current program/area of study?**
Mark only one oval.

- Civil Engineering
- Electrical and Computer Engineering
- Process Engineering
- Mechanical Engineering
- Ocean & Naval Architecture
- First Year Student (Faculty of Engineering)
- Student from Faculty of Science taking first year engineering courses

7. **How would you describe the family you grew up in?**
Mark only one oval.

- Mother & Father lived in the same household
- Single Parent (Mother)
- Single Parent (Father)
- Other: ______________

8. **What do you estimate is your parent's household income?**
Mark only one oval.

- Less than $50,000
- $50,001-$100,000
- $100,001-$150,000
- $150,001-$200,000
- More than $200,000
- Don't Know

9. **What is the main source of funding for your education?**
Mark only one oval.

- Self-funded (Work)
- Self-funded (Student Loans, Bank Loans, etc...)
- Funded by Parents/Relatives
- Scholarships and Awards
- Other: ______________

10. **What was your highest level of education before entering your current program?**
Mark only one oval.

- High School
- Post-Secondary Certificate or Diploma
- Undergraduate Degree
- Graduate Degree
- Doctorate
- Other: ______

11. **What is your mother's highest level of education?**
Mark only one oval.

- High School
- Post-Secondary Certificate or Diploma
- Undergraduate Degree
- Graduate Degree
- Doctorate
- Other: ______

12. **What is your father's highest level of education?**
Mark only one oval.

- High School
- Post-Secondary Certificate or Diploma
- Undergraduate Degree
- Graduate Degree
- Doctorate
- Other: ______

13. **How many siblings do you have?**
Mark only one oval.

- 0
- 1
- 2
- 3
- 4
- 5 or more

Section B

For each of the following statements please check the box that best describes your decision to study for a degree in engineering.

1- Strongly Disagree
2- Disagree
3- Neither Agree nor Disagree
4- Agree
5- Strongly Agree

**My decision to study for an engineering degree was influenced by:

14. **Advice or encouragement of parents**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

15. **Parental pressure to study in a science or engineering field**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

16. **Tradition of science and engineering occupations in my family**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

17. **Parental pressure to be academically competitive**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

18. **High value for science and/or engineering education among family members**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

19. **Advice/pressure from extended family member(s)**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

20. **Advice or encouragement by teacher or other staff member in my school to study science or engineering**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

21. **High School-level pressure to study science or engineering**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

22. **Career counselling advice received in high school**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

23. **Academic focus/emphasis on science and engineering (STEM - science, technology, engineering or mathematics) in my high school**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

24. **Teacher (or other school staff member's) pressure to be academically competitive**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

25. High value for science and engineering among teachers and/or other staff members in high school

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

26. General social pressure to study science or engineering

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

27. General information and/or counselling from other sources (social media, advertisements, news sources, etc.)

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

28. Career seminars, career fairs, etc.

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

29. Friends and acquaintances

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

30. Societal pressure to be academically competitive (Example. A rigid competition to get into engineering)

Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

31. **Social value/status of a career in science or engineering**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	⬭	⬭	⬭	⬭	⬭	Strongly Agree

32. **Personal Motivation**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	⬭	⬭	⬭	⬭	⬭	Strongly Agree

33. **Earnings potential of a career in science or engineering**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	⬭	⬭	⬭	⬭	⬭	Strongly Agree

34. **Aptitude for science and/or engineering subject matter**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	⬭	⬭	⬭	⬭	⬭	Strongly Agree

35. **Academic success in previous STEM related subject matter**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	⬭	⬭	⬭	⬭	⬭	Strongly Agree

36. **Co-curricular school activities in science and engineering (e.g. Science fair, robotics clubs, etc.)**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	⬭	⬭	⬭	⬭	⬭	Strongly Agree

37. **Personal desire to work as a scientist or engineer**
Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	⬭	⬭	⬭	⬭	⬭	Strongly Agree

