EVALUATING ENGINEERING CAREER RESOURCES AVAILABLE WITHIN THE ONTARIO HIGH SCHOOL SYSTEM

by

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Abstract

Awareness and knowledge of both engineering education programming and the engineering profession is important for students in high school because strategic course choices must be made for students to qualify for university enrolment. Strategic and informed high school course selections must be made so students will graduate with the prerequisites needed for application to a university program. This complexity may be particularly concerning for students who realize late in high school that they wish to pursue an engineering education.

This research aims to provide insight into how Grade 12 students learn about post-secondary programs and career planning, and how students are supported in this learning by teachers and guidance counsellors. The students were surveyed to learn how they use resources to learn about post-secondary programs. Grade 10 Careers teachers, Grade 12 mathematics and science teachers, and guidance counsellors were interviewed on their advising experiences and their knowledge of engineering was explored. A phenomenological qualitative approach encouraged participants to describe their experiences and the meaning they associate to them.

The findings show that student participants found value in the visibility of many universities and programs online, and in their interactions with resources. Teacher and guidance counsellor participants frequently associated students who presented academic strength and interest in mathematics and science, particularly physics, as those who could become engineers. These participants also described conflicting surface knowledge of engineering disciplines. Advising by teachers and guidance counsellors was found to be very focused on getting students to a post-secondary program in which they will likely succeed. While there was little discussion by the teachers and guidance counsellors in advising on the alignment between the post-secondary program and the students’ intended career path, findings from the student survey showed that students do refer to their teachers for career-related information. With the common
association of strong mathematics and science student with engineering, low confidence in their engineering knowledge, and academic planning focused advising, there is little assurance that high school students currently have the knowledge needed to make an informed decision selecting an engineering education and career pathway.
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Chapter 1

Introduction

The structure of the Ontario school curriculum requires that students begin making decisions about the subjects they wish to pursue early in high school. These choices ultimately lead to the educational and occupational pathway for the students after high school. There are many career resources available to students, both internal and external to high school, in formal and informal settings. Past studies have shown that few primary or secondary school students can accurately describe the engineering profession or what an engineer does. It is important that students have access to the necessary post-secondary program and career information to make educated choices.

Engineering is a complex profession, described by Dr. Tom Brzustowski, P.Eng, past president of NSERC, as,

the professional activity of creating artefacts and systems to meet people’s material needs, with design as the central creative process, scientific knowledge and economic considerations as its essential inputs, and public safety as its overriding responsibility [1].

The complexity of the profession is reflected in the demanding prerequisites for successful application to a university engineering program. Awareness and knowledge of both the engineering profession and engineering education programming is important for students in high school because strategic course choices must be made for students to qualify for university enrolment. A need has been identified to ensure that students with the appropriate qualifications, potential and interest have the necessary knowledge to consider engineering as a profession, and in turn are able to pursue the necessary high school pathway to apply to university engineering programs.
A report on the Canadian engineering labour market [2] identifies four major trends that will affect Canada’s ability to moderate the labour market conditions: (a) expansion demands, (b) replacement demands, (c) post-secondary programs and (d) immigration. A national expansion of 8%, approximately 16,000 engineering jobs, in ‘engineering intensive’ industries is expected between 2011 and 2020. An expected 95,000 job openings are expected over this range as engineers retire. Enrolment in post-secondary engineering programs is expected to increase until 2013-2014; at that point, the number of Canadians under age 34 (the source population for enrolment) declines. Immigration of internationally trained engineers is expected to trend lower from 2011 to 2020 than over the 2001 to 2010 timespan. According to this report, these overall trends imply that in many markets, there will be moderate pressure to supply engineers to fill these employment gaps.

Public knowledge of the engineering profession has been identified as a concern that could affect the ability to fill these gaps, especially the knowledge held by secondary school students. Students from this population will be enrolling to become engineers and fill these gaps. A variety of science, technology, engineering and mathematics (STEM) outreach programs and research has been conducted around the world. There have been many studies investigating elementary and high school student perceptions of engineering specifically; most of these have been conducted in the United States, with few that investigated the understanding of Canadian students. In general, the studies found that many students have misconceptions about the work engineers do, and the academic preparation required. Some of the misconceptions led students to think it was too challenging to become an engineer. Students were also found to be pursuing engineering without knowing much about the profession. Some implications of these findings are that ill-suited students could be pursuing an engineering career, or well-suited students are misinformed and are being deterred.
Ill-suited students who enter a university engineering program are unsatisfied, and transfer out of the program results in administrative time and financial losses. Ill-informed students could in some cases successfully complete an engineering education, but be uninterested in the types of work engineers do. This could result in a variety of consequences, this unsatisfied or uncaring engineer could compromise public safety, or they could need to return to school to acquire different qualifications. Conversely, students who could become a strong professional engineer (creative problem-solver who designs solutions grounded in mathematics and science), could avoid pursuing the profession because they do not fit their perceived profile of an engineer. To optimize the number and types of students applying to university engineering programs, it is important to learn about the resources that students access for information, about the influences on students’ decisions, and about the information they need to make informed and educated decisions about their post-secondary pathway.

A close match between personality, aptitudes and values of the student and their post-secondary decisions (both at the post-secondary level and career level) leads to motivation, satisfaction and success in these future endeavours. To embark on a career in engineering, the Canadian Engineering Accreditation Board has outlined attributes required upon matriculation from a university engineering program. The knowledge, skills and professional values described by the attributes showcase the types of students who would be most suitable for a career in engineering. Before making post-secondary decisions, high school students should ideally consider the alignment between their personality, aptitudes and values as well as what will be required of them in their future educational study and career. Due to the qualities demanded of a professional engineer and the general lack of knowledge of engineering, it is a challenge to ensure these suitable students have adequate knowledge to properly consider engineering as a career option.
For a student who wishes to pursue engineering, there are many post-secondary pathways that they could take. It would be both efficient and cost-effective to help students make the informed choices about their future. In making these decisions about their future, there are a variety of factors that are within the students’ control. Effective decision-making theory states that students need to be ready, and have adequate and correct information. Self-discovery is an important part of the decision-making processes; students need to develop an awareness of what their interests and values are as it applies to their educational and career options. Academic planning early in high school will help ensure students select the appropriate courses and levels of study so they can graduate with the required prerequisites of the post-secondary program(s) to which they wish to apply. In addition to self-awareness and completing application requirements, an understanding of the programming would assist students in selecting the appropriate program for themselves. Students should also have sufficient information about the career and career path available to them as a result of their post-secondary education. With this as the foundation of knowledge needed to make a post-secondary and career choice, the resources and support available to help students acquire this information can be optimized.

There are a variety of ways for students to learn more about what they can do after high school. Formally in the high school system, the Ontario Curriculum Documents [3] outline course goals for student learning. The document for the mandatory half-credit course in Grade 10, Career Studies, describes that the goals of the course are to help students with developing self-awareness, learning about opportunities, and learning effective decision-making strategies. Within the high school environment, teachers and guidance counsellors are well-positioned to support students in this learning. Research shows that science teachers are considered by students to be resources for science-based career information [4]. In addition to the many advising and counselling responsibilities of guidance counsellors, one of the responsibilities of guidance counsellors in Ontario is supporting a student’s career development [5].
Among the other responsibilities of guidance counsellors is assistance with academic planning and application to post-secondary opportunities. For application to programs with many and specific course requirements, such as many university engineering programs, students can eliminate options by neglecting to consider the level of study they pursue. In addition to course subjects and level of study requirements, many university engineering programs also have ranges or minimum grades that are required for acceptance into their program. Students lacking the appropriate prerequisites would be denied admission or be required to make other arrangements that would complicate their plans (e.g.: take an equivalent course in their first year of post-secondary studies).

Outside the high school system, learning about university programming and career paths can be less structured, and require motivation on the part of the student to engage. Representatives from universities visit high schools to host information sessions for students on their institution, and answer questions. Attendance for these sessions is generally voluntary. Many universities hold prospective student open house days where students visit the university’s campus. These events often involve a balance of campus-wide exposure and program-focused information. Other opportunities for students to learn about university programs include resources such as internet searches, university viewbooks, and current or past students. The Ontario Universities’ Fair showcases booths of Ontario’s 21 universities. Students who attend the September weekend fair have the opportunity to talk to representatives from these universities to gather information to help students make decisions about which university and program to pursue. Throughout the weekend, each university also hosts scheduled information sessions. A plethora of additional materials about programs, admission requirements and student life are also available and distributed to students [6].

Acquiring information about careers is even less structured. In the Ontario science curriculum documents, career exploration and discussion is mentioned in passing and is perhaps prioritized lower than the
academic subject matter of the course. The documents state that students should be able to identify careers related to the study of the academic subject, the training required, and notable individuals in the career [7]. Information about careers can come from a variety of sources. One source is discussions with individuals in that profession, however access may not be easy if they are not a family member or friend. Day-to-day career responsibilities of a job will be more transparent with individuals students have had interactions with, for example: teachers, doctors, and dentists. Additionally, perceptions of jobs and career paths could be developed from other passive exposure such as in the news and on television shows. Where learning is less structured the quality, reliability and accessibility of the information comes into question. While there are many opportunities for adolescents to learn about engineering (e.g. specialized camps, outreach programs, family members, etc.) not all of these resources are commonly accessible to all students. Of the variety of resources that could be used to disseminate information, it was decided that optimizing a commonly accessible resource within the Ontario high school system would help ensure necessary information was available to the vast majority of students applying to university programs.

According to the Ontario Universities’ Application Centre, the majority of potential applications to an Ontario university engineering program are from an Ontario high school (at the time of writing, this was approximately 71%) [10–12]. As the Ontario high school system is common to the majority of potential applicants to a university engineering program, it was considered important to learn more about the interactions and career-focused learning that goes on there. Students have frequent interactions with their subject teachers, and career exploration is outlined, albeit briefly, in the senior science curriculum documents, and very briefly in the senior mathematics curriculum documents. Additionally, although it varies from school-to-school, there is often a program in place that requires all students to meet with their assigned guidance counsellor at least once during high school. There are a variety of parties and factors that can influence a student’s decision; however, with the near-daily interactions with their teachers, and a program to meet with a guidance counsellor, it is assumed that teachers and guidance counsellors are
equally accessible to the majority of high school students. There are already established venues (e.g. school board initiatives, department heads, in-school mailboxes, school board emails, professional development) to disseminate information to these instructors. The resources external to those in the high school system are out of the scope for this research.

Along with the planning for university program application, the four year structure of the Ontario high school system and its many graduation requirements puts modest pressure on students to make careful and informed selections to ensure a smooth journey through to study at university. Engineering programs are typically known for their many prerequisites and high marks required for admission. With lower public visibility of the engineering profession, it was unclear as to what Ontario high school students and their support system (parents, family, teachers, guidance counsellors, peers) consider as individual traits and characteristics of work that describe engineering, and in turn how students apply this knowledge in their post-secondary decision-making. The complex academic preparation required to embark on engineering education and the elusive skill set required of a professional engineer outline the challenge in ensuring suitably capable and interested students apply to university engineering programs.

There is little literature providing insight into this challenge as a whole. The literature explores knowledge of engineering or decision-making behaviours but rarely on the importance of career knowledge on post-secondary program selection. It was identified that this area required exploration. Research questions were created to respond to these issues with the goals of determining opportunities for improvement as well as to develop more specific questions.

This study was designed to learn from two groups of participants, students and teachers, about how they use resources to learn, and/or to advise on educational and career pathways. Grade 12 students were surveyed to learn about what resources they use and the characteristics that make resources helpful. Grade
12 mathematics, Grade 12 science, and Grade 10 Careers teachers, as well as guidance counsellors were interviewed to learn about the resources they use to prepare for further education/career focused interactions with students. Additionally, their experiences in advising students on engineering-related post-secondary educational and career paths were shared. The setting of this study was the Ontario high school environment common to many potential applicants to a university engineering program.

It is important to learn how teachers and guidance counsellors interact with students in formal and informal career advising scenarios to gain insight into effective practices and common challenges they encounter. There is little published information as to their knowledge base for careers advice. Subject teachers and guidance counsellors are generally accessible to all students in high school, including those who are considering and could be considering engineering.
Chapter 2

Literature Review

In the pathway from high school to post-secondary school to a career, students’ decisions can propagate and have a great effect on their resultant career path. These career decisions are affected by many factors. Children develop and interpret their interests starting with their home life, the media they are exposed to, and in primary school classrooms. As students graduate to elementary school and high school, there are a variety of resources and support available to them within the school environment such as career discussions and advising offered by teachers. With the sheer amount of information and sources, among other reasons, there are many barriers that inhibit effective decision-making.

For complex educational-to-career pathways, such as with engineering, there is perhaps additional knowledge or advising needed to ensure efficient application and entry. Along with the previously mentioned multitude of prerequisites, a university engineering program itself is demanding in many subject areas and develops a broad range of skills. After university graduation, there are many varied opportunities within the engineering profession. It is important to learn about what high school students know about engineering, as a university program and as a profession, as they will be the ones applying to engineering programs. In addition to learning what students know, it is important to learn how students acquire and interpret this knowledge. Along with knowledge, attitudes and perceptions have been shown to affect students’ career decisions. Within the classroom, positive experiences, particularly with science subjects, has been shown to influence positively influence students’ attitudes towards science [8]–[11].

Another source of career decision support in high schools is guidance counsellors. There are many career resources available to high school students, but of particular interest is the support that teachers and guidance counsellors provide in terms of engineering education and career guidance.
By age 13 or 14, it has been shown that adolescents have developed perceptions about occupations [12]. In media programming that is variably accessed and accessible for different reasons, professions such as doctors and lawyers are heavily represented, while engineers are rarely shown [13]. It has been recognized that in optional outreach programs and interventions to increase engineering knowledge, participation could be due to external encouragement, true interest or perhaps participants just wanted a day off school [13]. Largely absent from the reviewed literature is insight into teacher and guidance counsellor advising scenarios with students who present an interest in engineering. The sole study found relating to teacher identification of potential engineering student showed that teachers were highly influenced by students’ academic and socio-economic status as factors to predict student success in engineering [14]. Other studies found that early exposure to engineering fundamentals, and student values and interests were important considerations in career advising scenarios. The literature explored throughout this Chapter supported the need, design and analysis of this study.

2.1 Making Career Decisions

Formalized career planning in Ontario involves a mandatory, half-credit (nine-week) course in Grade 10 for Guidance and Career Education, Career Studies. As described in the Ontario Ministry of Education Curriculum [15], the course focuses on three strands: (1) Personal Management, (2) Exploration of Opportunities, and (3) Preparation for Transitions and Change. The Personal Management strand aims to help students develop the ability to “describe and assess their personal strengths and interests, and to draw on their knowledge of themselves when exploring and deciding on work and life goals”. It is expected that along with this self-awareness, they will learn how to get the resources and support they need. The Exploration of Opportunities strand encourages students to learn how to research and find information about learning, work and community opportunities. The benefits of a broad range of skills and learning about workplace economics, and societal trends are also covered. In Preparation for Transitions and Change, students develop the awareness needed to anticipate and respond to change. It is in this strand
that they develop an ability to make effective decisions, set goals, and evaluate and modify plans [15].

The Ontario Ministry of Education Curriculum document also provides recommendations for teaching approaches, such as providing a wide range of activities to ensure students develop inquiry/research skills and become self-directed learners.

The Ontario Careers class curriculum appears to follow recommendations for career planning by Herr & Johnson [16], [17]. Students are to actively seek alternative choices; learn about their own skills, values and interests; and to discover educational and career opportunities. This career planning prepares students to become an ‘ideal career decision-maker’. Gati et al. [18] described the idea of an ‘ideal career decision-maker’ as someone who is aware that there is a need to make a career decision, is willing to make the decision, and is capable of making the decision based on an appropriate process and that is compatible with the goals and resources of the individual. Any deviance from this model will be an obstacle that may affect the decision-making process by either preventing a decision, or by leading to a less than optimal one.

In the model, three major difficulty categories are outlined, Lack of Readiness, Lack of Information and Inconsistent Information. Lack of Readiness pertains to the attitudes and motivation of students with regard to decision-making. These difficulties would likely arise at the beginning of the decision-making process. The latter two contain difficulties that may arise during the process [18]. The difficulties in Lack of Information and Inconsistent Information are broken down into more specific categories in Table 1.

<table>
<thead>
<tr>
<th>Lack of Information</th>
<th>Inconsistent Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of knowledge about the steps in the</td>
<td>Unreliable information (unreliable, or contradictory)</td>
</tr>
<tr>
<td>process</td>
<td></td>
</tr>
<tr>
<td>Lack of information about the self</td>
<td>Internal conflicts (e.g. contradictory preferences)</td>
</tr>
<tr>
<td>Lack of information about the various</td>
<td></td>
</tr>
<tr>
<td>alternative occupations</td>
<td>External conflicts (e.g. influence of significant others)</td>
</tr>
<tr>
<td>Lack of information about the ways to</td>
<td></td>
</tr>
<tr>
<td>obtain information</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Two difficulty categories of Gati et al.’s model of the ideal career decision-maker [18]
The effects of these specific categories have been further studied [19], [20]. It has been shown that information about the self helps shape students’ career expectations. Students have identified that their interests, personality and values are most influential on their career choices [19]. These factors are significantly affected by the students’ environment. The Dick and Rallis study [20] describes the areas of a student’s life that is affected by the people in their life, “socializers”. Parents, teachers and peers affect how students’ interpret and evaluate their lived experiences [20]. Parents, friends and same-sex teachers, in this order, have been identified as most influential [19]. Specifically with regard to science-based careers, daily interactions with parents, teachers, peers, extended family and counsellors influence students’ belief of the value of science, if the student is capable, and whether the student would be well-suited to engage in science [2]. Additionally, the awareness of role models (“seeing people like me in the specific career”), and the media (“things that I have read in newspapers or magazines or seen on TV about specific careers”) [19] have been shown to influence students’ career expectations. These external factors, home, school, and popular media, have been shown to be significantly influential on students’ career decision-making. The following literature review sections show that these external factors have low knowledge or misconceptions about engineering. As a result, high school students have limited and/or skewed information about science, engineering, and mathematics careers [8].

Additional variables in students’ lives include counselling experiences, science courses and teaching, peer academic attitudes, access to real scientists and their work, and family support. These differences in resources, experience and interactions, challenges and opportunities, as well as expectations, feedback and advice from important figures, framed the students’ perceptions of their abilities, choices, career options, and chance to succeed [8]. In taking into account these individual differences, how students weight their interests and strengths, and the effect of external influences it is important to consider how students develop and value themselves and the role external influences have on students.
2.1.1 Development and Interpretation of Interests

Students have a variety of experiences that shapes their interests and values. The idea that career choice begins early in one’s life and continues to develop over a lifespan was presented by Super [22]–[25]. It has been found that the idea to pursue a science-based career begins at home, and parental influence on student educational aspirations has been well documented [22], [26], [27]. Davis-Kean’s 2005 study [28] supports the predictions in Eccles’ socialization model that parental educational expectations have both direct and indirect effects on their children’s academic achievement. Explicit parental encouragement of their child’s engagement with science, mathematics and technological activities is evident through the selection of toys, availability of technology, endorsed hobbies and informal learning resources (e.g. science centres, zoos, aquariums, etc.). These activities supplement the formal schooling and activities at school, field trips, videos, and projects.

Continuing to high school, positive interactions and science-related experiences at school (either curricular or extracurricular), a strong science mentor or role model, and teachers and counsellors prioritizing science by including hands-on inquiry activities, meaningful projects or encouragement to do or study science have been shown to influence students’ perceptions of science, engineering or math-related careers [8]. Miller and Kimmel [22] showed that students who have a preference for science, technology, engineering, mathematics or medicine (STEMM) careers may opt into a non-STEMM field; however, they showed that very few students who do not intend to pursue STEMM in high school migrate into a STEMM field later in the process. With additional exposure in media and peer experiences, there are a wide variety of experiences students can draw from that shape their impression and value of science in their life.

Strengths and interests have been shown to be an important consideration for students making career decisions [18], [19]. There are a variety of personality and inventory tests available to students online; some are used in the Grade 10 Careers course. A popular interactive career guidance and pathway
planning tool, Career Cruising, is in use in over 20 000 schools, centres and libraries [29]. Personal inventories and assessment results in career matches help students develop self-awareness and provide a starting point for career exploration. Career interests were often traced to positive experiences in activities that they perceived as relevant to the future job, or were encouraged to explore the options by important people in their lives [8].

While academic strengths has been shown to be a common consideration for potential engineering students contemplating what subject area to pursue in post-secondary education and career paths, strong preparation in mathematics and science in high school has been shown to be insufficient for students to fully consider the range of career options in science and technology fields [20]. This identifies that students need more than academic subject preparation to make an informed decision about an engineering career path. While the curriculum documents for the Careers course and senior level mathematics and science courses have recommendations for career exploration, there appears to be a gap: in 2007, a survey of over 9000 Canadian Grade 12 students found that 20% of students did not think that high school provided adequate information to make good choices about their career path [30].

2.1.2 Resources and Support Available to Students

In this information-rich society, getting access to the necessary information is not the greatest challenge career decision-makers face. If high school students, as these decision-makers, do not know how to use the information available, more information will not improve the choice [31]. Volume of information alone may not be sufficient for effective career decision-making, the content and usefulness of the information must be taken into account [16], [31], [32]. In addition to gathering information, students must also evaluate the information that they have, and how it relates or affects them. Part of both the Ontario Guidance curriculum, and the ‘ideal career decision-maker’ model by Gati et. al. describe the importance of ensuring that students have information about, and are capable of logically selecting an alternative educational or career path. However, students have identified that it is frustrating not having
enough help in planning and decision-making related to their post-secondary choices. Difficulty in understanding of how entrance requirements connect with career direction, and the complexity of information and applications were cited as major frustrations [33], [34]. In gathering and evaluating information, the opportunity for encouragement or intervention by informed individuals could help students develop awareness, and encourage students to investigate and consider career paths that they may not have known about, or known enough about, to make a reasonable decision.

These informed individuals could be any number of influential individuals in a student’s life. As discussed earlier, a variety of research has shown differences in who students approach for information on making career decisions [13], [18]–[20]. Commonly listed influences on adolescent career decision-makers are teachers, parents, friends, and guidance counsellors. Hirsch [13] discussed that students listed ‘teachers’ (27%), ‘parents’ (25%), ‘no one’ (23%), and ‘friends’ (21%), in order of frequency, as to whom they speak to about their career decisions. Only 16% of students surveyed indicated they spoke to guidance counsellors [13]. As mentioned before, Dick and Rallis identified those with influences on students’ career choices as ‘socializers’. The relationship between a student and socializer is not one-way; the student develops impressions of careers based on the socializers’ beliefs, and the socializers’ interactions with students are shaped by their impression of the type of student (engagement, ambition, academic performance, work ethic) [20].

A study in 1982 found that teachers were recognized as a greater influence on adolescents career choices, even more than parents or peers [35], [36]. When asked who was most helpful in making decisions on majors or careers, college students in 1991 stated that teachers had a significant influence, and were second only to parents [35], [37]. More recently in 2007, a study showed that 92% of participants remarked that their parents and guardians encouraged post-secondary education. While social and peer influencers are present, other family members and teachers were cited as more influential than friends.
While this shows a trend of influence shifting, teachers are still cited as being a source of information and influence on career decisions. Teachers are frequently in the top three most influential individuals on students’ decision-making behaviour, with particular influence on the belief in the value of science [13], [19], [38]. With regard to the quality and usefulness of the information provided, King found that 40% of his participants found teachers’ information ‘helpful’ or ‘very helpful’, approximately 33% found the information ‘slightly’ or ‘not’ helpful, and 20% of students claimed they received no information from guidance counsellors or teachers [39], [40].

It has been recognized that few students approach their guidance counsellors with specific questions about post-secondary education and that most interactions were about high school grades and courses [33], [41]; however, it was recognized that information from guidance counsellors was generally more helpful than not. In a study with representative sample of 21,385 Ontario Grade 11, 12, and Year 5 students (from the Double Cohort year), King [33], [39], [40], [42] found that when students do get information from guidance counsellors approximately 50% found the information ‘helpful’ or ‘very helpful’. Approximately 25% of students surveyed found the information ‘slightly’ or ‘not’ helpful. Dietsche [33] found that a challenge faced by guidance staff in schools across Ontario was that little time was spent helping individual Grade 10 students with career planning. He proposed that multiple role demands and high number of students assigned to them for advisement may contribute to this challenge.

As student interactions with guidance counsellors tend to be more focused with concerns about high school grades and courses, it is not surprising that parents and teachers are, instead, recognized by students as the most influential individuals in their career decision-making behaviour. Specifically for students who choose engineering and science careers, teachers and parents, respectively, were perceived to have the most influence on career decision more often than for students choosing other careers [20].
The survey findings also showed that students who chose engineering or science-based careers had some specific encouragement to do so [20].

Guidance counsellors tended to perceive parents as most influential on the career planning of Grade 10 students [33]. Parents who are knowledgeable about their adolescents’ career interests seem to be open-minded about where their high school seniors obtain career-related information from. Parents perceived people working in the field of interest and school to be the most favourable and viable career information resources [43]. Educated parents, with updated information on current careers, can be a strong resource for their children [44]. With current knowledge on careers and their understanding of their children, parents are well positioned to discuss post-secondary pathways with their children [44]. Other research has found that while parents may be largely a positive influence, they may not be aware of the broad range of educational and career opportunities available, or they may promote options that would not complement their children’s interests and talents [44]. Without considering their child’s interests or aptitudes, career counselling from parents can cause stress and confusion for students [44].

As noted earlier, some high school students are unsatisfied with the support and knowledge available to them at school. Students identified career counselling, written materials, internet sites and career fairs as only somewhat helpful [45]. Many widely available resources are recognized as only somewhat helpful, but others with more limited availability were perceived to be very helpful [33]. Outside of school, children spend over 80% of their waking hours at home [41], [47]. Though parents have been recognized as influential by high school students, even parents who self-identify as complementing their child’s engineering education at home were often unable to express the difference between engineering and science, or engineering and design. Additionally parents, who themselves were engineers, were able to discuss what they specifically did for a living, but were uncomfortable talking about engineering as a field and distinguishing between engineering, science, and design. These parents who acknowledged they were
helping their children learn about engineering recognized that they do not explicitly talk about engineering, but that they teach fundamentals such as science and mathematics [46].

The media, games and toys are also recognized as an inspiration to study STEM in post-secondary education [48]. Students can use the internet very easily, it provides immediate answers, but requires students to be aware and critical of the information that they find [40]. Additionally, the portrayal of gendered roles in the media has been shown to have an important effect [49]. Media, in the form of printed and video material, begins to affect a child’s understanding of career development and learning based on their personal characteristics [50], [51]. Men are portrayed in occupational roles, both more frequently and in a greater variety of occupations than women are [50], [52].

Students also have the opportunity to access information in a variety of other ways including but not limited to participating in a co-op work experience course, outreach programs, attending career and university fairs, or perusing career and university information through the library or guidance department. The availability and accessibility of these resources affect which students are able to participant an obtain information (e.g. if students are unable to visit a university open house because they are unable to drive themselves, or their parents are unable to drive them due to distance, cost of travel, or cost of taking a day off work).

With potentially insufficient information for career decision-making within high school [30], little or skewed information about SEM careers from school, home or popular media, few or inaccessible related extracurricular opportunities to participate in real science to obtain more accurate information about options, SEM career practicalities are inaccessible to students [8].
2.1.3 Career Advising by Teachers

Career guidance is not a formal responsibility for teachers in Ontario [53]; however, teachers often voluntarily take on this support role in the hopes of helping their students reach their maximum potential [44]. Advising by teachers is often based on their interactions with students, their observations and understanding of students’ abilities and interests [44], and their values and beliefs [54]. For example, teachers often emphasize the importance and relevance of the subjects they teach [44]. Teachers also provide an awareness about various career opportunities [44]. Though teachers believed career counselling was essential, this advising is often informal and unstructured as it was challenging to find the time to do it more formally [44].

Although many studies have found that teachers are influential and valued by students as sources of information and support when learning about their post-secondary options [13], [18]–[20], [30], [35]–[37], remarkably, science teachers do not see themselves as resources for information on science-based or technology-based careers [4]. Science teachers do not feel able to stay current with career information, and this is a low priority as there are others with this formal responsibility [4]. It may not always be the career knowledge that students use in their decision-making, but students are inspired by kind and competent teachers. These qualities often make students wish to follow in their footsteps [40]. While Metheny, McWhirter and O’Neil [49] showed there may not be a direct relationship between adolescent-perceived teacher support and career certainty, their findings suggested that these perceptions are important for adolescents’ self-efficacy in making career decisions, and expectations for career-related choice outcomes. Additional role variation is that in rural areas, where parents are often less educated, there is more reliance on teachers for guidance and career counselling [44]. Though teachers and students perceive teachers’ role in career advising differently, and there are geographical differences, it is well documented that teachers are an important factors in students’ discovery and exploration of post-secondary options.
2.1.4 Barriers to Effective Decision-making

Awareness of alternative career options and the ability to find this information was also noted by Gati et al. as a potential barrier to ‘ideal’ decision-making. Canadian students have identified that they did not know what information was needed to make an informed decision about their educational and occupational futures. Students remarked that it was unclear to them where to go for information and who may be a source for information. Additionally, there are too many places for students to get help. Adding to the information gathering challenge, students were also unclear as to the decisions they needed to make. Other barriers could include discouragement by sources they turn to for information, or inaccurate or inappropriate information [16].

Delaying post-secondary planning has also been recognized as a potential barrier to effective-decision making. When students were asked to reflect on what advice they would provide to younger students, they unanimously identified the need to begin preparing for post-secondary plans earlier [55]. Waiting until Grade 11 or Grade 12 to beginning planning may result in the inability to align high school courses with future educational expectations [55]–[57]. With a lack of adequate preparation for post-secondary study, students need to take additional courses in their post-secondary program that could extend degree completion [58].

2.1.5 Alignment between an Individual and their Work

A satisfied student has been found to be more motivated, and chooses to stay in their situation [59]. On the contrary, mismatch between the student and their situation may result in student dissatisfaction and potential drop-out or transfer to something that fits, or is more suitable, for the student’s values and needs [60]. Work in a career fulfils basic life needs, such as pleasure and the need for contribution [61], [62]. It has been suggested that “the fit between one’s personality and the nature of one’s work” may directly relate to getting pleasure from this work [61]. Antony summarized the work done by Williamson and described that individuals have a unique set of capabilities and traits. As there are requirements for
specific jobs, individuals successful in their job tend to be those who possess the capabilities and traits required [61] (extended references cited in reference [61] can be found in Appendix E). He also described work done by Klein and Weiner in that while individuals with a wide range of traits could be successful in a given job, there are certain traits that are required for success. When personal characteristics and these required traits are closely aligned, success, productivity and satisfaction is more likely [61].

2.2 Student Knowledge of Engineering

This research aims to add to the body of knowledge about what the public knows about engineering. A Master’s thesis from 2011 by Mary Spencer [63] discussed Canadian Grade 7 students’ perceptions of engineering. She found that very few Grade 7 students could accurately describe the profession. Students could identify that math and science were important, but were unable to describe how they related to engineering. A large majority of students did not know what high school courses were prerequisites to enroll in a university engineering program. Additionally, students held varied and mostly inaccurate perceptions of what engineers do. The choice to study the perspectives of Grade 7 students allowed the option for intervention and follow-up. Existing research has identified common student perspectives of engineering. It is widely recognized that there a lack of knowledge what engineers do, the academic preparation required, and many misconceptions [64]. Studies have also found that students do consider pursuing the profession even though they do not know much about it [13], [64].

Misconceptions are held by students early in their education. The misconceptions held are about what engineers do, how engineering work is compensated, and who should pursue engineering. Students in Grades 1 through 5 described engineers as a mechanic who fixes engines, a car/truck driver, a labourer who builds or fixes infrastructure, or a technician who fixes electronics [65]. Continuing into high school, students have identified that their perception of engineering is that it requires no knowledge of business or the environment, is a career incompatible with family life, and the monetary reward for the job is not worth the effort [13]. Common ideas of engineering tend to be negative stereotypes (engineers are nerds)
or exaggerated positive ones (engineers need to be geniuses) [13]. Studies have indicated that a gender bias seemed to still be present as neither males nor females indicated that they thought engineering would be an interesting career for women [64]. In a Canadian study with over 4,000 high school students from the Greater Toronto Area, the top four ideas of engineering held by all participants, although ranked differently by males and females, were that engineering “uses a lot of math”, “uses a lot of machinery”, is associated with a “high salary”, and is an “exciting, creative career” [64]. A study developed at the University of Cincinnati [66] surveyed Grade 6 to 12 students, and found that in the lower grades, students associate engineers with technicians and, as Spencer found in Canada [63], students did not see the connection of mathematics and science to engineering [66]. When asked to describe the study of engineering, the Grade 6 to 12 students used statements such as the following to describe it as “hard”, “too many classes”, and “no room to accommodate other interests” [66]. Additionally, engineering students were described as “smart but nerd”, “introverts”, and as those who “do not have the opportunities to enjoy life” [66]. Middle grade students listed tasks they believed as part of engineering (“drafting, building”), and found mathematics and science difficult. This leads to them to not enroll in these subjects in their senior years. In the upper grades, students described skills needed by an engineer (science, mathematics, design, and computer) [66]. Some wished to pursue the profession, but saw it as impossible to get there [66].

This description is a summary of common ideas presented by students about engineering. Many of the studies referenced cite representative samples of their intended population. There are conflicting ideas presented about engineering. Some descriptions hold true for certain pathways in engineering but seem incorrect for other options. Some ideas would largely be considered incorrect descriptions of professional engineering work. The summary presents a fragmented description of engineering by students with varying degrees of correctness.
With regard to the lack of academic preparation, it has been found that students have been underprepared in science and mathematics [13]. Without an early understanding of how mathematics and science related to engineering [63], [66], and with the belief that these subjects are too challenging to continue pursuing [13], [66], by the time students reach university program selection it is likely that students will not have the academic preparation required for this post-secondary study. However, even if students enter a university engineering program with good grades, poor attitudes or lower impressions of engineering, such as those presented in [66], affected the students’ persistence in pursuing the major [13]. Poor attitudes or low impressions of engineering, or a lack of awareness of the profession is not corrected in the Ontario high school science curriculum.

In the Ontario high school science curriculum, Career Exploration is part of the focus of one of the units in every course [7], [67]. It is mentioned at the end of each course, students will be able to identify and describe a variety of careers related to the field under study, as well as the training required for the careers. The curriculum documents also highlight the need for students to be able to describe the contributions of scientists in that field of study. A few examples of careers are provided. Engineering is either mentioned in passing, or used in reference to bioengineering or genetic engineering. This brevity leaves a lot of freedom in the control of the individual teachers, and as discussed in Section 2.3, if teachers are not adequately educated, prepared or confident, the career exploration may not be covered in depth.

Apart from Spencer [63] and Anderson et al. [64], the other studies discussed were all conducted in the United States. While it is understood that there are many similarities in cultural exposure, lifestyles and values, this still reveals that little is known about Canadian student perceptions and misconceptions of engineering. While there are generally positive attitudes held about engineering in general, the misconceptions describe a potentially unattractive career path. While there are extracurricular and optional programs in place to educate keen students who voluntarily attend, this leaves potentially strong
engineering candidates un- or misinformed. Anderson et al. indicated that many high school students do not participate in outreach programs like the one they studied. This emphasizes the importance of learning about the knowledge of engineering held within elementary and high school classrooms as this would reach more post-secondary bound students [64].

Currently there is a wide variety of extra-curricular programming offered by a variety of sources (e.g. universities) aimed at improving student perceptions of engineering and the engineering profession. Many programs involve both technical and hands-on application of concepts in mathematics and science. Inclusion of applications of the high school mathematics and science helps lend authenticity to high school courses and can show students what it would mean to embark on a career in that subject area [68]. Outreach programs that are aimed to prepare students for engineering at a post-secondary level should be academically rigorous to improve self-efficacy at the higher education level [69].

In addition to creating awareness for engineering work, outreach programs can expose students to different career paths. Outreach programs aimed at high school students have found that programs with the goal of increasing the awareness of engineering should be focused on younger students. Many students around 16 years of age have already made up their mind [70]. Another study found that about half of their participants, students between 16 and 18 years of age, were still impressionable regarding their future career choices; however, the other half of the students had already settled on a career choice and identified they had not been affected by the additional information provided in the program [68]. A vast majority of students participating in an outreach study identified that the most important part of the program was that it gave them an awareness of careers they did not know existed [68]. While the effect of engineering outreach programs has been shown to increase high school students’ self-reported perceptions of their awareness of engineering, there is less certainty whether some of the myths surrounding the
profession had been dispelled [64]. It has yet to have been discovered what knowledge is required for learners to be successful in pursuit of a STEM profession [71].

2.3 Teacher Knowledge of Engineering

The values and beliefs that teachers’ hold influence their instructional behaviour [54], counselling, and course recommendations, as well as students’ interests and aptitudes [44]. Specifically, science teachers are a strong influence on students’ motivation towards science through classroom experience [4]. However as few high school mathematics and science teachers have much contact with engineering or related careers, many have misconceptions about engineering [72], [73]. As it has been shown that teachers’ are influential in their students’ career decision-making [13], [18]–[20], [30], [35]–[37], these misunderstandings could affect students’ impressions and intentions to pursue engineering. Little is known about what or how much post-secondary education or career knowledge is required to be held by teachers so they can be supportive and useful in their advising with students.

In 1970, Carey and Strauss found that years of teaching experience was not significantly related to teachers’ conceptions of science [74]. In a different study in 1970, Carey and Strauss corroborated the findings of their previous study, by showing no relationship between a teacher’s academic background variables and their conception of science [74], [75]. More recently, Yasar et.al [76] learned that years of teaching experience did not have any significant impact on instruction of design, engineering and technology. Teachers with the least amount of teaching experience noted that their pre-service training did prepare them to teach DET. This shows that there are factors other than teaching experience and academic background that affect how a teacher forms their conception of science and engineering. The importance of learning about where teachers form their conceptions and add to their knowledge is showcased by the complex influences that affect teachers’ conceptions on classroom instruction (curriculum constraints, administrative policies, teachers’ attitudes about students and learning) [74].
Thompson [54] stipulated and confirmed that if teachers’ behaviours are a function of their views and preferences about the subject matter and its teaching, then it is important to understand the conceptions held by teachers and how they relate to the teachers’ practice. Without knowing how these conceptions shape teaching behaviours (or where teachers get their information from), it will be difficult to provide guided efforts to improve the quality of instruction in school. The study showed that the teachers’ explicit conceptions of mathematics and their delivery of the instruction strongly suggested that the teachers’ views and beliefs do influence their practice.

Studies on high school teachers’ general knowledge of engineering show that engineering is thought of as an ‘exact’ science. Many teachers do not know what engineers do or about the overlapping skill sets in engineering fields. The design process and problem-solving, both core elements of engineering [77] were generally not identified. The ability to work with others was also an overlooked by teachers [78]. In identifying important skills for entry into a post-secondary engineering program, many teachers with traditional teaching training, put a strong emphasis on purely strong academic performance in mathematics and science courses, without mention of other engineering concepts or complexities [14].

Many stereotypes are held by teachers about skills/characteristics needed to be an engineer [79]. Engineering is perceived as intellectually difficult and a profession that requires a love of mathematics and science [71]. Because of this, teachers do not see engineering as an accessible career path for many of their students [71], [80]. Teachers identify few students who meet their perceived criteria of what is needed to pursue engineering. As a result, engineering education is not seen as valuable to include in the classroom as it will only benefit a few students in their careers. Frequently, the focus in the classroom is to get all students to meet general standards [71].
In addition to engineering being seen as not applicable to all students, another challenge to including engineering in the classroom is teachers’ comfort in instructing the material. It is recognized that educators are most effective when they comprehend a concept and feel comfortable teaching it [81]. However, teachers of elementary and middle school students are often expected to teach subjects outside of their principal area of preparation and training [82]. Elementary and middle school science and technology teachers in particular regularly report a lack of confidence in ability to teach those subjects [82]. Science teachers who were unfamiliar with teaching design, engineering and technology (DET), lacked confidence their ability to teach DET [79]. Teachers are typically uncomfortable teaching content they do not understand well. It has been suggested this is due to the fear of not being able to answer students questions on that content [71].

Additionally, without the appropriate experience or content knowledge, it is difficult for teachers to anticipate difficulties that students may encounter in their learning [71]. Along with challenges in supporting students in learning concepts and content teachers themselves are unfamiliar with, there are additional challenges in incorporating and evaluating engineering problems in the classroom. As answers to engineering problems are open-ended, there is no list of “correct” answers for teachers to use for evaluation. Grading students’ solutions requires evaluation of how well the final design meets its intended function. Teachers must be able to evaluate a student’s solution, the reasoning behind it, and the validation for the design or the explanation for whether or not it functions. Teachers require content knowledge and experience, of which they often do not have, to make this evaluation [71]. Even through challenges in instructing students in unfamiliar and uncomfortable subjects, and evaluating student work, most teachers are were willing to learn more about their subject (in the study referenced, science) to instruct their students more effectively [79].
2.3.1 Professional Development
For teachers already in service, professional development is a well-known option to further development their knowledge in a variety of subject matter. There are many venues to disseminate professional development material. Teachers’ interest in learning more through college courses decreases as the number of years teaching increases, and teachers were most interested in learning about DET through workshops [76]. Workshops have been proved to increase comfort and self-assessed knowledge [65]. Teachers with less experience have identified that they felt their pre-service training prepared them to teach DET, in the future this venue could be important in preparing teachers further to teach DET [76].

As mentioned previously, teachers are frequently untrained in the field of guidance, they guide students based on the students’ needs, interests and abilities [44]. However, outreach activities with the goal of exposing teachers to social, scientific, multifaceted, humanitarian views of engineering has been recommended after seeing the results of a study with student participants [70]. This further information would help teachers support students in learning about these other facets of engineering.

2.4 Role of Guidance Counsellors
Career development is only one of the three areas that falls within the role of a guidance counsellor in Ontario. Students’ well-being and growth in the three areas, personal development, interpersonal development and career development, is part of the mission of a guidance counsellor. Career development involves supporting students in transitions, from elementary to secondary school and from secondary to various post-secondary destinations, as well as in self-assessment, looking for educational and career options, decision-making and pathway planning. Additionally, in their responsibilities, guidance counsellors are to help students develop resilience and realize their potential for success [5].

However, with the evolution of society follows that traditional roles need to evolve as well. When older individuals are asked about how they got to be doing the work they are involved in, they are generally unaware of how influential social forces were on their work destination [83]. In today’s society, children
still generally do not have a clear awareness of their career path or personal identity. The responsibility to teach how to judge a fitting career path falls to parents and school career staff [83]. Specifically guidance counsellors are expected to take some responsibility in teaching or guiding students. With the plethora of information available now, in what is referred to as a ‘knowledge society’ [83], and the influences on students’ career decision-making, the role of guidance tends towards helping students develop the ability to manage information and to be active in responding to these influences [83].

With the many responsibilities expected of guidance counsellors, time for professional development is scarce. To further their knowledge, the methods are less formalized. Guidance counsellors often rely on each other for information, do their own research and share it, or search the internet for more information [84].

2.4.1 Counsellor Knowledge of Engineering

Significantly less research exists on what guidance counsellors know about engineering. Career advisors, a position in the United Kingdom, have been found to rely considerable on their personal networks of friends and family to increase their confidence in discussing science and tech careers and subjects [4]. With the wide variety of responsibilities of a guidance counsellor, there is little time to do research. Advising is target-driven, and since students rarely ask about engineering, it has been identified by career advisors that it is not time-efficient to learn about jobs and careers in that field [4].