Withdrawal

Participants cannot withdraw from the study once the responses are submitted

Appendix 2- Revisions to Survey Instrument

MEMORIAL UNIVERSITY

Sundly, Amit <as0887@mun.ca>

Changes to the Survey Questionnaire: ICEHR #: 20170729-ED; Researcher Portal File #: 20170729

Sundly, Amit <as0887@mun.ca> Sun, Jan 22, 2017 at 3:44 PM
To: lana.williams@mun.ca
Cc: "Galway, Gerald J." <ggalway@mun.ca>

Lana

I carried out a Pilot test of my Survey Instrument and have made the following changes:

1. Question no. 6: Options edited and added
Edited: **First Year Student has been changed** to **First Year Student (Faculty of Engineering)**
Added: Student from Faculty of Science Taking First Year Engineering Courses

2. Question No. 13: Option Added
Added: **0**

3. Question No. 17: Question Edited
Edited: **Parental Pressure to be Competitive** to **Parental Pressure to be Academically Competitive**

4. Question No. 20: Question Edited
Edited: **Advice or encouragement by someone in my school to study science** or **Engineering** to **Advice or Encouragement by Teacher or Other Staff Member in my School to Study Science of Engineering**

5. Question No. 21: Question Edited
Edited: **School-Level Pressure to Study Science of Engineering** to **High-School Level Pressure to Study Science of Engineering**

6. Question No. 24: Question Edited
Edited: School (teacher or other school staff members) pressure to be competitive to Teacher (or Other Staff Member's) Pressure to be Academically Competitive

7. Question No. 30: Question Edited
Edited: **Societal pressure to be competitive (Example. A rigid competition to get into engineering)** to **Societal pressure to be academically competitive (Example. A rigid competition to get into engineering)**

8. Question No. 35: Question Edited
Edited: Academic success in previous STEM subject matter to Academic Success in previous STEM related Subject Matter

A copy of New Questionnaire is attached with this email.

Please advise if I can go ahead with the new questionnaire.

Thank You

Kind Regards,
Amit Sundly

Appendix 3- Ethics Approval Letter

MEMORIAL UNIVERSITY

Interdisciplinary Committee on
Ethics in Human Research (ICEHR)

St. John's, NL Canada A1C 5S7
Tel: 709 864-2561 icehr@mun.ca
www.mun.ca/research/ethics/humans/icehr

ICEHR Number:	**20170729-ED**
Approval Period:	November 16, 2016 – November 30, 2017
Funding Agency:	N/A
Responsible Faculty:	Dr. Gerald Galway Faculty of Education
Title of Project:	*Perceptions of the social and economic factors influencing engineering and applied science students' choice of degree program*
Amendment #:	***01***

January 25, 2017

Mr. Amit Sundly
Faculty of Education
Memorial University of Newfoundland

Dear Mr. Sundly:

The Interdisciplinary Committee on Ethics in Human Research (ICEHR) has reviewed the proposed revisions to the above referenced project, as outlined in your amendment request dated January 23, 2017, and is pleased to give approval to the revised survey, as requested, provided all previously approved protocols are followed.

If you need to make any other changes during the conduct of the research that may affect ethical relations with human participants, please submit an amendment request, with a description of these changes, via your Researcher Portal account for the Committee's consideration.

Your ethics clearance for this project expires November 30, 2017, before which time you must submit an annual update to ICEHR. If you plan to continue the project, you need to request renewal of your ethics clearance, and include a brief summary on the progress of your research. When the project no longer requires contact with human participants, is completed and/or terminated, you need to provide an annual update with a brief final summary, and your file will be closed.

Annual updates and amendment requests can be submitted from your Researcher Portal account by clicking the *Applications: Post-Review* link on your Portal homepage.

The Committee would like to thank you for the update on your proposal and we wish you well with your research.

Yours sincerely,

Kelly Blidook, Ph.D.
Vice-Chair, Interdisciplinary Committee on
Ethics in Human Research

KB/lw

cc: Supervisor – Dr. Gerald Galway, Faculty of Education