2.5 Characteristics of an Engineer

It has been shown that students, teacher and counsellors generally have a low awareness about engineering careers, and the knowledge, skills and aptitudes required of an engineer. Engineering is a multi-faceted profession that, in part, demands a strong foundation of related scientific and mathematical concepts, problem-solving skills, creativity, design abilities and communication skills. In addition to previously discussed capabilities and interests of students, a student’s character is very important; their social, moral and ethical values affect their success, and guidance needs to be given with these in
consideration [44]. With the broad skill set, characteristics and knowledge required in engineering, it may pose a challenge for students to self-identify engineering as a potential career path. Additionally, without a similar awareness of the facets of engineering, teacher and counsellors could find it difficult to guide students and bring awareness to who should consider engineering.

Existing studies have shown that there is no universally agreed upon set of characteristics of engineering students [85], nor has a specific profile of an engineering student emerged [86], [87]. However, current research does show that different researchers have investigated specific characteristics of engineering students as it pertained to their areas of research. Li’s research [85] drew on over 20 years of engineering education research to identify three categories of characteristics:

1. **External characteristics** are defined as engineering-related properties of the community where the student is located. Students are unable to change these characteristics through ‘personal endeavour’. Examples of these include adult influences, institutional environment and average income of engineers.

2. **Internal characteristics** are further broken down into cognitive and affective characteristics. Cognitive characteristics include high school grades (particularly mathematics), learning style, and writing abilities; they will influence the student’s potential academic performance in engineering. Affective characteristics will potentially influence the motivation to succeed, and attitude towards engineering education.

3. **Demographic characteristics** include factors such as age, gender, race, socio-economic status. Sometimes these characteristics fit into the previous two categories.

Another useful indicator of interest in engineering education is early participation in STEM, in both formal and informal learning environments [88]. An indicator of higher self-efficacy in post-secondary engineering is early exposure to pre-collegiate engineering content [69]. Formal STEM participation could be inclusion of engineering fundamentals in primary and secondary school curricula [88].
Participation in pre-engineering and technology classes also leads to higher self-efficacy in post-secondary engineering students. Informal STEM exposure also leads to this higher self-efficacy, particularly through hobbies with the following attributes: self-motivation, use of problem-solving strategies, hands-on application of complex subject matter, use of computer applications, and immediate feedback on success of effort [88].

The sole study found relating to identifying potential engineering students from a high school population was conducted comparing the effects of student academic performance and social background on teachers’ identification of students [14]. As engineering is a complex profession that requires a broad skill set, the use of academic performance and social background is insufficient to identify a student who should consider pursing engineering.

2.5.1 Canadian Engineering Accreditation Board Graduate Attributes

The Canadian Engineering Accreditation Board (CEAB) identifies a list of attributes that graduates of university engineering programs must demonstrate. The CEAB has identified that the qualities expected of a graduating engineer are the academic requirements for an individual to become licensed as a professional engineer in Canada [77]. The graduate attributes of an accredited program are used to measure a student’s acquisition of skills and knowledge. The CEAB graduate attributes, listed without description for brevity, are:

1. A knowledge base for engineering,
2. Problem analysis,
3. Investigation,
4. Design,
5. Use of engineering tools,
6. Individual and team work,
7. Communication skills,
8. Professionalism,
9. Impact of engineering on society and the environment,
10. Ethics and equity,
11. Economics and project management, and
12. Life-long learning.
Teachers generally do not think that engineers need to be skilled written or oral communicators, nor skilled in interpersonal interactions. Engineers are viewed as individuals that are proficient in mathematics and sciences, like to fix things and as individuals who earn good money [76]. This is a very narrow set of skills that is missing many of the facets mentioned in Section 2.5, and few graduate attributes are mentioned. It is not expected that students enter an engineering program with these attributes; however, the attributes are a description of who has the potential to eventually become a professional engineer.

While knowledge of the CEAB graduate attributes may be an overly optimistic request of high school teachers and guidance counsellors, there is little research about what these individuals need to know to be able to best support students. A model has been suggested to explain the idea of how to describe “know a profession”. Twenty-four attributes were identified that described a profession, including difficult entry requirements, excellent communication skills, personal liability for malpractice, glamorous position and interesting work [89]. Perhaps the model in its entirety is too much detail for teachers to know about every possible profession, including engineering; however, it enforces the importance of ensuring facets other than strength in a subject are visible to those needing to select a career pathway.
Chapter 3

Research Design

3.1 Objectives and Questions

The purpose of this study was to investigate how support resources in high schools assist students in their discovery of engineering as a potential career path. The two overarching research questions study were:

1) How do students use the resources available to them to learn about careers and the required educational training for these careers?

2) How do teachers and counsellors apply their knowledge of engineering when advising students on engineering programs and career paths?

To respond to the second research question, a sub-question was developed. In learning how teachers and guidance counsellors apply their knowledge of engineering, it was important to pose the question: “what knowledge of the engineering profession do these individuals currently hold?”. These questions were developed by reviewing existing literature and recording the questions that arose.

The study utilized data from two sources (a) Grade 12 university-bound students and (b) Grade 12 mathematics teachers, Grade 12 science teachers, Grade 10 Careers teachers and guidance counsellors. The Grade 12 students were surveyed to learn what resources they rely on to discover university majors and career paths. The science, mathematics, career teachers and guidance counsellors were interviewed to gain insight on the skills and aptitudes they recognize are valuable in an engineer, and how they guide students in learning about engineering. The research also investigated the knowledge of engineering held by those who support high school students in making educational and occupational decisions. The focus of the study was on support accessible within the high school system since the majority of students applying for a university program have equal access to this support. The media, parental and societal perceptions were beyond the scope of this research.
3.2 Methodology

Qualitative research aims to capture the voice of the participants. This study possesses many of the common characteristics of qualitative research identified by Creswell [90]. Data collection was conducted in a natural setting for the participants. They were invited to select a quiet location for the interview; most selected a classroom they instruct in or their empty office. Through designing the open-ended interview questions, conducting the interviews, and analyzing the data, the researcher was the key instrument in the study [90]. The questions focused on exploring the meaning the participants gave to their experiences. The purpose and essence of the questions were held firm as per General Research Ethics Board (GREB) requirements.

A phenomenological approach was used as a basis for this study’s research design. This qualitative approach investigates an individual’s or a group’s perception of reality as they understand it. The phenomenon in this study is how science, mathematics and career teachers, as well as guidance counsellors, guide and inform students about engineering education and careers in engineering. This approach provided guidance in designing the study to gather insight into how the individuals learn about engineering, and how they identify students who could become engineers.

Creswell discusses the importance of understanding several individuals’ experiences with the phenomenon. As recommended, 10 participants were interviewed on their experiences with advising students about post-secondary educational and career decisions [90], [91]. Patton recommends capturing this experience and focusing on how individuals who have lived this experience firsthand perceive, describe, remember and make sense of it [92].
The open-ended survey questions and the semi-structured interview protocol were designed to guide participants through the data collection while giving them the opportunity to respond to the questions freely and add detail as they saw fit. Particularly with the semi-structured interview, it allowed for the researcher to pose follow-up questions to attempt to add clarity and focus to some participants’ answers. Through both data collection methods, participants were able to include additional information that may prove to be useful, but would not have otherwise been gathered as no question directly inquired about it. It is important to consider all pieces of information (‘codes’), regardless of the number of mentions or number of participants who provided the comment. While participants may state something not in direct response to a question, the value of qualitative research is that the idea would not have been shared in a closed-ended environment. Though an idea may be stated infrequently, or by few participants, if a question were posed directly regarding it, the comment may have come up and perhaps in further detail.

As described by Creswell [90], by using a phenomenological approach and interviews, best advising practices can be investigated, insight into the knowledge held can be gained, and gaps and misconceptions can be identified. The analysis of this data will help support recommendations for practices and policy to strengthen the career advising within high school.

### 3.3 Position of Researcher in Qualitative Research

In qualitative research, the data and resulting analysis is conducted by the researcher. The observations, patterns identified and recommendations were developed through the researcher’s interpretation of the data and analysis. It is important to acknowledge the researcher’s background and experiences shaped the lens through which the interpretation occurred. Limitations on the study as a result of the influence of the researcher are discussed further in Section 5.6.5.

#### 3.3.1 Autobiographical Statement

My interest in improving undergraduate engineering education was realized abruptly in the final year of my undergraduate program while applying for a teaching assistant position. Throughout my
undergraduate program in mechanical engineering, I volunteered at recruitment events and emphatically described how much I enjoyed studying engineering, and explained to high school students what engineering was. The amount of passion I had for engineering was inspiring, even to me, considering that five years prior, I had a very limited understanding of what it was.

When considering post-secondary options, I assumed that my next step was university. Throughout high school, my grades were just above average in all subjects, and I had no strong inclinations towards any field of post-secondary study. As a result, in every grade at course selection time, my mother recommended that I keep my post-secondary options open by not eliminating any courses that would be prerequisites to a post-secondary study. In Grade 12, I was enrolled in three science courses, two mathematics courses, Enriched English, Writer’s Craft and music. With the assumption I was going to university, my mother and I visited a variety of university campuses during their respective Fall Preview Open Houses.

Once I stepped foot on the Queen’s University campus, I knew I wanted to attend for my undergraduate degree. My next step was to decide what I would study at Queen’s. My mother went through the program offerings at Queen’s alphabetically, and we highlighted engineering as an option. I was only truly aware of the option because a few close friends were applying to engineering programs. In considering whether I wanted to commit four years to studying engineering, the factors I considered were: my interest – not strength – in mathematics and science, my enjoyment of Ontario Science Centre visits, and my curiosity in learning how things worked. To the 18-year-old me, this was engineering.

I was hesitant in selecting engineering and had a limited understanding of engineering career opportunities, but knew. However, I had been told that job prospects after graduation were promising and had little interest in pursuing the further education I thought was required to embark on a career path after
other Bachelor degrees. My first lecture of my undergraduate career was Chemistry at 8:30am with Professor Bill Newstead. He started by welcoming my class and acknowledging our decision to study engineering. He spoke of engineering as logical and creative problem-solving for the betterment of society; I became certain that it was exactly what I wanted to study. As I learned more about engineering throughout my undergraduate career, I knew that studying it would lead me on satisfactory career pathway.

Ever since this realization, I was eager to volunteer at all Faculty of Engineering and Applied Science recruitment events. These volunteer experiences gave me an opportunity to inform prospective students about engineering, in the hope that they will be able to make an educated decision in choosing their undergraduate program. In the fifth year of my Bachelor’s degree, I returned to school from a 16-month long internship and I embarked on my final year with a fresh perspective on my engineering education. I shifted my priorities from taking everything I was learning at face value to reflecting on what I was learning and how I might apply it in the professional workplace. In reflecting on all of the undergraduate courses I took, as well as my professional experience while on internship, I have come to realize the multitude of qualities expected of an engineer.

Engineers need to be highly capable professionals with thorough technical knowledge, the ability to analyze a problem, the creativity to develop innovative solutions, as well as the communication skills to express and justify their solution. Engineering education poses a great challenge: to teach students theory, processes, tools and skills during a four or five year undergraduate degree program so students can excel and contribute in the workforce.

In recognizing these challenges, it has inspired me to be a part of the improving the dynamic process of educating students to become professional engineers. Due to the breadth and depth required of engineers
in the workplace, as well as civic responsibilities bestowed upon them, it is critical to ensure that engineering education is high-quality, relevant and thorough. By studying the current practices, and combining it with industry expectations, engineering education researchers will be able to understand how prepared engineering graduates are for their transition to the professional workplace.

3.4 Ethical Considerations

As the goal of the research was to survey and interview participants, clearances and approvals were required from Queen’s University and external School Boards. This documentation is included in Appendix A. GREB clearance from Queen’s University (Appendix A.1) was obtained, and The Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans Course on Research Ethics (TCPS 2: CORE) (Appendix A.3) was completed. External research approval from the Ontario School Boards was also obtained (Appendix A.4 and A.5). Modification of one question required an amendment, and was cleared. This is also included in Appendix A.2. Contact with the schools varied depending on the policies for external research of the school board. Appendix B contains the information letters (Appendix B.1) provided for the principal and the Grade 12 teachers (Appendix B.2) who helped coordinate the research. Letters of Information and Consent were provided to all participants, and are included in Appendix B.3 and B.4, for the teachers and guidance counsellors, and students respectively.

To maintain the confidentiality of the participants, survey respondents were assigned a random numeric identifier, and all interview participants were assigned pseudonyms.

3.5 Participant Selection

The focus of the research was on the secondary school system in Ontario. Focus on one province was chosen as the curriculum documents would be consistent for the participating schools. The selection of participants from multiple school boards allowed for wider selection of participants to increase the transferability of the findings. One of the goals of the study was to recruit participation from a range of
school environments in the public school sector. Of particular interest was to investigate if a high school’s close proximity to post-secondary intuitions affected what the high school students knew about their post-secondary options. Close proximity to a post-secondary institution may have the influence of post-secondary run programs/outreach opportunities and additional media exposure of university activities.

The intended participant population was to have been approximately four school boards. Applications were sent to seven school boards representing multiple locations in Southern Ontario from east to west and some in Central Ontario. Based on the time and resource limitations of the study, no Northern Ontario school boards were contacted. Approval was obtained from four school boards across Southern Ontario, however, correspondence confirming participation was only achieved with two boards. In one case, a conditional approval was granted upon the researcher providing further information. No response was obtained after the information was sent. The administration of the other school board allowed direct contact between the researcher and the school principals; however, responses to initial phone calls and one follow-up went unanswered.

With the school board approvals, a map was created with the locations of post-secondary institutions and the high schools. Multiple schools with and without close proximity to a post-secondary institution were contacted; specific numbers of school contacted varied based on initial success. For example, six schools were contacted from the first school board that responded. Correspondence was immediately successful with an urban and a suburban school; correspondence between a suburban and rural school was initialized but eventually phone calls and emails were not responded to. Based on the specific school boards requirements for external research, correspondence with their schools entailed one initial email from the board to all schools. With no responses, accommodation was provided allowing the researcher to phone each school once with no follow-ups. Phone calls to 17 principals were made, 15 went unanswered, one
replied negatively and one agreed. Based on the timeline required of the study, it was considered to be unrealistic to attempt further correspondence.

Three schools in two school boards, one in Eastern Ontario and one in Southwestern Ontario, participated in the study. School A and C are located in a suburban environment. School B is located within a city.

The demographics and Education Quality and Accountability Office (EQAO) scores for mathematics testing and literacy testing is summarized in Table 2.

<table>
<thead>
<tr>
<th>School</th>
<th>Number of Grade 9 Students (2013-2014)</th>
<th>Percentage of Grade 9 Students at or above provincial standard in Mathematics (2011-2013)</th>
<th>Number of First-time Eligible Students (March 2014)</th>
<th>Percentage of Fully Participated Students who were successful in the OSSLT¹ (2011-2013)</th>
<th>School Population (in 2013)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>32 Applied 75 Academic</td>
<td>65% Applied 83% Academic</td>
<td>112</td>
<td>78%</td>
<td>737</td>
</tr>
<tr>
<td>B</td>
<td>12 Applied 139 Academic</td>
<td>66% Applied 84% Academic</td>
<td>199</td>
<td>93%</td>
<td>851</td>
</tr>
<tr>
<td>C</td>
<td>51 Applied 114 Academic</td>
<td>45% Applied 89% Academic</td>
<td>212</td>
<td>78%</td>
<td>908</td>
</tr>
</tbody>
</table>

Schools A and B are in the same city as three post-secondary institutions. School C is in a city without a post-secondary institution although the city does have two satellite college campuses.

A point of contact at each school assisted in coordinating information sessions for the teachers prior to the launch of the study. The point of contact was given the criteria for participants in the study and forwarded all email messages to these individuals.

¹ EQAO Ontario Secondary School Literacy Test
3.5.1 Identifying Student Participants
Based on the GREB requirements for consent in data collection, and the likelihood of Grade 12 students being minors (under 18 years old), distribution methods were carefully designed. The survey timeline was organized to allow for the consent forms to be signed by their parents/guardians and returned. All Grade 12 students from the three schools were invited to participate in the survey. Through the liaison for external research at each school, first period Grade 12 teachers were contacted and given a prepared package containing one letter of information for the teacher, letters of information and consent and the survey for the students.

3.5.2 Identifying Teacher and Guidance Counsellor Participants
An information letter was distributed by email through the principal or external research liaison at each school. As a follow-up, an information session at lunch was held in each of the three schools. Grade 12 mathematics, Grade 12 science, and Grade 10 Careers teachers as well as guidance counsellors were invited. Discussion was purely around what the research goals were and was carefully non-persuasive. All teachers present expressed an interest in participating, signed a consent form, and filled out a paper copy of the survey. The survey is included in Appendix C.1. The survey was designed to assist in participant selection based on educational and occupational background.

From the surveyed individuals, maximum variation sampling was utilized to inform interview participant selection so the interviews would gather data from a variety of cases. This technique gives a selection of cases to “get variation on dimensions of interest” [92]. The dimensions of interest were educational and occupational background. For each of educational background and occupational background, two extreme cases are identified in Figure 1. The eight permutations of cases shown in Figure 1 in the right-hand column were goals for the interviews.
Figure 1: Participant selection criteria for individual interviews

This sampling technique allows for diverse variations in the cases to emerge from each participants’ experience adapting to different conditions based on their training and work experience [92].

It was noted earlier that Careers teachers were of interest to be interviewed, however due to school variation on Careers class teaching assignments, these cases were considered to complement the eight science, mathematics teachers, and guidance counsellors. Teachers appointed to teach the Grade 10 Careers course vary from guidance counsellors to teachers who need additional classes to maintain a particular employment status. Due to this variation, the Career teacher cases were considered in addition to the eight interviews with teachers and counsellors. The varied background of Careers teachers presented an interesting opportunity for participants without mathematics, science or engineering backgrounds to participate increasing the variety of perspectives presented in the study.
3.6 Designing the Measurement Instruments

The measurement instruments were designed to elicit information to help respond to the research questions. To collect data from every Grade 12 student in the participating schools, a survey was selected as a data collection instrument as the goal was to collect responses from a large sample size. The teacher and guidance counsellor were surveyed to collect information about their educational and occupational background in a simple and comparable format to facilitate participant selection. The questions in the Grade 12 Student survey and in the teacher interview were designed to elicit answers that would help respond to the two research questions developed from gaps in the literature reviewed. The participant selection survey questions were designed to collect information that would help with selecting participants using a purposeful sampling technique, maximum variation sampling, that is discussed further in Section 3.5.2.

Both surveys were intended to be conducted online using a survey tool, FluidSurveys\(^2\), for easier data collation. However due to the increased correspondence required in distributing the survey link to students requiring parental/guardian consent to participate, paper surveys were used for data collection for both participant groups. Paper surveys allowed teachers to fill it out during or immediately after the information session. For both participant groups, paper surveys increased the presence of the research and showcased how concise the survey was.

An interview protocol was designed to encourage participants to talk about their experiences interacting with students in career exploration or advising scenarios. A semi-structured interview protocol was used to allow for opportunities for follow-up and clarification of participants’ statements. Techniques detailed in Section 3.6.2 detail strategies used to elicit rich-description. The systematic data collection procedures

\(^2\) FluidSurveys is an online survey system used by Queen’s University with a variety of instrument designs, and deployment via web link, personal emails and social media [105].
for both the surveys and interviews aim to produce high-quality data that is trustworthy, authentic, and fair to participants [92].

3.6.1 Survey for Student Participants
The student survey collected data from Grade 12 students about the (a) the resources available to them, (b) resources are used, (c) resources that are deemed to be helpful, and (d) the ways in which the resources are useful. A multi-choice question was used to invite students to identify the resources they used to learn about post-secondary opportunities. A list of resources was generated for students to select from based on the resources the researcher had used to prepare for selection of a post-secondary major, and supplemented by additional studies [45], [94]. An ‘other’ option was made available to not restrict the thinking of the participants. A short-answer question invited students to describe what made a resource helpful. Students were given a few lines of blank space in which to write their answer. The final question asked students to briefly identify the post-secondary pathway they had chosen (e.g. post-secondary program, job, etc.). The survey is included in Appendix C.2.

3.6.2 Survey and Interview for Teacher and Guidance Counsellor Participants
A survey was designed to gather data about educational and occupational background of Grade 12 mathematics teachers, Grade 12 science teachers, Grade 10 Careers teachers, and guidance counsellors. The educational and occupational background information was collected using multi-choice and short answer questions. There was also a multi-choice question asking participants to describe the nature of their career advising interactions with students. The survey was designed to assist in the selection of eight interviewees who represent a wide cross-section of the teaching/counselling supports with a variety of rich experiences.

The interview questions were carefully designed to elicit rich information to explore the phenomenon. To avoid calling participants’ practice into question, situation questions were used to create a personal context for the participant, having the participant visualize the situation encouraged detailed descriptions.
from the respondent [92]. The participants were encouraged to talk about their experiences without feeling judged on the accuracy of their information about engineering. The interviewees were asked to describe their knowledge of engineering, and how they support their students in learning about and making decisions about a future in engineering. The interview protocol can be found in Appendix C.3.

In addition to the questions that were designed to help answer the research questions, and consistent with the nature of a semi-structured interview, probes and follow-ups were used to increase the richness of a participant’s response. A conversational tone was used throughout the interview, and especially in the probes and follow-ups, to investigate deeper into the participants’ lived experiences [92].

3.7 Data Collection
Data collection strategies for surveying the Grade 12 students, and surveying and interviewing the teachers and guidance counsellors are detailed in the following sections.

3.7.1 Surveying Grade 12 Students
Grade 12 first period/home form teachers assisted in the distribution of the letters of information, letters of consent, and a paper copy of the survey. A script was provided to teachers to assist them in introducing the study. The researcher also offered to visit the classroom to introduce the study. Teachers were asked to remind the students to bring back the surveys once, between distribution and the planned collection date. Teachers collected returned letters of consent and the survey. In total, 39 surveys were accompanied with completed consent forms, and were included in the study.

Two teachers at School A responded to the researcher’s offer to introduce the study, one teacher provided an observation that many students were uninterested in participating and did not think a visit would help. The second teacher invited the researcher to speak briefly to the class. No teachers at School B responded to the researcher’s offer. With the help of the principal at School C, the researcher was invited into every
class to introduce, distribute and collect the surveys. Only classes with teachers that invited the researcher to speak to the students returned surveys. The approximate response rates for each school can be seen in Table 3. Total first period Grade 12 class size numbers obtained from the points of contacts were identified as estimates as it was pointed out that there were Grade 11 students who were enrolled in these classes.

Table 3: The Grade 12 survey response rates

<table>
<thead>
<tr>
<th>School</th>
<th>Response Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>School A</td>
<td>5%</td>
</tr>
<tr>
<td>School B</td>
<td>0%</td>
</tr>
<tr>
<td>School C</td>
<td>13%</td>
</tr>
<tr>
<td>Total</td>
<td>7%</td>
</tr>
</tbody>
</table>

The survey timeline was designed to capture data from students as they were applying, and soon after they applied to universities in mid-January. This timeline was to ensure that the students’ experiences were recent as this would help result in rich descriptions in the responses.

3.7.2 Surveying and Interviewing Teachers and Guidance Counsellors

The last question of the survey asked the participant if they would be interested in being contacted further for a 30-45 minute interview. Seventeen teachers or guidance counsellors filled out the survey, all but one volunteered to participate in a follow-up interview. Due to the small initial population size, and the surprising variety in backgrounds, all participants were invited to a follow-up interview. Some teachers did not respond to the invitation. Successful correspondence resulted in 10 interviews being conducted.

Participants who agreed to an individual interview were invited to select a quiet location; many selected their office or a classroom. The individual interviews were conducted in-person at these locations. The interviews were conducted at the leisure of the participants (between December 2014 and May 2015). All participants agreed to allow the interview to be digitally recorded. The recordings ensured the data was captured completely and assisted in maintaining a natural flow of conversation. The interview protocol used included a standardized introduction (varied nominally based on the profession) followed
by five carefully constructed open-ended questions. The protocol increased the dependability of the research such that the investigation could be continued with additional participants to add to the results presented. The sequence and flow of the interview content were standard across all 10 interviews. The goal of each interview was to gather data on how teachers and guidance counsellors perceive engineering: (a) what engineering is, (b) what engineers do, (c) what resources they refer to for more information, and (d) what skills and aptitudes they believe describe a student who could become an engineer. As detailed in the protocol, the order and phrasing of the questions were maintained for each interview; however, probing and follow-up questions were carefully posed to increase the depth of the responses [92].
Chapter 4

Research Analysis

A qualitative approach was used to collect and analyze data. This approach allowed rich, thick descriptions of the participants’ experiences to be captured. Thick description, as introduced by Geertz [95], requires the researcher to record the experiences, as well as the interpretations and contexts such that the experiences and behaviours are meaningful to the outsider. Initial impressions and points of note were recorded immediately after the interviews. The interviews were transcribed by the researcher within three days of the interview and additional annotations were recorded as the transcription was completed.

The variation in the sample obtained through maximum variation sampling helped identify both common practices and differences in career advising and familiarity with engineering [92]. The variety in school selection for the study, and the broad range of backgrounds of the interviewees imply that the common practices could be highly transferable to other situations. The differences will help explore unique cases and were of interest. Differences between cases could also identify where there are misconceptions or confusions about engineering programs and career paths.

4.1 Data Preparation

As paper surveys were used in data collection, the data was entered into FluidSurveys to easily collate the data. FluidSurveys allowed the data to be exported to an MS Excel compatible file format for analysis. The verbatim interview transcriptions were completed in MS Word and imported into NVIVO™ [96] data analysis software for analysis.

4.2 Approach to Analysis

The analysis was conducted to capture the meaning the participants associate with their lived experiences. Through the careful development of the data collection questions, the meaning emerging from the
analysis answered the two research questions. The systematic collection and analysis procedures described were implemented to increase the trustworthiness of the research [92].

The multi-choice data from the student survey was organized to display the responses provided by participants. This data complemented the written responses provided to the second question. The completed interpretation of this analysis answered one of the research questions. Familiarity with the qualitative student survey data was developed through reading the responses multiple times prior to coding. Open-coding was then used to capture the participants’ descriptions accurately. The ideas presented were broken down into units and meaning was captured in the code assigned to the unit. Predetermined codes were not used. After initial codes were identified, the list of codes was reviewed multiple times to focus the codes into a more concise list of categories. Once the qualitative data was coded and categorized, themes were identified thorough interpretation of the relationships between the categories.

Interview transcripts were read through twice before coding. Similarly to the qualitative analysis of the survey data, open-coding was used for the interview data. To start, the data was coded by question because specific experiences were explored in each question. In addition to the open-coding, commonalities in perceived role (Question 2), resources used (Question 3), engineering discussion topics (Question 4) and traits of an engineer (Question 5) were recorded as annotations in the first coding pass of the data. Through this coding by question, it was realized that some responses in fact lent insight into another question. As a result, the second coding pass was a holistic analysis.

4.3 Student Survey Data
Thirty-nine students returned a complete consent form and survey. No surveys were returned from School B. Seven surveys were returned from one class in School A. Each class in School C had at least one participant, with 32 surveys in total returned. The results are described below.
4.3.1 Question 1

Question 1 invited students to identify all resources they used, and in most instances they were asked to provide some detail about the resource (e.g.: how they made the connection to talk to the professional in the field). The detail requested for each resource is summarized in Table 4.

Table 4: The additional information requested of students

<table>
<thead>
<tr>
<th>Resource</th>
<th>Additional Information Requested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internet searches</td>
<td>Example(s) of websites</td>
</tr>
<tr>
<td>Career planning resource (e.g.: CareerCruising)</td>
<td>Name of resource</td>
</tr>
<tr>
<td>Teachers</td>
<td>Subject taught</td>
</tr>
<tr>
<td>Guidance Counsellor</td>
<td>Was it a self-booked or recommended appointment?</td>
</tr>
<tr>
<td>University Open House</td>
<td>none</td>
</tr>
<tr>
<td>University Fair (e.g.: Ontario Universities’ Fair)</td>
<td>none</td>
</tr>
<tr>
<td>Family</td>
<td>none</td>
</tr>
<tr>
<td>Students currently enrolled in program</td>
<td>none</td>
</tr>
<tr>
<td>Professional in the field</td>
<td>How did you set up this?</td>
</tr>
<tr>
<td>Other</td>
<td>[text line]</td>
</tr>
</tbody>
</table>

As the survey was completed on paper, as opposed to online, there was no way of ensuring students added written details. Figure 2 shows that most students wrote additional information about the resource they used. The questions that requested no additional detail from students are shown as hatched bars in the figure.
Figure 2: Profile of the responses to Question 1

As this question invited students to select as many options as they wished, this question also revealed that most students used more than one resource. Figure 3 shows that the majority of students used three resources when learning about their post-secondary options.

Figure 3: Number of resources used by students
The majority of students, 84.6%, used the Internet as a source of information. Many students indicated that they attended a University Open House. Approximately half of the participants reported that they spoke to a guidance counsellor or their family. Table 5 summarizes the percentage of participants that indicated that they used specific resources.

Table 5: Percentage of reported uses

<table>
<thead>
<tr>
<th>Resource</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internet Searches</td>
<td>84.6%</td>
</tr>
<tr>
<td>University Open House</td>
<td>61.5%</td>
</tr>
<tr>
<td>Guidance Counsellor</td>
<td>58.8%</td>
</tr>
<tr>
<td>Family</td>
<td>51.3%</td>
</tr>
<tr>
<td>Teachers</td>
<td>38.5%</td>
</tr>
<tr>
<td>Students Currently Enrolled in Program</td>
<td>30.8%</td>
</tr>
<tr>
<td>Professional in the Field</td>
<td>30.8%</td>
</tr>
<tr>
<td>Career Planning Resources</td>
<td>28.2%</td>
</tr>
<tr>
<td>University Fair</td>
<td>10.3%</td>
</tr>
<tr>
<td>Other</td>
<td>7.7%</td>
</tr>
</tbody>
</table>

For the options that requested students provide additional detail, the breakdown of the resources used is described below.

4.3.1.1 Internet Searches

The categories on the x-axis in Figure 4, Figure 5, and Figure 6 were taken verbatim from the student surveys; URLs were left as URLs, however capitalization was fixed to reflect brand names. Additional clarification for the acronyms used by participants: OUAC is the Ontario Universities’ Application Centre [97] and eINFO is a guide “a guide to Ontario universities for Ontario high school students and guidance counsellors. It provides information about university programs, admission requirements and more” [98]. Most frequently used internet resources were found to be the websites of specific schools, and eINFO. Figure 4 shows the descriptions students provided about the internet resources they used.
Figure 4: The types of Internet resources students reported using

4.3.1.2 Career Resource Tools

Eleven students reported using Career Resource Tools. Fewer overall students indicated that they used specific tools, rather websites were identified. The types of resources they used are shown in Figure 5.

Figure 5: The types of Career Resource Tools students reported using
A few of the detailed responses shown in Figure 5 were unclear as to what they were referring to:

- “Ontario colleges” could mean the Ontario Colleges website, or actually visiting Ontario Colleges,
- “Careerplanning” could refer to an about.com page, http://careerplanning.about.com/, and
- “Practical Nursing” could refer to searches about this program, as opposed to a specific website/tool used.

It can be noted that many of the Career Resources used are internet resources, for example myblueprint.ca has been identified as both an internet resource and as a career planning tool. In these two options, Internet and Career Resource Tools, students identified resources that were artefacts (as opposed to personnel) that they consulted in their exploration. Table 6 outlines the distinction between artefact and personnel and recognizes that some resources could involve some overlap.

**Table 6: Description of categories of artefacts**

<table>
<thead>
<tr>
<th>Resource</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internet searches</td>
<td>Artefact</td>
</tr>
<tr>
<td>Career planning resource (e.g.: CareerCruising)</td>
<td>Artefact</td>
</tr>
<tr>
<td>Teachers</td>
<td>Personnel</td>
</tr>
<tr>
<td>Guidance Counsellor</td>
<td>Personnel</td>
</tr>
<tr>
<td>University Open House</td>
<td>Personnel</td>
</tr>
<tr>
<td>University Fair (e.g.: Ontario Universities’ Fair)</td>
<td>Artefact/Personnel</td>
</tr>
<tr>
<td>Family</td>
<td>Personnel</td>
</tr>
<tr>
<td>Students currently enrolled in program</td>
<td>Personnel</td>
</tr>
<tr>
<td>Professional in the field</td>
<td>Personnel</td>
</tr>
<tr>
<td>Other</td>
<td>Artefact/Personnel</td>
</tr>
</tbody>
</table>

The main distinction with relation to this analysis is that artefacts and personnel vary in their interactive quality. Interacting with personnel allows for questions and immediate answers, and for some, students have developed a rapport with the individual which leads to personalized responses.
Combining the artefact resources shown in Figure 4 and Figure 5, Figure 6 summarizes the use of artefacts identified by students.

![Graph showing number of reported uses for various resources.]

**Figure 6: Aggregation of the Internet and Career Resource Tool resources**

Specific school websites and the website eINFO were the two most frequently reported as used.

4.3.1.3 Teachers

Over a third of the students surveyed identified that they referred to teachers in their exploration of post-secondary opportunities. The subjects taught by the teachers they identified are shown in Table 7.

**Table 7: Subjects taught by teachers utilized as resources**

<table>
<thead>
<tr>
<th>Subject</th>
<th>Reported Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kinesiology</td>
<td>4</td>
</tr>
<tr>
<td>[unspecified]</td>
<td>2</td>
</tr>
<tr>
<td>Co-op</td>
<td>2</td>
</tr>
<tr>
<td>Career Studies, Grade 10 Civic/Careers</td>
<td>2</td>
</tr>
<tr>
<td>Gym</td>
<td>1</td>
</tr>
<tr>
<td>Music</td>
<td>1</td>
</tr>
<tr>
<td>Bio, Chem</td>
<td>1</td>
</tr>
<tr>
<td>Guidances</td>
<td>1</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>1</td>
</tr>
</tbody>
</table>
Careers teachers were identified as a resource by two students; this supports the reasoning behind interviewing Grade 10 Careers teachers. Additionally, as shown in Table 16, one of these students plans on pursuing engineering.

Students were not asked to indicate if they asked their teacher subject-specific information. Only one student identified that a teacher was the most helpful resource; however, the subject taught by the teacher was not identified.

4.3.1.4 Guidance Counsellors

Of the 20 students who identified that they visited a guidance counsellor, most reported that they made the appointment themselves as opposed to having a meeting recommended to them. The detailed responses students gave are shown in Figure 7.

![Figure 7: Type of guidance counsellor visit](image)

Figure 7: Type of guidance counsellor visit
4.3.1.5 Professional in the Field

While 12 students recorded that they interacted with a professional in the field they were interested in, three of these students reported that they interacted with multiple individuals. The detail requested of the participants were how they set-up this interaction. The percentages shown in Figure 8 were calculated using the 15 instances of interactions with professionals (as opposed to the 12 individuals who interacted with professionals).

Figure 8: How students set-up interactions with Professionals in the Field

The Services category included chiropractor, radio station manager and electricians. School events described field trips and professionals’ visits to the school.

4.3.2 Question 2

Students were asked to identify the resource they found most useful and to describe why. Of the 39 responses to the survey, 34 participants responded to the question and provided details. Five students simply identified the resource or resources they found most helpful without any additional information.
As shown largest in Figure 9, the most frequently identified useful resource was University Open House.

![Word cloud showing the most frequently mentioned useful resource as largest in font size](image)

**Figure 9: Word cloud showing the most frequently mentioned useful resource as largest in font size**

The frequency of which students identified these resources as most helpful is shown in Appendix D, Table 19. The next most identified resources were Internet Searches, following that were University/College Websites, myblueprint.ca, University Representatives, Current Post-secondary Students and Family. Father was specifically identified twice, and was kept separate from Family in analysis.

The four common themes that arose in the student descriptions of why these resources were most helpful were Information, Quality of Information, Interaction, and Extras. The resources mentioned most frequently, unsurprisingly, have more description about what makes them so useful.

University Open Houses were described as helpful in all four themes. Six students found the content of the Information and the quality of information very helpful. Student 20 described these open houses and the booths at them as “very helpful because you get information straight from university student and they give information (booklets, pamphlets, etc.) to further your research on the programs you are looking into.” Students found that Open Houses gave them the needed variety of information about the university and the programs, as well as made all of the programs visible. Many students valued the ability to interact with current students and other “knowledgeable representatives” at a “well laid out” event. The Extras available to students at the Open House is that they get the opportunity to visit the campus, and get
guidance and resources for further research. Students who have identified programs of interest prior to visiting the Open House, such as Student 16, identified that they were able to get “a lot of information from talking to students enrolled in the program [they are] interested in.”

Internet Searches were identified as helpful by five students because of the Quality of Information, Information provided and the Interaction available. Students recognized the detailed information about programs, and the variety of information available, such as that every university is represented online as useful. The personal endeavor of searching online meant that a student who has identified their interests could find appropriate programs to suit. Student 21 described Internet Searches as “most helpful for finding programs that I liked, because every university is available online and you can look at every program.” The content identified as most helpful by students were that using Internet Searches was that they were able to find admission requirements.

University/College Websites were valued by three students specifically because of the information about admission requirements, tuition payments, and courses they needed to take. Also the completeness of the information available was identified as helpful, Student 7 noted that these websites “showed [them] everything [they] needed.” However, Student 31 found that information on university websites was “all over the place and poorly organized”. The school specific information on programs was valued.

The online educational planning tool introduced in both school boards, myBlueprint.ca [99], was identified as most helpful by three students. All four themes were present. The information provided about prerequisites, and tuition and residence costs was valued by students. Students found this tool to be well-organized with easy to find information. As mentioned previously, Student 31 contrasted using myBlueprint.ca with using university websites and identified that myBlueprint.ca was more helpful because the information was centralized and easy to find. The useful features and information of the tool
were detailed by Student 39: “the website will filter out programs that you are not qualified to take, and will also tell you the tuition and average residence price. The listed programs also provide a helpful link to the university's website program page.” The ability to interact with the tool and customize it, as well as the suggestions provided for future research were identified as the helpful characteristics.

Students identified Family members as most helpful for the quality of information they provide and the positive interactions they facilitated. The students who identified Family as most helpful acknowledge the supportive and encouraging nature of the interactions, and that the information provided was truthful and reliable. There was no mention of the information given in these interactions apart from Student 26 identifying taking recommendations from a cousin who was a current university student.

The distinction between University Reps and Current Post-secondary Students was not clearly identified in the survey or by the students. It is expected that there is some overlap especially when the context of student answers were considered. The main difference is that the participants identified that Current Post-secondary Students were frequently able to provide specific insight into the programs they are studying. Student 10 identified “currently enrolled students are a huge help with choosing a program because they can tell you what it's all about”. Students rarely detailed actual content exchanged in the interactions; however, the volume of information, immediate responses to questions and currency of information was identified as valuable. Additionally, participants valued the interactions because they were able to get their questions answered. Student 37 remarked that they found it important that the Current Post-secondary Students told them “what [to] look forward to.”

The Quality of Information that Guidance Counsellors was recognized as most helpful because the counsellor had the “most information or resources” or the most complete set of information. Student 23 identified that “visiting the guidance counsellor was the most helpful because it gave me many new
The personalized interaction with an identified resource has been acknowledged as being a valued characteristic.

As described earlier, Fathers were identified separately from the most general Family. Both students acknowledged their Father’s experience and knowledge about the field of interest as most helpful. Student 19 recognized the value of learning from their father’s “first-hand experience in the field” and Student 33 identified their father’s employment experience helped them learn what was needed to get into the field.

There were two students who identified each of the following as most helpful: University Fair, eINFO.ca, Co-op, Ontario Colleges Website. The University Fair was valued because it was a centralized location to get a large volume of information. The website eINFO.ca was recognized for the quality of information available. Student 22 identified that eINFO.ca gave them “all the information needed when researching a field of interest”. A co-op course allowed Student 8 to “see if [they] actually want to do it” and allowed Student 30 to “get a sense of [a] future career path.” The Ontario College Website was valued for the easy to find information and information on careers.

Resources identified as most helpful by a single student include: University Viewbooks, Ontario University Information Website, Teachers and Peers. A student identified that what made the University Viewbooks most helpful was the quality of information and the Information. Student 27 described the viewbooks as most helpful because “[they] were easy to navigate and gave clear and concise information about both the university and the courses offered.” Ontario University Info website was valued for representing all programs and providing brief descriptions. A student acknowledged their teacher was helpful in providing guidance in “what to consider when finding a career.” Student 34 was very concise when describing the value of the opinions of their peers, “friend's [sic] tellin [sic] me what's [sic] good.”
There were five students who simply identified the resources they found helpful, but did not respond to the part of the question that requested the helpful characteristics be described. The resources identified without further details were: University Visits to School, Visits to Campus, Talking to People in Job, and Work Friends.

4.3.2.1 General Characteristic Analysis

A second analysis of the coding was focused on the characteristics of the resources. Four themes emerged to describe the valuable characteristics of the resources identified. The two main themes were Description of the Information and Description of the Source. Two minor themes that emerged were External Influences and Other Qualities. Table 8 shows the categories under each theme.

Table 8: The four themes and their categories

<table>
<thead>
<tr>
<th>Describing the Information</th>
<th>Describing the Source</th>
<th>External Influences</th>
<th>Other Qualities</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Content in resource</td>
<td>• Accessibility of resource</td>
<td>• External influences</td>
<td>• Other qualities</td>
</tr>
<tr>
<td>• Quality of information</td>
<td>• Interactions with resources</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• General information</td>
<td>• Second-hand experience (from source)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>about university</td>
<td>• Personalized interactions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Quantity of information</td>
<td>• First-hand experience</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Learning about options</td>
<td>• Centralized location for Information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Program specific</td>
<td>• Connections with other resources</td>
<td></td>
<td></td>
</tr>
<tr>
<td>information</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.3.2.2 Describing the Information

Responses varied in detail. Some participants were very specific in the type of information they needed: from broad decision-making considerations e.g. “what is important in finding a career” to specific application details, such as courses to take, admissions requirements, tuition and residence costs. In
contrast to these specific pieces of information that students identified as needing, a few other responses simply noted that the resource “gave them all the information they needed”.

In addition to identifying the content that is useful, participants recognized the importance of quality and quantity of the information. Students recognized that detailed and complete information about the university program is useful to them. Additionally, the information should be clear, concise, reliable and up-to-date. Participants also acknowledge that sources with a lot of information, particularly for a specific program, were advantageous to have.

Participants indicated that resources that have information about the university as well as the programs were particularly useful. Students wanted both brief descriptions of programs and access to an overview of all of the programs offered at a university. Additionally, students wanted “all information about one program” from one resource. Students identified that a useful resource would help them learn about different options within and across different schools. The idea of a resource providing “insight” into a program was identified as helpful, but further detail was not given.

4.3.2.3 Describing the Source

Participants also identified characteristics about the sources to which they referred. Accessibility of a resource described how information was disseminated, as well as the students’ interaction with the resource. Students frequently identified that visiting the university campus was helpful, one offered that a well-laid out open house was helpful. Often mentioned along with visiting campus was the value of interacting with the representatives and current university students. In these notes, participants described helpful interactions as with individuals that were easy to talk to, approachable, and they could answer questions directly. For artefact resources, students remarked that they were helpful if they presented information concisely, in an organized fashion, and that the sources were easy to navigate. Students also
valued a resource that had “all of the information needed.” A centralized location for information, such as a comprehensive website or an extensive open house or fair was acknowledged as helpful.

Related to the accessibility of a resource, participants found that being able to interact with the resource was helpful. In particular, students found that the knowledge held by individuals and the personalized interactions with them were valuable. The ability to have their personal questions answered immediately was appreciated by students. Participants also recognized the value of first-hand and second-hand information. A few students identified their co-op or work experience as the most useful source of information. One student identified that their co-op experience “gave them a sense of what to expect”. Students also found it was valuable to be able to talk to individuals who have or are experiencing the program or career path they are interested.

4.3.2.4 External Influences and Other Qualities

There were a few students who identified that recommendations from informed or trusted individuals, such as current university students or family members, were helpful. One student identified that their friends’ opinions were a valued resource. Students also valued resources that helped them identify where to find additional information. University representatives provided students with paper documentation, and myBlueprint.ca had hyperlinks to university websites for more specific information.

4.3.3 Question 3

While students were asked to identify the post-secondary career path they intended on pursuing, and examples were given, detail in responses varied greatly. Table 9 summarizes the breakdown of the intended pathways of student participants.
Table 9: Post-secondary pathway identified by participants

<table>
<thead>
<tr>
<th>Post-secondary Pathway</th>
<th>Number of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assumed University</td>
<td>3</td>
</tr>
<tr>
<td>College</td>
<td>11</td>
</tr>
<tr>
<td>University</td>
<td>18</td>
</tr>
<tr>
<td>[Not Specified]</td>
<td>7</td>
</tr>
</tbody>
</table>

The “Assumed University” category was derived from the degree program description given, for example “Gym Teacher”. Pathway did not seem to have a marked effect on the descriptions they gave and did not have an effect on the number of resources that students used.

As the survey was distributed after applications to programs were due, it was expected that students would have narrowed down their program choices. Out of 39 students, 22 students identified having settled on a plan, identifying either a program, or a program and a post-secondary institution. Eight students identified two programs they were deciding between, or a program and multiple post-secondary institutions they were deciding between. Nine students identified a pathway (university, or college), or the name of an institution, and did not indicate a program. The 30 students who had either made a choice or had narrowed down their choice to a few programs or institutions, on average, indicated approximately four resources. The nine undecided students, on average, indicated using fewer than three.

Three participants indicated they intended to pursue engineering at a post-secondary level. Student 19 identified their father as the most helpful resource “because of his first-hand experience in the field.” For Student 38, the university open house had a lot of information and the individuals the student interacted with “knew what they were saying.” Student 28 also found that the event was well-laid out. The third participant, Student 39 recognized myBlueprint.ca as most useful and went on to detail the features (quoted above in Section 4.3.2).
4.4 Teacher and Guidance Counsellor Data

Ten interviews were conducted, and a sampling with maximum variation was obtained. The description of each participant as it pertained to the variation is shown in Table 10. Pseudonyms were used to maintain confidentiality of the participants. Additionally, any identifying information in the interviews was generalized for confidentiality. Context was maintained through analysis of the coding, as well as through selection and presentation of quotes.

Table 10: Summary of the educational and occupational background of the interview participants

<table>
<thead>
<tr>
<th>Interviewee</th>
<th>Education</th>
<th>Educational Role</th>
<th>Occupational Background</th>
<th>School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angelina</td>
<td>PhysEd</td>
<td>Guidance Counsellor</td>
<td>Workplace Experience</td>
<td>A</td>
</tr>
<tr>
<td>Molly</td>
<td>Science</td>
<td>Guidance Counsellor</td>
<td>Workplace Experience</td>
<td>A</td>
</tr>
<tr>
<td>Arthur</td>
<td>Science</td>
<td>Grade 12 Biology &amp; Guidance Counsellor</td>
<td>Workplace Experience</td>
<td>A</td>
</tr>
<tr>
<td>Sybill</td>
<td>Arts</td>
<td>Grade 10 Careers</td>
<td>Straight into Teaching</td>
<td>A</td>
</tr>
<tr>
<td>Mary</td>
<td>Math</td>
<td>Math Teacher</td>
<td>Straight into Teaching</td>
<td>B</td>
</tr>
<tr>
<td>Oliver</td>
<td>Engineering</td>
<td>Guidance Counsellor</td>
<td>Workplace Experience</td>
<td>B</td>
</tr>
<tr>
<td>Tim</td>
<td>Science</td>
<td>Grade 12 Biology</td>
<td>Workplace Experience</td>
<td>B</td>
</tr>
<tr>
<td>Gregory</td>
<td>Science</td>
<td>Grade 12 Chemistry</td>
<td>Workplace Experience</td>
<td>C</td>
</tr>
<tr>
<td>Lily</td>
<td>Science</td>
<td>Student Success Teacher &amp; Grade 11 Chemistry</td>
<td>Workplace Experience</td>
<td>C</td>
</tr>
<tr>
<td>Charlie</td>
<td>Science, part-Engineering</td>
<td>Grade 12 Physics</td>
<td>Workplace Experience</td>
<td>C</td>
</tr>
</tbody>
</table>

At School A, each guidance counsellor is assigned a grade to focus on. Angelina, specializing with the Grade 10 students, outlined the typical guidance structure, “most schools have one or two guidance counsellors and they do everyone and they split by alphabet.” The benefits of this structure were discussed in some of the interviews.

Three themes emerge through the analysis: Advising Practices, Knowledge and Gaining Knowledge. Two threads present in each of the themes were Self-identified Limitations and Outreach. Figure 10 illustrates the relationship of these ideas.
Many of the responses lent insight into the advising practices of the participants. The advising practices that participants described were both informal interactions with students as well as formal discussions, such as guidance appointments. The categories that emerged through the analysis described these practices. The advising role and limits to this role were discussed. The three most prominent categories in this theme were: decision-making considerations, teacher experience used in advising and promotion of outreach. Additionally, it was common practice to learn about the student through observations as well as by initiating a dialogue. Commonalities arose within the different roles, mathematics/science teacher, Careers teacher and guidance counsellor, and are discussed separate from the general advising role analysis in Section 4.4.1.1 to 4.4.1.3.

The commonly perceived advising role was that, as teachers and guidance counsellors, they were to support students in their self-discovery, in finding resources and in making decisions. Very few teachers identified that they would provide direction for a student in the decision-making process, the remark was consistently accompanied by the statement that the direction would be only after the teacher had become
well informed. Additional facets of the advising in guidance role were to check that students have the program prerequisites and to provide advice on strengthening an application. In the classroom, teachers aimed to ensure students had the information they needed, but also to guide students in their decision-making, which was seen as necessary because of the sheer amount of information available.

Self-awareness was identified by participants as part of their advising role. In addition to the personal inventory quizzes and personalities tests, discussions of self-awareness arise in guidance appointments. Angelina described her conversations with students who present an interest in science. For Grade 10 students, ‘science’ is still one subject. She recognized that part of her role was to bring bringing awareness to students about different science fields,

“in a lot of ways, they don’t necessarily know that when they get into senior level science you can specialize and choose, like you can take just biology or just chemistry, so I think those are kinds of discussions we have. Maybe science as a whole didn’t go so well but was there a unit that you were particularly interested in, and how did that go, and why might that be? So again a lot about the self-exploration, really knowing yourself and how things went and why that went the way it went.”

Many of the questions that participants led their discussions with were inviting students to think critically about themselves. In this way, participants were learning about the students they were interacting with, and students were given the task of considering their responses to the questions. For students presenting an interest in engineering, Oliver stated that he asks why to check the students’ understanding of the pathway, “[I] ask someone why they want to do it, because if they don’t like math and science, I really don’t think they’re going to like it.” Peter described that he asks his classroom of students why they are taking the class, “right at the beginning of the year I ask them about their interests and why [they]’re taking my course and sort of, where [their] future career aspirations lie. So I can connect with them in that sense. And then, my focus is generally on careers related to biology, because I’m a biology teacher, so any opportunities to get to make those connections in class.” Both looking at future aspirations and discussing academic performance in a subject were common topics of conversation with students.
While participants were happy to discuss these topics with students, many identified that students have the responsibility to learn on their own. Molly outlined her process of discussing post-secondary pathways with a student, ‘‘I start: ‘what are your interests’, ‘what do you enjoy’, ‘which ones are you doing, are you the most successful in’ and then I give them the websites, and ‘go do some research’.’’ She then outlined her perceived limits in her role as a guidance counsellor, ‘‘but they have to take this on their own. I’m not going to sit here, and say, okay ‘you should be an engineer and you should be an accountant’ they should do some research to find out what it means to be in that job and what the, everything, job prospects and what it entails, and so [on].’’

Sybill echoed a similar sentiment when trying to engage Grade 10 students in Careers class assignments. Many of the assignments have the goal of making sure students are aware of their options and what preparation is needed to get there. Sybill described her interactions with the spectrum of students, those who think they know what they want to do: ‘‘some of them have the idea, ‘I’m going to be an engineer’ and I say ‘Okay well, research! And see!’ Maybe, do you have – and actually it sort of teaches them the requirements they need for high school because that’s the goal, I guess.’’ and those who do not: ‘‘some of them have no idea. They don’t have any idea, so I’ll say, ‘if you could research a career, what would you do?’ I said, ‘you might never do it, but find out about it.’’ To further that exploration, she would recommend to students to, ‘‘try to choose something that interests you, OR that you’ve heard about and you maybe want to explore it.’ That’s the other way, ‘You might have thought about this, you’re artistic; look it up, what would they do?’ Yea that’s about all I can do.’’ She identified in both cases that there is a limit to her teaching role, and all students have the responsibility to do their research.

While participants frequently identify the students’ role in learning, another common practice is supporting students in finding information. In the spontaneity characteristic of guidance appointments, Angelina described moments where students will ask questions she does not have an immediate answer
She described that in these moments, she found “that as long as I’m willing to be honest with myself and with them, and say like that ‘I really don’t know’ so let’s figure that out together, they’re pretty open to that, kids are pretty awesome like that.” She later pointed out that working with the students has other benefits, “I also really like working with the student and showing them, this is how I would get the information if I needed it, so I can help them with some self-advocacy and some self-learning on their own. So in the future they’re like, ‘Oh Ms. [Name] just Google searched this and we got the answer and it was pretty simple’.”

Molly identified that she works with students when they have specific questions, “I do have two websites that I refer to often that, we’ll sit here at the computer and look at them together, especially if they have question about programs or universities, or what universities have to offer.” Similarly, when Mary is approached with questions about pre-requisites, she’ll ensure that students understand the requirements by working with students: “some students will say – like for the IB [International Baccalaureate] program, they’ll say ‘Universities have asked for higher level math, is that realistic?’, and I’ll say, ‘Well let’s just read the whole thing.’ And they actually didn’t read it properly and we’ll look into it further.” In addition to the value of working with the students, Lily outlined the challenge with telling student to do their own research, “often if I have kids asking me a question... We [teachers] know as soon as we [suggest] ‘well you go ask them.’ they might not.” Her strategy to ensure students actually get the information they need is to work with them, “so you can go on the computer and see if, see what you find is enough knowledge, and if it isn’t, you want to talk to somebody specifically.” In addition to working with students, participants often identified suggesting different resources to use, such as reading, speaking to people, or seeing the university/college presentations at the high school. Teachers have also described the support as offering to initiate communications for the student with guidance, or with other individuals for information.
Self-awareness and obtaining the necessary information are two facets that make an ideal career decision-maker. In a moment of critical reflection, Lily identified many finer points of observation about current guidance practices and student decision-making tendencies:

“Besides just giving them the information about careers, we probably should have more components than we do about self-awareness, about being confident in your own decisions, about not looking ‘What’s my friend taking?’ You have sometimes, in adolescence, it’s an outside-in decision, and it has to be an inside out decision. So I might talk to them about something like that, because I personally believe, you have to shut that off, read, learn and now you really got to think what works for me. Within that reading and study, [there] should be that emotional component of self-awareness, self-confidence, believe in yourself to make, some of them don’t even know they can make a good decision, even though they are really smart, academically smart kids. They haven’t, they don’t really know that they also with that, can make a really good decision for themselves, and they’re not confident, so they pick safe things.”

Other participants also identified the importance of students making these decisions; this was particularly evident in the strong focus that emerged of the advising practices of participants was helping students with making decisions.

Guidance counsellors consistently listed factors students needed to consider when making post-secondary choices. Guidance counsellors identified inquiring about student interests, subjects they enjoy, academic strengths, and trends in grades guided their advising on decision-making. A few teachers identified these considerations, but others also gave much more broad decision-making considerations. Many teachers identified that ‘fit’ with the post-secondary institution was important to consider, in person if possible, as the mental and emotional component of being on campus had an effect. Peter identified that he would check in with students on their decision-making process: “I certainly like to check in with them every now and then, and just see ‘Okay, so hang on, Where are you applying?, What are you applying for?, What is the program?, How much research have you done?’” Both guidance counsellors and teachers acknowledged that factors such as financial commitment, big-picture career planning, and specifics about the post-secondary institution (e.g. distance from home) can affect students’ decisions. In addition to informing students of the factors to consider in the career decisions, a nuance of the town in which School C is located, offers a unique opportunity for guidance. In Grade 8, students got to pick what high school
they wanted to attend. Lily identified that she would remind students of this and tell them to draw on their own experiences for what to consider.

In addition to this guidance, participants also identified limits to their advising role. Oliver and Lily both acknowledged that decision belongs to the student and perhaps their parents or family. Oliver identified the challenge in creating this dialogue and the caution he exercises. He stated that, “if they don’t know what they want to do, you have to get it out of them, what they might want to do, and it’s hard. It’s hard. And but I think, the thing is their parents are paying lots of money for them to go to school so you have to be careful ... what you say to someone.” Lily similarly outlined the extent of her role particularly in her discussions with an undecided student or a student with multiple interests:

“I am reluctant to steer because I think ultimately they have to make their own decision, and I would prefer that majority of that be done by the family and the student, themselves, so I think, my philosophy would be, I’m going to give you as much information as I can so you can make the decision that’s best for you .... [Then] Do your reading, speak to people, can I connect you to somebody? Usually, it evolves and they make their own decision. But they have to, I think, make that decision for themselves, so it’s more of a, now collect all the information possible and don’t miss any. And that’s not always easy, because you have your own set of strengths and your own personal interest.”

In her role as a guidance counsellor, Molly outlined that it was not her place to “say that ‘you can’t be successful at this’, and to say ‘you won’t make it as this’.” She found the signal for intervention as “if there is concrete evidence there, like if they’re not in the right pathway, they’re going to have to do something, they’re going to have to go back and upgrade and do some academic programming.”

In addition to these advising interactions, participants also described their observations of students. Teachers observed differences between their college pathway and university pathway students. Mary observed that university pathway students asked different questions in class about the application of the material, “[college-bound students will] actually ask, ‘where am I going to use this?’ Where the students in my university-bound classes – they never ask ‘where are we going to use it?’ They seem to know that ‘I have to know do this in order to make sure that I get to the next, through the next gate, kind of idea.”.

Teachers have identified that their role in the classroom is not to just prepare students with the
prerequisite course material. Part of Gregory’s advising practice is in classroom discussions or ‘pep talks’ about the importance of study habits in addition to the curriculum material they are covering. He found that the university-bound students were much more receptive to this conversation than his college-bound students.

Guidance counsellors frequently commented on their observations as they pertained to describing a ‘student profile’ based on marks, interests, learning style and work ethic. Through these observations, guidance counsellors described another part of their role – ensuring realistic student goals. Students were observed to often have a goal in mind, as early as in grade 10, and often show an awareness of a range of jobs, at least by job title or field. Molly discussed a case where a student wished to pursue acting at an American university which costs substantially more than attending a domestic institution, “could she be a famous actor some day? I don’t know her well enough to judge that, but I do need to make sure that she has the realities in place.” This quote represents many participants’ attitude towards advising. Many try to withhold judgement about what the student should pursue, but aim to ensure the student has thoroughly considered their options and if they will be able to ‘succeed’. To facilitate these discussions, Angelina discussed a tool she was developing and how it helped guide the conversation, “we always start here [with ‘Who am I?’]. [Then], because of these things, or with these things in mind, ‘What are my opportunities?’; ‘Who do I really want to become?’. Some students have this in mind first and we have to go back to ‘Who am I?’ to say okay, is this realistic given this [who I am].”

General observations of the school environment were also discussed. Application time is observed as stressful for students, and that they are concerned about finding the right program, the right school, and getting high marks. Having to make decisions adds to this stress. Some students take an extra year in high school to take more time to decide and work, spend more time in high school to make the decision, or earn missing prerequisites. Lily observed that students and their parents are unaware of the career paths available,
“I really think it’s a huge deficiency, just socially, even for parents. Because, you still have kids say, I’m going to be a, and they name all the little professions, a doctor, a dentist, a veterinarian, a lawyer. I don’t know what else you might consider. There is very low awareness of the careers that are out there, period, outside of those. Even by all the adults too. Even though they might, or probably are in one of those other ones.”

It was common practice for participants to discuss drawing on their own experiences when in advising situations. Many individuals who referred to their own experience also discussed experiences of their friends, family or past students. Half of the teachers, and one guidance counsellor reported using these experiences in advising scenarios. Some participants used their personal experiences to explain decision-making considerations. Others used them to engage students in the classroom. Some teachers are sought out by students because of the known educational or occupational background of the teacher. A prominent discussion topic throughout the set of interviews was self-identified limits of participants; drawing on personal experience was no exception. Mary recognized the limits to her knowledge of university, “I went to university but I only got to see my part of the university piece”, and her limited exposure to other fields, “I’ve also seen the chemistry piece because I know people in chemistry”. Oliver used his experience in choosing his post-secondary program to develop a litmus test to check student fit for a program. He discussed why he chose to study engineering, and the insight this experience gave him:

“That was [it] really, I like math and science, and an aunt of mine was a librarian in a research facility and she said, you should become an engineer if that’s what you like. And so that’s why I did - really bad reasons. I had no idea what engineers did, and I had no interest in really math and science, other than that it wasn’t that hard. And for me, it was something that I didn’t really, I’ve said to people, I didn’t learn anything in four years of engineering, I don’t remember any one course, I don’t remember any stimulating conversation or anything. But I think I try to get, to ask someone why they want to do [engineering], because if they don’t like math and science, I really don’t think they’re going to like it.”

Similarly, Charlie reflected on his university experience and found that specific information would have been helpful. The engineering program he entered was specialized right out of high school; however, upon entry he became dissatisfied with it. He recalled, “I looked back and thought that a general first year would have been a lot better for me, and I probably would still be, or I would’ve carried on in engineering had there been a general first year.” As a result, he makes sure to make students aware of this option. Lily also referred to her own experience in explaining how she used her decision-making
Ongoing professional learning through courses, accredited by Ontario College of Teachers, recorded on a teacher’s Certificate of Qualification and Registration [106].
solicited, “I only ever said that I only say that I’ve heard good things about this from former students.” Similarly, Gregory reported being comfortable stating his limitations when responding to student inquiries.

The Outreach thread was present in advising practices in the form of awareness. Outreach refers to programs run by an external organization, such as the Ontario Universities’ Fair, clubs with external mentors, University Open Houses, and University/College visits to the high school. The commonality in advising practice was the promotion of outreach. Teachers often get notification of outreach programs, guest speakers and special events; the onus is on them to make sure students know about the opportunities.

Email is available to all teachers and is a popular method of communication; however the actual usage varies as Lily points out: “[There are] A lot of emails. Oh my gosh, and not everyone reads them. I’m one of those people that seriously reads them. Sometimes I think, I’ll go back and read that attachment, and I don’t get to it. Because it’s the amount of, it’s exciting, there’s so much communication, but that’s good!” Even well-intending teachers could be overwhelmed with the volume of emails. Lily identified that the morning announcements was another method, but it was not without flaws: “[Students] don’t necessarily listen to the announcements. You can put on an announcement and invite them.” She identified the way School C was approaching promotion of event was by “word of mouth. And now that they’re catching on it’s pretty good. So we have a list of kids we know [who] have said, ‘anytime you have something science, math, sort of that, area, um, please ask me, invite me’. … The list keeps growing, and that’s Grade 9 through 12.”

Along with Lily’s acknowledgement of word of mouth, other participants have identified that in addition to general promotion to their class, it would be more effective if they could communicate with interested
students directly. Lily outlined an example of a challenge in identifying interested students, “we’ll sort of canvas classes and let them know what’s there, and maybe even speak to a couple of people you think [would be suitable/interested], but that’s got a huge error in it, because that’s teacher impression, so you could definitely miss a whole bunch of people.”

Another method of communication teacher identified were getting flyers in their mailboxes. Gregory described how he brings awareness of these opportunities to his students:

“Every now and then, there’s a sheet in my mailbox from [local university] about women in engineering, I tend to read it, and say, ‘hey everybody listen up, this is for you, hey look at all the names you learn in science, it’s mostly guys, so they want to encourage, it’s just another branch of science, most of you girls are getting higher marks than the boys anyways’. So, I usually just kind of let them know, I don’t really follow-up on it. I just say, the information’s up here if you need it, look online. But, I certainly, I promote them, I don’t think I promote them very hard, but I certainly give them a moment, and then say, someone else wants me to talk about this [other] thing, and I think it’s important too, so I’ll read it, and that’s about as far as it goes.”

4.4.1.1 Role Specific Challenges: Mathematics/Science Teachers

Additional categories in the Advising Practices theme were unique to the teaching role. Teachers identified their advising role as evolving and not prescriptive. Peter summarized this evolution: “more and more our role as teachers is, with so much information available and excellent resources available outside the classroom, we need to be able to facilitate, and guide learning but also guide these choices that students are making in terms of their career paths.”

Two teachers who had both gone straight into teaching repeatedly identified their encouragement of students to explore different fields and pathways after high school. The emphasis on exploration in the classroom was presented exclusively by these individuals; however, it echoes the similar sentiment presented by the participants in discussion of the limits to their advising role and their hesitation to provide direction for a student. Mary identified her strategies was to be enthusiastic when she learns about what a student wants to pursue, whatever it may be, and then she remarked, “once I know that, then I try
to figure out if there are ways if I can fit something like that into, like if the math we’re doing after - that I know is coming up I try to remind them, ’oh, this is used here.’ So I try to find a place where that happens.”

For a teacher, the priority in the classroom has been identified as covering the curriculum. There was a moderate degree of discussion on the focus on high school content. Lily described the changing focus of education to be inquiry-based and how she incorporated this into her classroom. With the greater education community shifting towards inquiry-based learning, many more resources are available than there were previously. She mentioned she had professional development training in inquiry-based learning and discussed modifying the labs in the course that she teaches to incorporate facets of real-world application, and industry simulation based on her work experience. The awareness of industry application works both with the lab environment and in informal discussions. With these modified labs, the focus is shifted away from judging the final product as right or wrong, and towards assessing the ability to reflect and discuss the reason behind the results of the experiment.

However, a challenge exists with the students accepting this style of evaluation as Lily identified, “we try to do inquiry based, it’s not always that easy though, because it requires a certain base amount of knowledge and confidence, and if those things aren’t in place, some of [the students], it can really turn off, they’re just not used to it still.” She outlined a strategy that exemplifies the larger problem: “They’ll buy in if you simply say, you’re not losing marks for having a mess at the end, but I want you to be able to explain the mess, and part of that they’ll be finding someone who did it well and finding out what you did differently. You want to prompt them to enjoy the learning process without a whole lot of pressure.” Unfortunately, the pressure of achieving high marks, especially in Grade 12, is the focus – particularly for admission and scholarship requirements. Lily acknowledged that more application and inquiry-based education would be beneficial for students, but there is time for perhaps one lab per unit and she always
has it in the back of her mind to bring up as much as she can. She noted that the inclusion science application discussions also worked in informal conversations. She remarked, “you have [the students’] attention, they do want to know about that stuff, way more than they want to know about the structure of the atom.”

Although career choices and career opportunities is a part of the written science curriculum, Gregory indicated that he was skeptical about the amount of time any teacher spends on formal discussion about career choices. He remarked that in his classes career choices would come up, in “you can do this, you can do that’, but it would rarely, if at all, be part of student assessment. He described the career choice curriculum requirement in his class as “exploratory” in nature. He remarked that by doing a multi-day lesson of exploring careers would result in missing the chemistry content needed for those jobs. He stated that he’d “rather get the content, and then [students] have doors open and [if students] do well in it, and [if students] like it, [they]’ll go looking for these opportunities. I don’t think I need to teach [students] about them.”

In the discussion of discussing integration of real-world connections in the classroom, limits were identified by participants. Mary remarked that identifying relevant mathematic applications was limited based on her personal knowledge. Lily reported a similar challenge when trying to relate lab experiments to industry routines from her work experience. She acknowledged that she was drawing from a small set of examples.

While there are limitations to personal knowledge, teacher participants identified students often asked for their opinions. Gregory recalled that students want reassurance about whether they would be a good fit and would succeed in their choice,

“sometimes they just want my opinion, because they value my opinion, [they ask] “So what do you think? So do you think I’ll be okay, do you think I’ll know my stuff enough?” And then those kids [who] know
they don’t work hard enough. And they know that I’m going to tell them, you can do it but it’s the workload issue and it’s a time management issues and … those skills that we don’t give you marks for in high school, the skills that you get no credit for, I mean directly.”

Charlie described similar interactions, “‘what do you think of Queen ’s?’ It’s usually the first question that comes out”, where simply his opinion is requested.

Some teachers are sought out by students because of their personal experience. When students hear about a teacher’s post-secondary education experience or their workplace experience, teachers get approached with specific questions. This reveals some of the information that students want in their decision-making process. Charlie described the questions he gets asked: “I’ve been at four different universities, so the kids know that I’ve been around and I know what the university life is like and often, yes, kids of course want to ask questions to people who know what the university life is like.” Arthur recalled that due to his specialty in biology, students with certain intentions approach him,

“students who have, who would tend to go on to study biology, physiology, anatomy, kinesiology, life science, will seek me out and ask my opinion of various universities, various programs within universities, what I think the mark range is likely to be to get into a specific program, whether I think they would make a good nurse, kinesiologist, anatomist, physiologist. When the questions become a little bit more specific about health science, as a broader term, I’m the person that generally they’ll come to talk to.”

He also found that students interested in science in general will approach him with specific questions, he recalled,

“kids will talk to me as well even if their interest lies outside the health sciences but within science in general, so kids who will want to go into engineering or physics or chemistry or environmental science will often seek me out and ask my opinion. Or ‘I’m this profile of student, I’m looking for this in my post-secondary education, what school might you recommend, what marks might I need to get there?’”

As mentioned earlier, Lily found students would ask her more general questions about her experience:

“the questions [from] kids for me more would be more informal, ‘What school did you go to? What did you take? Do they have that there? I like that university.’ [In these conversations] they just want to talk about, ‘Oh, you went to Western and Toronto and Guelph? Why did you switch, what did you like, what didn’t you like?’” On the other side of the discussion, Peter speculated that his background probably eliminates him as a resource for specific questions: “they don’t ask me questions about engineering. They
know that I’m probably not their best resource, I expect. They know I’m not an engineer, we have engineers on staff who are teachers, and they probably get more questions.”

When teachers found students asking questions about the university application process, common practice was to refer the student to guidance. Peter recognized the strength of School B’s student services department and observed that students were interacting with them about post-secondary decisions. He also reflected on his advising practice, and stated: “I would probably say that would probably be a weakness of my practice that I probably would need to have a stronger awareness of the programs that are out there. I think, maybe I’m relying too much on - I generally would redirect them to the guidance department.”

Specific questions about how to reach a career path led Gregory to refer students to guidance, he described, “occasionally they ask, ‘I want to be this, what should I take?’ I usually instruct them to talk to guidance. Um, not, (pause), and I don’t want to sound like I’m dissing guidance, but not because I think they have a better understanding, but I know that they answer those questions more often. And my fear is that I don’t want to misguide students. I say, here’s what I think, go confirm it.” The fear of misinforming students was also identified by Lily. She described her process when students ask about the mechanics of the application process, “I will always refer them to guidance because I don’t want to get it wrong. So I’ll say, if it’s a simple question and I think I know the answer, but I always say, ‘these kinds of things, because of the importance of making sure that application is correct, you need to see your guidance counsellor as soon as possible; if you need help with that, you let me know. They [guidance counsellor] really do have all that down pat.” Not only have teachers identified that they refer students to guidance, but all have identified that they are confident that guidance will have the answer.
Guidance counsellors have also acknowledged referring to colleagues for assistance. The structure of guidance at School A lends itself to this interaction. Molly, specializing in interactions with Grade 11 students, stated “if it’s something that’s beyond my scope or too specific, I send them to the guidance counsellor who has the Grade 12s, and who does all the university and college applications and information with them.” Angelina also referred to times where she referred a student to a colleague, “for some students, for example who perhaps were thinking about going to the States for school, that’s not my area of specialty by any means, but we have one guidance counsellor who does, he knows all of that inside and out. So I can just say, ‘you just need to make an appointment with him’ and it’s done.”

4.4.1.2 Role Specific Challenges: Grade 10 Careers Teachers

Some of the challenges in engaging students in learning about pathways and decision-making were mentioned previously, particularly concerning Grade 10 students. While teachers have identified methods of drawing students out, Sybill discusses the logic behind the early education, “the reason we do it in Grade 10, some people say they’re too young, in Grade 10 for it, but it helps them choose their Grade 11 and 12 classes. If we wait ‘til Grade 12, it might be too late and they might think ‘Oh shoot, I should’ve taken that course’ right?”

4.4.1.3 Role Specific Challenges: Guidance Counsellor Appointments

A strong commonality in the advising practices of the guidance counsellor participants was the focus on high school planning, the marks and the pathway selection. As discussed in Section 0, many participants mentioned mediating student aspirations and actual capabilities. The complex role of guidance was also commented on.

The guidance role understood by participants consists of pathway planning for high school and ensuring students’ academic foundations are set. To initiate discussion with students, Molly outlined her approach,
“one of the first questions I ask them is ‘What do you want to do?’ that will often guide me on what pathway they should be in, and whether they should be taking U[niversity] level courses, C[ollege] level courses, and that usually opens up the conversation.” With Grade 10 students, Angelina has identified that some “students, perhaps, have more of an idea of what they want to do”, at which point her discussions revolve around “planning for Grade 11 – ‘what courses might you want to pick now that you’re going to have some more choice?’” Oliver observed that students often have a goal in mind, “a lot of the stuff we’re talking about is actually planning for high school. A lot of our appointments are, I mean kids in Grade 10 who want to get somewhere after university, so they have to get there, they have to get to a university. We spend a lot of time, looking at, with the younger students, whether they need to take chemistry or biology or whatever.”

In addition to ensuring that student are taking the courses they want or need, pathway discussions occur to ensure students are in the appropriate one. Angelina outlined how she determines a student’s pathway, “so whether they want to take an apprenticeship pathway, head towards the workplace, head towards college or head towards university. We have discussions about how classroom stuff goes and then we make decisions about what pathway they should take.” One specific example Angelina pointed out:

“I don’t have a lot of kids identifying to me that ‘I want to be an engineer’. I have had one Grade 10 student this year talk to me about wanting to be a chemical engineer and so we look through his marks and things like that and realize that math is really not a strength, like significantly not a strength, and because of his grade and things like that, more than likely he’s bound for a college pathway or a workplace pathway.”

She acknowledged that conversations about mismatched capabilities and aspiration were difficult to have, but further knowledge about options within the engineering field for college or workplace educated individuals would help her in these scenarios. Similarly, Molly’s interactions involve discussion around student performance in prerequisite courses, if they are prepared for the courses they are to be enrolled in, and strategies for success. Another part of the guidance counsellor role included timetable revisions to ensure student have the correct prerequisites in general for their high school courses. Mediation of
aspirations and capabilities is described as occurring through discussion about the factors to consider in decision-making, and was discussed in Section 0.

The pathway planning, review of course performance, and management of realistic goals, are only part of the perceived guidance role. Oliver briefly described the additional guidance responsibilities as,

“[providing] help for applying, help getting help for personal issues. But we tend, well, we can’t help, but we usually refer them along to someone else, because I’m not a trained, I’m not trained social worker. So I need to send them on to someone else.” Due to this multi-faceted role, many guidance counsellors identified that it was hard to prepare for appointments as it is not clear what assistance they required.

4.4.2 Knowledge

Within the Knowledge theme, three topics were defined: Knowledge of Engineering, Knowledge of Post-secondary Pathways, and Knowledge of Career Paths. While the knowledge referred to in these topics was generally that held by teachers and guidance counsellors, through analyzing their described experiences, perceived student knowledge of engineering emerged. In discussing the questions students asked them, the interviews provided insight into what students want to know about these topics.

4.4.2.1 Knowledge of Engineering

Through describing their observations and interactions with students, teachers and guidance counsellors gave insight into what students know about engineering. This insight emerged from the questions that students pose, both questions for knowledge ‘what is engineering?’ and questions to confirm their knowledge ‘designing things, is that what it is?’ These questions were actually asked of Gregory. In addition to the perceived knowledge of engineering held by students, the sources in which the interview participants learn about engineering were also mentioned. Many participants relied on, or credited their personal relationships and contacts for contributing to their knowledge of engineering.
Oliver described the effect that an extracurricular robotics design program has on student knowledge, “they all think they’re going to design things. Or do really cool things. We do have this robotics group at the school so I think that leads kids to think that that’s – and which, some people do, um (pause) I think that they, some of they have specific, and they have mentors in the robotics program, maybe they are going on to do whatever it is that those people do.” He observed that students may develop knowledge and perceptions of what engineering work is through this program, or through interactions with mentors (many of whom are usually engineering students, or have an engineering background).

Sybill presented an uncertainty of the extent of student knowledge of engineering when they state, “I’m interested in being an engineer” or “I want to be an engineer”. In response to these statements, Sybill remarked that she would respond with “Oh, okay, because you like physics and math, is that it?” She poses the question to students, with her association of enjoyment of physics and mathematics as a common idea for interest in engineering.

Through Gregory’s reflection, he stated that he couldn’t picture anyone presenting a curiosity about engineering, but remarked that “a few kids will ask, ‘what is engineering?’ It’s a common [question]” He mimicked a student asking the question “Designing things? Is that what it is?” which outlines that some students connect engineering with design, but are not confident in this association. Along with this exchange, Gregory acknowledged that he sometimes “stumble[s] and don’t fully (pause) have a good answer for them.” He outlines that student awareness of post-secondary programs “very often [is] physics, chemistry, uh, biology and math. Those are what kids think, because that’s all they get [as high school classes], there’s no engineering class.”

For schools with resources and support to provide the opportunity for a limited number of students to participate in engineering-related opportunities, both Oliver and Lily observed these extra-curriculars as
effective avenues to increase awareness of engineering. However, Oliver’s comments suggest that student may be forming a sole association between engineering and the work done through the robotics program. Lily discussed a student who had many individuals to support her learning, including her brother who was studying engineering. Lily identified that “[the student] needed to learn more about what she might be doing... She had enough base knowledge, she was more interested in something more specific, like what’s the difference between an electrical and chemical engineering.” At this point, Lily acknowledged the limits in her knowledge, “I can’t answer a question like that. I can say that one is a study of electricity (laughs) one’s a study of (laughs), but that’s about all I can offer.”

Just as all participants stated an acknowledgement of the limits to their knowledge, along with Lily, many participants specifically acknowledged limits to their knowledge of engineering. Arthur recognized that he had “little experience” in responding to “specific questions or specific interests in fields of engineering”, citing that he would “put students in contact with [active students in engineering, active as young professionals in engineering and active as P.Eng’s]” in these situations. In response to a student declaring “they’re into engineering”, Sybill stated that she could identify some types of engineering, “I, at least know, well, there’s civil, there’s uh (pause), I know there’s civil, and there’s science engineer (pause), that’s about all I really know about engineering. And I’ll have to say you’ll have to go look it up. I don’t know too much about it.” After she had resigned from adding to her list, the interview was redirected. She, then, remembered another discipline she knew, “chemical engineering! Yea, because that’s the big one now with the nuclear power plants and all that.” She summarized her knowledge and interaction with students on their interest in engineering as, “so I know, where I can kind of say, ‘What kind of engineer? What do you think?, and then I’ll get them to look it up.” Sybill also identified that she “kind of [has] an idea of what they do”, she attributed this knowledge to having “two uncles that were

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4 The license to practice professional engineering in Ontario.
engineers”. She distinguished this from her explanation of chemical engineers as describing her uncles were “more with bridges, which is civil engineering, with the cities.”

As in Sybill’s case, it was common for teachers to discuss or refer to the experiences of individuals they had interacted with. These relationships ranged from familial, friendships, work colleagues (experience prior to teaching), and contacts from their time at school. Many participants referred to these individuals’ experiences when responding to questions throughout the interviews, including when discussing their knowledge of engineering. Lily explained how she uses her knowledge of her friend’s career to educate students about different career paths, in this case a career path of a mechanical engineer, “my friend from university, first year, she’s a mechanical engineer, with um, [company]? ... Sometimes I talk about her career because it’s pretty cool. Because it is military stuff. The tanks and so on? It takes her all over the world though. And we can also talk about the political things from there, because people don’t realize that where they’re building them in some places in the world [has an effect].” In addition to the comment about travel, she opens discussion in her class with the inquiry, “what does [the effect of local politics] tell us?”

In addition to her friend’s career path, Lily also described referring to the knowledge she gained through her job prior to teaching. She explained what she talked about in class, “[the] engineers that I worked with, when I was in industry were chemical engineers, it was all sanitation, clean-in-place, so we talk about that [in class] and the science of Tide; that kind of stuff, hydrophobic, (pause), and now I’m going to forget all my terminology. You’re trying to ensure that it will pull out a water-based stain and an oil-based stain. That’s not easy, laundry science.” She explained that one of her friends was a key engineer for a Tide project. In both of these anecdotes, Lily stated that she observed that “[students] are always interested in hearing about stuff like that [real world applications and career paths].”
As mentioned previously, Arthur also referred students to his personal contacts who are engineers, engineering students, or ‘P.Eng’s’ when they had specific questions. Arthur was the only participant to mention the Professional Engineers’ license. The quotes above describe the knowledge of engineering gained by teachers through interacting with personal contacts; however, this acquisition of knowledge does depend on the individuals and the relationship between them. Lily had also mentioned a family member, her brother, who was an engineer. She described him as a person who would enjoy talking to students in schools about his career pathway. She stated that he now owns his own business that she doesn’t understand. Lily outlined her understanding of the job as “something to do with some computers, in some capacity.” She went further and pointed out that, “no one [in the family] really get[s] what it is; he’s really bad at explaining it, I think he just gets impatient with us.”

When participants were posed with the question (Question 4), “When a student approaches you asks about engineering, how do you respond?”, participants identified the following topics: strength and interest in science and mathematics, their awareness of engineering disciplines, the post-secondary engineering program experience, the engineering profession and the need for more knowledge. The first discussion topic identified varied across the participants. Of the 10 participants, three identified strength or interest in mathematics and science, three mentioned identifying engineering disciplines, two described helping students find more information from other sources, one responded as not doing anything special for engineering and presenting general encouragement, and the final remarked that students do not approach him about engineering. Other points of discussion arose as participants reflected on or hypothesized the advising scenario posed.

The three teachers whose first responses were regarding mathematics and science all emphasized at least moderate strength in science and/or mathematics was required. Molly described her advising process in this scenario, “[I would first] make sure that in their planning that they have their maths and sciences. I
would also take a look at their credit counselling summary and take a look at their Grade 9 and 10 marks in the subjects to see first of all if they’ve been taking applied or academic programming.” This showcases the focus on high school planning, a reasonable first step. She noted that next she should ensure their performance in the correct pathway was at least sufficient, and would discuss “what strategies need to be put in place for them to be successful if they’re going to continue in that route.”

Angelina described a similar process of looking at student performance trends in science. Enjoyment of the subject matter was emphasized by Oliver, he identified that based on his experience in engineering he is of the opinion that, “if they don’t like math and science, I really don’t think they’re going to like it.”

Later in two participants’ responses, they identified that interest or strong understanding of physics in particular would be required of students who wished to pursue engineering.

Identification of engineering disciplines was also a common first discussion topic. These three participants identified four disciplines, two disciplines, or a confidence in their knowledge of the identifying “what the standard disciplines involve”. Gregory stated that “there’s a lot of different branches of engineering, and very specific concepts in engineering. You go from mechanical to computer, and (pause), civil, and suddenly you’ve got chemical too, and it’s, they’re kind of, all under this engineering umbrella, there are very different disciplines from another. And in fact a lot of them involve, (pause), like chemistry engineering, you have to have a full background in chemistry, you don’t just jump into chemistry engineering.” Quoted earlier, Sybill identified civil and science engineering before acknowledging that was the limit of her knowledge; although a bit later in the interview, she remembered chemical engineering. She described her understanding of civil engineers to be related to bridges and working for the city, and chemical engineering was involved in nuclear power plants. Charlie, who had been partially educated in engineering before switching to a pure science degree, described his confidence in explaining the disciplines to interested students, “I can certainly explain typically what the standard
disciplines involve and I also have told students there are some, kind-of, fringe disciplines in engineering.”

Other participants showed an awareness of disciplines, but were limited in describing them in detail or certainty. Angelina was upfront in identifying that there were some specializations, “I know like for example I know that there is chemical engineering and a huge number of things but what those are? I have no idea, and what’s involved in one versus the other, I have no idea.” While Gregory identified that there were great differences between the disciplines, Lily explained her understanding that “engineering doesn’t divide too, too clearly.” Lily also identified that being able to describe the differences would help in advising students who already have “base knowledge” of engineering.

The other initial responses included, Arthur and Lily discussing that they would put students in contact with more informed individuals, or would work with the student to find information. Mary expressed that she presented a general enthusiasm for students who had decided on a goal, and engineering was no exception. Peter remarked that no students had ever approached him for information about engineering.

Some participants stated that they would discuss engineering in the context of the post-secondary program. Upon reflection, Charlie recognized the value of entering an engineering program in a general first year, without specializing in a discipline. He remarked the lack of knowledge prior to, and during his engineering education was concerning and was skeptical that future employers would understand his specialization. Gregory explained his typical dialogue, “I say, I know it’s a lot of work. First year, if you survive the first year, odds of getting through are increased significantly, first year is definitely a filter year, and they overload you, and stay away from the heavy drinking. And, the people that brag about being in engineering but do nothing about engineering, those are the ones to stay away from”, then briefly mentioned his son’s experience in an engineering program.
Ideas about the engineering profession were discussed by two participants. The sources of these ideas appeared to be the media, work experience prior to teaching, and the experience of a personal relationship. When Sybill explained engineering as an evolving career, she recalled the prominence of chemical engineering as “big one now with the nuclear power plants”. Lily mentioned two aspects of the engineering profession. In describing her colleague’s experience as a key engineer with a Tide project, she alluded to a challenge in conflicting design requirements in the design of a solution to “pull out a water-based stain and an oil-based stain.” After describing characteristics of a student she would recognize as one who should consider engineering, she reflected upon herself and acknowledged that she did not think she would be a good engineer. She recognized the accuracy expected in the engineering profession and her lack of patience to work through the math to arrive at a correct answer. She supposed if she were to design a bridge the result would be, “the bridge is out by that much (hands apart). ‘It’s okay, they can step over.’ (laughs) that’s how I am right? I loved research and I loved the idea of, ‘what if you do that? What would that look like?’, that really appeals to my brain, but I know that I wouldn’t be very good at engineering, not that I couldn’t, necessarily, but I don’t even know, but it just would be, I would be swimming upstream with the level of accuracy that is expected in that profession. I think would be nervous all the time.” In referencing her mechanical engineer friend, Lily also acknowledged the variation available in an engineering career path, pointing out travel as well as the complexities introduced when building goods on foreign land.

As mentioned in Advising Practices, and throughout the previously discussed analysis, participants often acknowledge the need for more knowledge. Angelina mentioned that it is a challenge to ensure students’ capabilities are on track to meet their career aspirations. She discussed a student who wished to become an engineer, but due to his low academic achievement in mathematics would likely be bound for a college or workplace pathway. She outlined how more knowledge would help her advising practices: “I think if I knew more about engineering and the options within engineering, I’d be able to say ‘hey, like, you may be
bound for college or workplace, but here are some cool jobs within the engineering field that you can do, like that would be really valuable." Described in Section 4.4.1.1, Mary and Lily have both outlined how their limited knowledge about real-world applications affects their instructional practice. Gregory identified that he stumbled on providing a good answer to students asking about engineering. Upon Charlie’s reflection of his university engineering experience, he suggested that a concise message about the post-secondary program and career options of engineering disciplines would have provided helpful guidance for his decision.

4.4.2.1.1 Engineering Characteristics
While Question 5 specifically posed a question to participants about what traits they would recognize in a student who should consider learning more about engineering, the holistic look at the data showed that participants brought up traits they identified in other responses. Three categories of characteristics developed: 1) Strength and Interest in Math/Science/Physics, 2) Approach to Work, and 3) Additional Traits. Two of the 10 participants did not respond with any characteristics: Peter identified that students do not approach him with questions about engineering, and Mary stated that she had not pinpointed anyone, and that students “always seem to find the path themselves”.

The identification of a characteristic describing Strength and Interest in Math/Science/Physics was the most common and most confidently given response. The subjects were often listed together, participants equally mentioned Math and Science, or specifically Physics. Participants identified that consistent accuracy in mathematics, having a mathematics background, and strength in mathematics were important traits for someone who wished to pursue engineering. Lily described her identification of the importance of mathematics in her understanding of “level of accuracy that is expected in that profession”. She outlined, “you have some kids that just always nail the right answer, right in math, they can, and they just have that. And to me, that stands out as an engineering trait.” Her reasoning behind this was that in engineering “you have calculations and they do matter if you get the right answer”.

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In addition to ability in math, science and physics were both identified as important in engineering. The role of Physics, specifically the Grade 12 university level, in perhaps its simplest terms was recognized by Charlie as a prerequisite for application to a university engineering program. He acknowledged many students taking this course could be thinking about engineering. Even though Angelina and Sybill primarily interacted with Grade 10 students, both acknowledged that the Physics strand of science would be of importance to consider. Sybill listed it in her list of mock questions of a student considering engineering, “you’re good in math, you’re good in sciences, you like physics”; she acknowledges that in first semester, students’ evaluation of these subjects is still early, she clarified, “you like physics, well not necessary physics, in Grade 10 they’re just touching on that. And this is first semester, so some of them haven’t had math, they don’t have it [until second semester], so they still have an idea from [their] Grade 9 [mathematics experience]”. Angelina also mentioned that students may not have a strong grasp of what Physics is yet, “especially with Grade 9 and 10 because they take like it’s still called (air quotes) ‘science’ they look at the different ‘units’. Like in a lot of ways they don’t necessarily know that when they get into senior level science you can specialize and choose, like you can take just biology or just chemistry.

In an attempt to distinguish Physics from other areas of science, Charlie acknowledged his bias as well as utilized his experience with engineering education to provide his idea: “I hope I’m not having too biased opinion here, but I think physics is really fundamental issue with engineering, more so than chemistry. Because [with] chemistry, if you wanted you can still go into engineering and avoid chemistry completely; but you can’t do that with physics. It’s always there.” This is an idea he perceived as true based on the knowledge and experience he had at the time. However, with universities that have a general first year of engineering studies, chemistry is required.
To help students with this awareness, Angelina identified how she advised students in how to consider their interest and strength in a subject, “I think those are kinds of discussions we have. Maybe science as a whole didn’t go so well but was there a unit that you were particularly interested in, and how did that go, and why might that be.” This idea about ensuring students understand themselves, their strengths and interests is echoed in Oliver’s description of the role of Physics in engineering. He discusses further ramifications of disinterest or weakness in the subject, “there’s a lot and physics in particular and if a kid doesn’t really like physics or doesn’t get it, I just don’t think they’re going to enjoy engineering. And then, they’re not going to do well and they’re going to feel badly about themselves.” He warns that a mismatch in subject strength and interests could affect the student’s success and emotional state.

In identifying students that they would not recommend for engineering, performance in mathematics and science was commented on by participants. Molly stated that she observed students that were strongest performers in mathematics and science courses with percentage grades from “97s up to 100” often pursued “the pure or the applied sciences”. Oliver also identified that “a student that goes to summer school every year to improve a failing mark in math” would “not likely to be a good candidate for engineering”.

Approach to Work characteristics were the second most commonly identified traits of a potential engineering student. When Gregory responded to Question 5, he very quickly stated “work habits” as a characteristic he would observe in a student who should learn more about engineering. He expanded on this concept as, “so when I see kids that work hard and want to do well and they want to know stuff, not just do well, but want to know stuff, they’re not so keen on marks, but they’re like, ‘am I understanding this right?’ Those are the ones that stick out, those are the ones that will do well.”

5 Interestingly, engineering is considered an applied science (generally considered to be the application of existing scientific knowledge to practical applications, including technological developments and inventions).
Lily and Charlie both identified that they observe how students approach problem-solving. Lily described students who are not deterred by arriving at an incorrect answer at first, but persevere in finding the correct answer could be well-suited for engineering. In keeping with her understanding of the level of accuracy required in the engineering profession, she describes students who she indicates “should explore [engineering]” and “might match”: 

“when I have kids that can just sit and focus for long hours and (miming looking at a sheet and working on writing) when they see that calculation error, and back they go, and they have to get that calculation right and they can do it. And they have [an]other quality, tenacious. [Ones who thinks] ‘I can, I’m just going to keep at this, and it doesn’t matter what’s going on [elsewhere], I’m going back and doing this again.’ That kind of kid stands out to me.”

Charlie also described students who have “perseverance with tough problems” as ones who should explore engineering. He commented that, in setting up solutions, some “kids that need help right from the get-go”. He contrasted this with the students who he would identify as suited for engineering as those who were able to set up solutions to problems easily, ones “who have set a lot of things up – a couple of little small mistakes and I can look at that and go, ‘it’s just a small issue, you did most of the work here, you’ll be okay next year’.”

In addition to checking their Strength and Interest in Math/Science/Physics, Sybill identified a list of questions she would pose to students interested in engineering, “are you a kinesthetic learner, are you math smart, are you logical?”. These descriptions perhaps detail a student who has a propensity for tactile learning or building things, a natural talent in math, and presents a rational approach to problems.

The final category, Other Traits, encompasses three additional characteristics identified by participants: Approach to Learning, Communication and Teamwork. Lily indicated that students who present an interest in engineering tend to have a different approach to learning. In describing her advising interactions with these students, she identified that “the kids that are applying to [engineering], they tend to be pretty self-motivated and they can sometimes they answer their own questions.”
In a separate response, she identified specific communication skills as descriptive to her as an important trait for success in engineering. She commented on noticing “kids that communicate well”. She described it as “writing for science”. She emphasized that this was “very different than Writer’s Craft” and described this communications style further, “some kids when they innately can write well and get their scientific ideas across well and the precision there too. I’ll notice and think, ‘you’d be very good in university science and engineering and areas where there’s a [need to] communicate extremely well using scientific writing.”

Arthur described the students who he observed pursuing engineering as from two populations, the international students and those among the school’s “most well-rounded students”. He stated that the well-rounded students, “who intend to go into engineering, tend to be students who are heavily involved in other things whether it’s athletics or arts or music or technological initiatives, or robotics or those kinds of things. They don’t tend to be kids who are spending all of their waking hours, locked in their rooms studying chemistry or physics. Rather they’re the kids who are point guard on the basketball team or the lead in the play.” He also observed that in addition to their extra-curricular involvement, often in team environment, “they just seem to have some strengths in math and science and as a result have probably in many cases been somewhat directed to an engineering pathway.” Arthur identified in seeing some academic strength in these active students encouraged some action on his part, “you see in Grade 9 or 10 some promise in a student, in their science and maths and sort of start to recommend that they at least explore engineering as a possibility down the road”.

Participants did not identify any traits as a direct result of their workplace experience. Neither Lily’s workplace experience nor her personal contacts gave her confidence in responding to the question – except for

6 This course emphasizes knowledge and skills related to the craft of writing. Students will analyse models of effective writing; use a workshop approach to produce a range of works; identify and use techniques required for specialized forms of writing; and identify effective ways to improve the quality of their writing [107].
relating her awareness of complexities of the profession to identifying the importance of accuracy.

Considering both the discussion above and the summary in Table 11, it can be stated that there were no clear patterns with regard to a participants’ occupational background and the characteristics they identified.

**Table 11: Coded summary of the engineering traits identified by participants**

<table>
<thead>
<tr>
<th>Interviewee</th>
<th>Occupational Background</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angelina</td>
<td>Workplace Experience</td>
<td>Strength and Interest in Math/Science/Physics</td>
</tr>
<tr>
<td>Oliver</td>
<td>Workplace Experience</td>
<td>Strength and Interest in Math/Science/Physics, Not an engineer</td>
</tr>
<tr>
<td>Gregory</td>
<td>Workplace Experience</td>
<td>Approach to learning, Ambitious, Approach to work, Curiosity</td>
</tr>
<tr>
<td>Molly</td>
<td>Workplace Experience</td>
<td>Not an engineer</td>
</tr>
<tr>
<td>Lily</td>
<td>Workplace Experience</td>
<td>Approach to work, Communication, Strength and Interest in Math/Science/Physics, Not an engineer, Approach to learning</td>
</tr>
<tr>
<td>Arthur</td>
<td>Workplace Experience</td>
<td>Strength and Interest in Math/Science/Physics, Teamwork</td>
</tr>
<tr>
<td>Sybill</td>
<td>Straight into Teaching</td>
<td>Approach to work, Strength and Interest in Math/Science/Physics</td>
</tr>
<tr>
<td>Charlie</td>
<td>Workplace Experience</td>
<td>Approach to work, Strength and Interest in Math/Science/Physics</td>
</tr>
<tr>
<td>Tim</td>
<td>Workplace Experience</td>
<td>[none]</td>
</tr>
<tr>
<td>Mary</td>
<td>Straight into Teaching</td>
<td>[none]</td>
</tr>
</tbody>
</table>

Many participants identified personal limits in knowledge and/or in their perception of the advising scope that was within the responsibilities of their educational role. Many of the participants were honest and forward in prefacing their answer, saying things like: “*not being an engineer myself, the only thing I would know, or that I think I know, and I could be wrong...*” or, “*I know, like for example, I know that there is chemical engineering and a huge number of things but what those are? I have no idea, and what’s involved in one versus the other, I have no idea.*” Lily acknowledged a personal bias in identifying
a student who could become an engineer as one that reminded her of her brother who is an engineer; however she did identify that there was a student who she would identify as a potential engineering candidate that did not remind her of her brother.

Hesitation was apparent in a few cases in which the participant was a bit reluctant in providing concrete responses. Three identified that in their role they didn’t see it as their responsibility to tell students what to pursue, stating that they would encourage students to learn more but as Mary stated, “[I would] try really hard not to impose what I think might work for them”. She pointed out that she would avoid recommending engineering to a student just because she knew their older sibling pursued engineering; she stated, “they are each their own individual”, and emphasized that “I would say I haven’t actually pinpointed anyone, but I’ve always encouraged them to do whatever they want”. Molly identified the perceived limit to her role by questioning, “who am I to say that ‘you can’t be successful at this’, and to say ‘you won’t make it as this’. But if there is concrete evidence there, like if they’re not in the right pathway, [then] they’re going to have to do something”. Angelina provided many disclaimers before her answer about characteristics important to an engineer, “I feel like the only thing – not being an engineer myself the only thing that I would know or think I that I know, and I could be wrong you’ll have to tell me”.

In response to a clarification after Question 4, “Could you tell me about a time when a student approached you with a curiosity about engineering, what sort of things would you discuss with them?” , Sybill’s initial response was, “Ooh, that’s a good one, (pause) I don’t know!” after this and some further reflection, she provided her response. The majority of participants stated that they were comfortable acknowledging their limitations, some of them remarked disclosing it to students.
4.4.2.2 Knowledge of Post-secondary Programs

A less prominent category in the Knowledge theme was discussion of participants’ knowledge of post-secondary programs. Commonly acknowledged by participants from all three schools was the opportunity to attend presentations by representatives from various post-secondary institutions. Peter outlined the availability of these talks and the role teachers take in promoting it, “now we have schools that, obviously, that have representatives that come here all the time. So that stuff is available to all the students and we do make students aware of when those presentations are happening.” Peter also identified that his knowledge of post-secondary programs generally comes from specialized programs with active outreach. He acknowledged knowing less about programs, “that aren’t actively outreaching to specific departments, or school boards.”

Another area of knowledge that participants discussed was not program specific, but related to university life. Charlie observed that students seek him out because they know he’s been to four different universities. He described the value in this experience as “kids, of course, want to ask questions to people who know what the university life is like.” This highlights part of the information that students want in their career decision-making.

Again, drawing on experiences of personal relations, in this case a past student, Mary identified alternate pathways for students after high school, “[college]’s also a lot cheaper which they think, ‘Yea, if I’m not really, not really sure about it’. Because I know one student, a number of years ago, told me that he wanted to be an engineer but he wasn’t 100% sure. So that he was actually going to do an engineering program at college and then once he completed that program that he was going to university.” Similarly, Arthur discussed the pathways available to students after graduating from high school,

“Rightly or wrongly, from the guidance standpoint I try and divide the universities into sort of three profiles, which sort of: universities where only our highest achieveers will likely apply and get in, universities where most of our university-bound students could apply and get in, and then universities where students who identify the desire to go to university but maybe don’t necessarily have the marks
required by most universities in Canada might consider and that would include community colleges that offer, with partnerships with universities, degrees as opposed to diplomas."

He went on to provide examples of his detailed knowledge of these options, “for example, St. Lawrence whose partnership with Laurentian where students can do a Bachelor’s of Arts, a Bachelor’s of Science, or a Bachelor’s of Business Administration and the entrance requirements are a little less stringent than they might be if the student were to apply to Laurentian directly.” Oliver identified community college in a different application; he described it as a path for students who initially may not be a good candidate for engineering, “people do change. I mean if you do a community college program and then moved into it. You could move into engineering.”

Charlie described using his experience in his initial post-secondary program as a cautionary tale for students,

“I went into systems design engineering, and nobody at that time could tell me at that time in one sentence clearly, what systems design was. And so I spent a year in there not really knowing my program was all about, and I’ll tell kids, careful of that, because if no one in your program knows what the program is about when you get out to the work force...how are you going to explain to an employer what your program was about, potential employers may not be aware of the program also.”

He outlines an important but scarcely mentioned connection between the post-secondary program and future career paths.

4.4.2.3 Knowledge of Career Paths

Participants’ knowledge of career paths tended to have been gained in part from workplace experience prior to teaching, or from their post-secondary experience. However, as Mary was quoted in Section 0 drawing from personal experience does have limits.

Lily, Charlie and Oliver all had experience in industry prior to embarking on their teaching role. Lily pointed out that she probably had more industry experience than some, particularly those who had gone “straight through [the] teacher education pathway”. She described the benefit of her experience in that it
“opens [her] eyes in the breadth of employment opportunities in the field of science that [she] was in.”

Charlie’s experience was in a smaller company, he reflected,

“there were maybe 10 people that worked in that company, so I didn’t get a lot of exposure [to other jobs], like we didn’t go out to any computer programming conferences or things like that. Within the company, can certainly see there’s a job for tech people that are support, they got to be able to program, and to be able to calm people down when they call and they’re aggravated. We had an awesome office manager and I can see what a difference, having a capable and personably person answering the phone can make to a work place.”

Oliver recognized himself as one of many people who acquire an engineering education and then “do something different”.

Mary described knowledge developed from one’s personal experiences as limited. She expanded upon the challenges it brings when discussing applications of mathematics. A guest speaker unknowingly corroborated a statement Mary had made about the importance of being able to do unit conversions in the construction industry, and the students were surprised. Mary responded to the speaker’s confusion, and said to the speaker, “I told [the students] that and they didn’t believe me, so it was really good that you were here for them to realize that I really wasn’t snowing them.” In her reflection on this interaction, she hypothesized,

“I think sometimes they know that I became a teacher, like I went through concurrent education, so I’ve only ever been a teacher. I haven’t actually worked in industry or anything like some other people in the building. So sometimes I think they think I’m just making it up. And then they don’t question it, like ‘she probably does know but maybe she doesn’t.’ That they were really surprised that [the construction application] actually was true.”

Many examples included thus far were about Lily’s experience including real-world applications and connections in her instructional and advising practice; she actually commented on why she included her experience in her instructional practice so frequently, “I loved my science jobs. So I always bring it in because I really enjoyed when I worked in science.”

The knowledge held by teachers and guidance counsellors is important as it has been shown to be of interest to students. The knowledge of these individuals was described to be included in classroom
activities and discussions, and was used to explain concepts in advising scenarios. In a similar way, teachers’ and guidance counsellors’ knowledge of engineering has been shared with students.

4.4.3 Gaining More Knowledge

The theme Gaining More Knowledge had two main focuses: 1) participants recognized professional development, and 2) accessing resources their methods for increasing their knowledge. The additional knowledge was frequently to improve their instructional and advising practices. Some identified that learning more about options in the engineering profession and learning the basics of contrasting engineering disciplines would be helpful. Others identified that more general knowledge about career paths and options would be helpful overall. Participants also identified the resources they referred to in advising practices. In many cases, participants outlined what features or information made the resource most helpful or relied on. A commonality in this theme is that Gaining More Knowledge requires a degree of initiative on the part of the teacher. The teacher and guidance counsellor participants indicated how they Gain More Knowledge and their desire to learn more. They also identified how they helped students Gain More Knowledge, specifically through bringing outreach opportunities to students’ attention.

4.4.3.1 Professional Development

With participants recognizing that that there were limits to their knowledge which affected their instructional and advising practice, a follow-up question was developed about professional development: “Do you find that there are enough professional development opportunities for you to learn about what opportunities are out there for students in the workplace or at schools?” The first interview participant, Mary, was not asked this question; rather her discussion points inspired the more direct follow-up question. This question was posed to the following nine participants and in each interview, a natural segue led to this question about professional development. As mentioned briefly in previous discussion, many participants identified that they had limited knowledge about engineering, post-secondary programming
and career paths. Six participants acknowledged the value of professional development, with a few stating that “there is always time for valuable [professional development].”

As Peter acknowledged the changing teacher role previously, he described that professional development would be useful to help adapt,

“well I think certainly, in terms of our professional development, I think that would be useful for sure. I mean because, it’s one thing to know your subject area and be able to teach courses. But it’s another, but more and more our role as teachers is, with so much information available and excellent resources available outside the classroom, we need to be able to facilitate, and guide learning but also guide these choices that students are making in terms of their career paths. Absolutely, I would like to know more and I could find out more on my own... [but a structured day] would be better.”

Gregory responded that more knowledge about career paths and post-secondary options would be useful for teachers, but was skeptical that it would be used because the classroom focus was on covering the curriculum. His suggestion to increase awareness of engineering was to have an engineering student come in to talk to students about: what they considered in their decision-making, about the interesting routes available, some of the interesting work they do. He emphasized the value of a short visit to plant an idea or generate a discussion over a drawn out session with ice breakers and activities. He suspected that,

“[it] would be worth more than a lesson, pre-made lesson package that a teacher just [presents the material].” He identified the challenges with these pre-made lessons,

“They seem so convenient, ‘Oh, here’s a package. Oh look, here’s your lesson plan’. ... They look nice and then you get to execut[ing] someone else’s material, and it never works. ... It’s very hard to, because [with your own material] you know what you meant by that line and how it links to three other things coming up. But when you get somebody else’s, it’s. I don’t know, (pause), you look at it and it just feels like a very prescribed, [and] someone else’s lesson. And the kids say, “Is this your-this isn’t your PowerPoint, is it?” “No it’s not.”

Another suggestion for ways for teachers to learn more to help their students was provided by Mary. In the statement that inspired the professional development follow-up question, she suggested universities have teachers “in for a day to, kind of see what actually goes on.” She proposed that it “might be good for people like me who doesn’t have an engineering background. It may not be helpful for someone who already knows what engineering is all about.” She likened the opportunity to a program whose funding was cut. The College for a Day program invited one person from each school board to attend, with the
hopes of cycling through new attendees each year. Attendees got to visit the mathematics classrooms of different college programs. Mary remarked that “it was really good to see what the math was at that level.” She described the benefits of seeing engineering at a university level could have a similar effect, “but that [college math for a day] really went a long way to see what’s there so I can actually say [to students], ‘You can actually do this, and then do this’.”

Participants identified four main forms of delivering professional development, 1) a session hosted by the post-secondary institution, 2) opportunities for guidance counsellors to visit universities, 3) enrolling in online courses and 4) guidance courses offer through universities. The majority of participants indicated that while they have interest in professional development, it requires initiative because actually doing it is a personal choice and time is often a substantial barrier. With the multiple roles required of guidance, or the logistics involved in being away from the classroom, participants have identified that professional development is undertaken on their own time. In addition to time being a barrier for teachers accessing professional development opportunities, Lily raised the issues that time to implement the learning from sessions is difficult. In contrast to the earlier statement that “there is always time for valuable [professional development]”, a more commonly echoed sentiment would be that “time can be made for valuable [professional development].”

The content of professional development that teachers have found valuable varies. Sybill and Angelina both identified that training for new initiatives, such as the current one with the myBlueprint website, helps things run smoother. Mary identified that professional development that “let teachers know what’s happening” would be beneficial. She observed that “students get invited to a lot of things”, but “thinks that the regular classroom teachers need to get invited to things” as well. Molly also identified that many would benefit from career planning or post-secondary program knowledge. She identified that it is not only guidance counsellors who are involved in advising students on these topics, but Learning Program
Support (for students with a learning exceptionality), and Student Success teachers would also benefit from additional professional development.

As mentioned previously, teacher initiative is an influential factor in participation in professional development opportunities. While the majority of participants identified that in advising scenarios they would recommend students do their own research, two participants explained that sometimes they would find information for a student. Their reasoning behind this was that they would be prepared for student questions about the topic in the future. Mary described her options, “I try to educate myself when a question comes up if I can’t answer it then I either direct them to someone that can or I try to find out the answer for them because the question may come up again”. Additionally she outlined that she reads as much as she can to improve and increase the real-world applications and connections in her instruction.

Arthur described that in his town while there were several local post-secondary institutions, self-motivation was needed on the part of the teacher to learn more about their programming. He described his interactions with the schools,

“[these institutions aren’t] knocking down my door saying, ‘we really want to show you what is happening in our building because we’re excited about some of the new developments in our programming, or some of the new research that is being done here and we’d really like your kids to know about it.’ At the same time, any time I’ve approached [the local post-secondary institutions] and asked for information or wanted a little bit of direction in terms of ‘what’s new in your faculty that I might highlight for kids?’, people generally respond very well.”

4.4.3.2 Resources Participants Used

Question 3 of the interview asked teachers about the resources that they used to prepare for student questions about post-secondary options and career paths. Table 12 summarizes the categories of resources that were indicated as used.
Table 12: Tally of the types of resources participants referred to

<table>
<thead>
<tr>
<th>Resource Category</th>
<th>Number of Mentions</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Media</td>
<td>12</td>
</tr>
<tr>
<td>From a University</td>
<td>11</td>
</tr>
<tr>
<td>Guidance</td>
<td>5</td>
</tr>
<tr>
<td>Family</td>
<td>2</td>
</tr>
<tr>
<td>School Media</td>
<td>2</td>
</tr>
<tr>
<td>Professional in Field</td>
<td>2</td>
</tr>
<tr>
<td>City - Info Day</td>
<td>1</td>
</tr>
<tr>
<td>School - Career Fair</td>
<td>1</td>
</tr>
</tbody>
</table>

The most commonly used resource categorized as general media, mentioned nine times, was the Internet or ‘online resources’ such as the website eINFO. General media included media widely available to the general public, including magazines and newspapers. Resources from a university included artefacts, personnel or visits to a campus. There were three mentions each of documents or books from post-secondary institutions, and interactions with post-secondary representatives. University websites, visits to local universities to view lectures and general interactions such as phone calls were also mentioned. Two participants from School A identified referring to their guidance colleagues with questions they themselves did not know the answer to. Three teachers cited referring students to guidance counsellors for answers and did not state that they interacted with guidance for knowledge. Of the family members referred to as resources, brother was mention briefly and information from husband was detailed much more in depth. This was due to the nature of the husband’s work and the relation to the teacher’s subject matter. School media included resources accessed and utilized in the classroom, such as myBlueprint. One teacher identified using personality quizzes in her advising practice to initiate a discussion about what a student could do. Two participants indicated either bringing a guest speaker from the industry or referring students to personal professional contacts. Information days or fairs, either city-run or organized by the school, were identified by one participant as unique to School C and the town School C is located in.
Participants not only identified the resources they referenced, they also described their perceived value of the resource. As shown in Table 13, there were many facets of each resource that participants found useful.

**Table 13: Value of the resource identified by participants**

<table>
<thead>
<tr>
<th>Value</th>
<th>Facets identified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content</td>
<td>7</td>
</tr>
<tr>
<td>Quality information</td>
<td>6</td>
</tr>
<tr>
<td>Feature</td>
<td>5</td>
</tr>
<tr>
<td>Accessibility</td>
<td>3</td>
</tr>
<tr>
<td>Speed of Resource</td>
<td>3</td>
</tr>
<tr>
<td>Preference for website</td>
<td>2</td>
</tr>
<tr>
<td>Many sources</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 14 details what participants wanted included in a resource, the medium for information delivery, and what made the resource useful.

**Table 14: Descriptions of the valuable parts of a resource**

<table>
<thead>
<tr>
<th>Value</th>
<th>Mentions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Content</strong></td>
<td>(7)</td>
</tr>
<tr>
<td>Admitting averages</td>
<td>1</td>
</tr>
<tr>
<td>Course marks</td>
<td>1</td>
</tr>
<tr>
<td>Faculty information</td>
<td>1</td>
</tr>
<tr>
<td>New program information</td>
<td>1</td>
</tr>
<tr>
<td>Prerequisites</td>
<td>2</td>
</tr>
<tr>
<td>Program awareness</td>
<td>1</td>
</tr>
<tr>
<td><strong>Quality information</strong></td>
<td>(6)</td>
</tr>
<tr>
<td>Confidence in guidance</td>
<td>1</td>
</tr>
<tr>
<td>Quality information from source</td>
<td>1</td>
</tr>
<tr>
<td>Reliability of information</td>
<td>1</td>
</tr>
<tr>
<td>Source for information</td>
<td>2</td>
</tr>
<tr>
<td>Source has high quality</td>
<td>1</td>
</tr>
<tr>
<td><strong>Feature</strong></td>
<td>(5)</td>
</tr>
<tr>
<td>Compare Options</td>
<td>2</td>
</tr>
<tr>
<td>Direction for information</td>
<td>1</td>
</tr>
<tr>
<td>Program eligibility</td>
<td>1</td>
</tr>
<tr>
<td>Projection of student goals</td>
<td>1</td>
</tr>
</tbody>
</table>
Table 14 (con’t): Descriptions of the valuable parts of a resource

<table>
<thead>
<tr>
<th>Value</th>
<th>Mentions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accessibility</td>
<td>(3)</td>
</tr>
<tr>
<td>Opportunities for Interaction</td>
<td>1</td>
</tr>
<tr>
<td>Colleagues with Information</td>
<td>1</td>
</tr>
<tr>
<td>Many Universities Present</td>
<td>1</td>
</tr>
<tr>
<td><strong>Speed of Resource</strong></td>
<td>3</td>
</tr>
<tr>
<td><strong>Preference for website</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Many sources</strong></td>
<td>2</td>
</tr>
</tbody>
</table>

The popularity of online resources was described by some participants. Angelina noted that after working with students to look up information online, she was able to print off the specific information. She contrasted this with book resources, by saying that “kids associate with technology more than anything at this point”, and she got a negative reaction from students if she gave a student a book to look through.

Sybill mentioned that while School A has a computer lab, only some of the computers work. She stated that they just got iPads for each student to use in class and would be trying to use them in class to work through setting up myBlueprint with them. Peter described his intention to have an interactive classroom where students work with each other, and use “digital devices”. He stated that he hopes that the students learn as much from each other as they do from him.

Most participants indicated that they referred to more than one type of resource when preparing for or responding to student inquiries. All four guidance counsellors identified using the internet to look up information on their own and while working with students in an appointment. Three participants identified using the eINFO website as their primary resource. The website allows the user to compare programs and provides a lot of admissions information. After using eINFO, or if the student had specific questions about universities or programs, the three participants identified the universities as a resource – either visiting their website, or placing a phone call.
Angelina, the guidance counsellor who identified slightly different practices, did actually follow a similar pattern. She identified that sometimes she uses two resources when searching for information. In looking for post-secondary program information, she looks online and through the books left by universities and colleges after their visits to the high school. Both Angelina and Molly noted that if they saw senior students, they would often turn to other guidance counsellors at the school who would know the answer, or refer the student to the counsellor with that knowledge. Angelina gave the example of students who wish to study at a school in the United States of America, and Molly identified her decision point to refer the student as, “if [the questions is of] something that’s beyond my scope or too specific.”

4.4.3.3 Helping Students Gain More Knowledge

As identified in the varied role of a teacher, the participants help students gain skills and knowledge outside of classroom material. Quoted previously, Gregory identified that he framed his course as preparation in course material as well as study habits. The observation that participants commonly described their experiences or experiences of their personal contacts in advising and instructional practice was discussed previously. While Lily and Gregory commented on their enjoyment of sharing these stories, they both identified challenges in this practice.

The challenge Lily previously identified was that students were very focused on grades for admissions and scholarships, and this impeded their engagement in inquiry-based learning. The inquiry-based focus aimed to develop critical reflection skills and communication skills. She also commented that she tried to make the inquiry-based labs reflect industry practice to bring some awareness of careers and industry applications.

Gregory identified a similar challenge in encouraging student to develop skills or knowledge that does not directly contribute to their grades. He used two stories to discuss the importance of study habits and preparation for the workload in post-secondary education. He observed students do not come prepared to
class, but still get satisfactory marks. In his story, he empathizes with students and likens their attitudes to his own when he was in high school. He spoke about how he was able to get by with marks in the low- to mid-80% range without studying, and being content with the situation. Gregory discussed the sheer amount of content in university and how his lack of study habits had significantly impacted his ability to succeed in university. He summarized this in the following quote, “I try to emphasize that, ‘build some skills’ and again, it’s these things they don’t get marks for, and so to a student, those things have no value, because they don’t look past the marks

In reinforcing the effects of these study habits Gregory encourages students to develop, he described telling a second story, this one about his brother who is 10 years his junior. In the story, Gregory pointed out that his brother was “a slacker” and “did very little” but did get into college somehow. The brother relished in the independence and “bit of responsibility that came with it”. In a conversation between the brothers, the younger one identified that college was going really well, he stated “it feels like I’m cheating on my tests. I study now, and I know the answers. And it feels like I’m cheating because I know [the answers]’.”

Gregory stated he recounted this story frequently to the Grade 12 college classes he taught. He emphasized that “that is what knowing things is about, that’s how tests should feel, it should feel when you’re being assessed on something, that you’ve been exposed to it, not for the first time during the test, but that you’ve seen it a few times.” He said that it was a fun story he loved to share and he observed that students enjoyed hearing it, but he was not sure if the lesson stuck with them. To reinforce the story he bring up a reminder of it often, “I don’t think it lasts long. But it allows me to jolt their memory with a quick story, ‘Remember the story about my brother?’”.
As commented on in Section 4.4.1, the responsibility of bringing awareness to outreach opportunities tends to be bestowed upon teachers. Many participants agreed that, with time permitting, having additional knowledge for themselves about post-secondary and career pathways would strengthen their advising practices. However, in addition to this, participants outlined the importance of student knowledge, initiative, and engagement in the learning process.

Participants identified that part of their advising practice was encouraging students to access outreach, particularly that which is available at the high school level. They indicated that all three participating schools were visited by representatives from post-secondary institutions to run information sessions with students. Lily identified being unfamiliar with the content of the sessions, “those universities are left to, … um, discuss what is ever on the agenda, students are also encouraged, I think, always by the rep, to ask about specific faculties they are interested in but I’m not sure how they run [the sessions].” Angelina, who had identified attending some sessions, described her experience:

“the people who come are pretty knowledgeable. Like I’ve sat in on some of the sessions and kids ask specific questions about programs and usually [the representatives] will be able to answer pretty specific questions about faculties. So that’s a positive for sure. I don’t know if that’s a case of them following trends and seeing where students are interested in going and they load up on that [information] before they go, but they do seem to be able to answer a lot of specific questions or at least point students in the right directions to find the info.”

Oliver stated that not all universities are represented though, he pointed out that if the trend is that few students from that high school apply to the university, it is unlikely the university will find the visit worthwhile.

As Mary outlined, it might be valuable to expose teachers to educational programming different from their own experience. She suggested having teachers visit different programs at a post-secondary level just to “see what actually goes on”. In visiting an engineering faculty, she acknowledged that it would help people without an engineering background with ability to advise with more confidence on options.
In addition to observing that university- and program-specific content is desired by students and also by teachers, participants identified that connections between post-secondary programs and careers is needed. Charlie identified it was important that a student could explain their niche post-secondary program to employers when looking for employment. This is an example of bringing awareness of the connection between one’s post-secondary program and eventual or resultant career path. Previously discussed was how Angelina identified that gaining more knowledge about careers would help her bring this awareness to students with whom she interacts.

4.4.4 External Influences
In following with the outcomes of a semi-structured interview, participants used the questions to guide their responses but frequently discussed ideas that were related but not directly inquired of them in the interview protocol. One of these topics was the external influences on high school students in their career decision-making. The two major categories that emerged here were the Culture of the High School and the effect of Parental Influence.

All participants identified external influences that affect students’ pathway planning, and career decision-making. The three participants from School B described school-specific influences on the students. Peter identified “a strong sort of culture, cultural background in [the] school, particularly in families, of post-secondary education”. He identified that he knows that “a lot of [students at this school] from an early age have been strongly encouraged that they will go to university for sure. Without, particularly, having that much guidance about where they’ll go or what programs they’ll go into. So that already exists here.” He also commented that many students “are quite focused and prepared in general”.

Oliver described that the students at the school are often “socio-economically higher than some places, so there is some maybe more, more, money in their homes and in their family”. He suggested an effect of this is that “they are able to travel [campuses] and see them” and as a result “a lot of the kids here are a little
bit more privileged” with these additional experiences to help in their decision-making. Mary and Oliver both acknowledged that at their school, there is a stigma attached with pursuing a college pathway. Oliver described that the school population is “more of a university-bound clientele” and he recalled overhearing that students who are not university-bound, “don’t feel as included”. He also identified that even though for a lot of students “the school is about going to university” there are “a lot of students who do go to college”. Mary described that “some students feel like they are failures if they actually want to go to college as opposed to university”. As a result she identified that she alters her practice to help them, “I actually have the college presentations happen during my college level math class, if at all possible, a) because they’re a captive audience, so that there’s somebody actually there, because at this school a lot of people don’t come, but b) because they need to see it.”

As particularly evident through this example, there are factors that could affect the opportunities for student learning, for example whether they are able to visit campuses, and whether they feel comfortable making pathway decisions. While this study is focused on university-bound students, it is worthwhile acknowledging that some students may struggle with the academic demands of a university program. However, these students may have other aptitudes that would suggest that they could still succeed albeit with lower marks, or could embark on engineering at a college-level first and switch into university later as Oliver and Arthur suggested.

Participants briefly commented on the factors that affected students’ decision-making. Arthur mentioned that exploring scholarships, living arrangements and transitioning away from home all cause a “fair degree of stress”. Lily commented on that some students were fixated on the reputation of a post-secondary institution, and she indicated that she pointed out to students that, “if [the university programs] are accredited and they have been around a long time, they probably got their act together and are doing a very good job.” She described students who perceived different business programs as better than others.
and how she would respond, “so we’ll talk about that, where I’ll say, never pick because this one’s a better _____. You’re looking for um, pause, for specifics of like of many things, and you got to get onto that campus and see.” Lily identified another influence on students were their peers. She discussed that in post-secondary decision needed to be a personal “inside-out” decision and not just consider what “[their] friend is doing”. Part of the tendency for the “outside-in” decision, Lily suspected was that while many students were academically very smart and capable of making good decisions, they were not confident and as a result would pick “safe things”.

The final External Influence discussed by three participants was the effect of parents. Gregory commented that parents discuss their student’s goals or their goals for the student at Parent-Teacher night. Oliver suspected that “a third of the ideas” that students present interest in, may be the parents’ ideas. He also commented that students may feel pressured to fulfill their parents’ wishes and feel like “they’re letting their parents down because they can’t do it.” As Lily was quoted on earlier, she suspected that low awareness of the range of careers is a significant deficiency in both student and parental knowledge. With a narrow understanding of options available for their student and with such an influence on their student, it is important to consider how this affects a student’s decision about their future.
Chapter 5

Discussion

The following sections will discuss how the data presented in Chapter 4 responds to the research questions presented in Section 3.1. The two research questions are:

1) How do students use the resources available to them to learn about careers and the required educational training for these careers?

2) How do teachers and counsellors apply their knowledge of engineering when advising students on engineering programs and career paths?

In addition to commenting on these questions, the data offered additional insight in the outreach interactions between high schools and post-secondary schools. One of the goals of the research was to investigate the effect of proximity to a post-secondary institution on student, teacher and guidance counsellor knowledge of engineering, or post-secondary programs. These topics are included in the Discussion as well as the Limitations of the study.

5.1 How Students Use Resources

The literature reviewed showed that students refer to teachers and guidance counsellors among the individuals they identify as resources for career planning information. While this has shown to be the case, little research shows what information they solicit from these individuals, and why students interact with them. The analysis presented in Section 4.3 provides some insight to enable a response to the first research question. Students were found to commonly use online resources, and used multiple resources to access different information or for a different purpose. Data from both the Student Survey, and the Teacher and Guidance Counsellor Interviews showed that students do rely on their teachers and guidance counsellors for advice or information in their career decision-making.
5.1.1 Students Use Resources Online

The observation that the Internet and Career Resource tools were identified as used more frequently, and that Career Resource tools were commonly online resources, is corroborated by the teachers and guidance counsellors who acknowledged that students associate comfortably with technology. Sybill described using the school’s computer lab to do personality quizzes online to facilitate student self-discovery, acknowledged that students sometimes “fool around with the online stuff” and likes to have students complete the quizzes on paper so she and they have a record of it for reference. Sybill also identified her intention to work with students in using technology. Her plan was to walk them through setting up and using myBlueprint. She noted that she had the opportunity to attend training on how to use myBlueprint and happily described functionality offered by the software.

The use of computers in appointments with guidance counsellors was also common practice. Counsellors identified looking up schools and programs online, as well as working with students to find this information. Teachers and guidance counsellor participants identified that students are comfortable with technology, and that formal advising scenarios often include the use of technology. These observations and the recommendation by some teachers to “go look it up!” provide some insight into the dependency of students on online resources.

However with this dependency comes the need for some awareness regarding the quality of the information online. Angelina identified that, “I know that at any point I could click on the internet and I could be led astray as well, so you have to think critically about what you’re looking and know with the background. So I can sort of pick up on that.” Earlier in the discussion she mentioned showing students how she gets information online; however, it was unclear as to whether the quality awareness was included in this demonstration.
As discussed in the literature, as decision-makers high school students must know that they need information, and know how to locate, evaluate, and effectively use the this information. This is also known as information literacy [100]. It was clear that many advising practices were very focused on acquisition of knowledge, in volume (“I’m going to give you as much information as I can so you can make the decision that’s best for you”), and in detail (connecting students to professionals in the field).

An information-literate high school student would be able to determine the type of information and extent of information needed, be able to understand how to access this information efficiently, evaluate the information (e.g. Is it from a credible source? Does this recommendation make sense with what I know about myself?) and apply it to their post-secondary and career decision-making. Peter identified the role of teachers as to guide students through the management of the high volume of career information that is accessible to them. This would include supporting students in becoming information-literate.

5.1.2 Students Use Multiple Resources
Students are likely to use approximately three resources in their post-secondary exploration. Twelve participants identified using multiple resources from the list provided. While the question posed to students, ‘what resources did you find most helpful, and why?’ invited students to identify multiple resources, only 12 out of 34 participants who included further detail described multiple helpful resources. One student identified three helpful resources, while the other eleven listed two resources.

5.1.3 Students Use Resources for Different Purposes
Ten students provided detail on the helpful information obtained from each source. The one student who listed two resources as helpful simply wrote “eINFO, work friends” with no other information. Of the multiple resources used, the following pairs were considered to be most helpful. The pairs are shown in Table 15. The underlined rows indicate that two students identified these were the strengths of the resources they found most helpful.
Table 15: Helpful pairs of characteristics

<table>
<thead>
<tr>
<th>Characteristic #1</th>
<th>Characteristic #2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information</td>
<td>Interaction</td>
</tr>
<tr>
<td>Academic Planning</td>
<td>Career Planning</td>
</tr>
<tr>
<td>Program Information</td>
<td>First-hand Experience</td>
</tr>
<tr>
<td>Insightful</td>
<td>Detailed Program Information</td>
</tr>
<tr>
<td>Broad Information</td>
<td>Specific Information</td>
</tr>
<tr>
<td>Quality of Information</td>
<td>Quantity of Information</td>
</tr>
<tr>
<td>Academic Planning</td>
<td>Academic Planning</td>
</tr>
</tbody>
</table>

Academic Planning was identified by one student to be the most helpful characteristic of both resources they identified. This analysis shows that students used different resources for different purposes. This supports the idea that there does not need to be one resource that is the decisive source for information about engineering. From the observation presented in Section 5.1.2, some students are comfortable identifying that multiple resources were most helpful for different reasons. Considering Table 15 as a whole, it broadly describes the categories of information that students consider necessary to their decision-making.

5.1.4 Students Ask for Their Teachers’ Opinions

While only one teacher was identified by a student as being the most helpful identified for the information they provided (what is important to consider when picking a career”), 15 students identified their teachers were resources they referred to when learning about post-secondary career paths. The fact that students interacted with their teachers, but may not have thought the information at the time as particularly useful, agrees with the previously mentioned study [39], [40] that found that students indicate the helpfulness of the information from their teachers varies.

Analyzing data from Questions 2 and 3 together, Table 16 shows that the subject taught by the teacher is generally related to the post-secondary plans of the student who identified them as a resource.
Table 16: Post-secondary plans of students who used a teacher as a resource

<table>
<thead>
<tr>
<th>Subject Teacher</th>
<th>Student Post-secondary Plans</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kinesiology</td>
<td>[nearby university], [university] bio or Kinesiology</td>
</tr>
<tr>
<td>Kinesiology</td>
<td>nursing/kinesiology -&gt; waiting for acceptance</td>
</tr>
<tr>
<td>Gym</td>
<td>Gym teacher</td>
</tr>
<tr>
<td>Kinesiology</td>
<td>Kinesiology - teacher?</td>
</tr>
<tr>
<td>Grade 10 Civics/Career</td>
<td>Business and Digital Art</td>
</tr>
<tr>
<td>Kinesiology</td>
<td>Gr. 13, then [nearby university]</td>
</tr>
<tr>
<td>Bio, Chem</td>
<td>[nearby university satellite campus] as a veterinary tech.</td>
</tr>
<tr>
<td>Co-op</td>
<td>[nearby college] - Early College Educator</td>
</tr>
<tr>
<td>Co-op</td>
<td>[nearby college] for Broadcasting - radio</td>
</tr>
<tr>
<td>Guidances</td>
<td>Electrical Techniques</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>I plan on going to [nearby college] and being a millwright</td>
</tr>
<tr>
<td>Music</td>
<td>[nearby college] - Music Industry Arts, OIART</td>
</tr>
<tr>
<td>Career Studies</td>
<td>[University] Bachelor of Applied Science in Civil Engineering</td>
</tr>
</tbody>
</table>

The designation ‘nearby’ is subjective; however, is used in Table 16 to describe an institution within 100 kilometers of the high school attended by the participant. Further discussion on this connection is not possible without additional information from the student about the advising interaction; however, it does appear that students do seek out a teacher with some subject knowledge related to the field they wish to pursue. In describing that students do not ask him about engineering, Peter identifies that they probably know that he is not their best resource. He identifies that there are some teachers on staff who were engineers and that students “probably” approach them with questions.

Further investigation on the teacher-student interaction would provide insight to assist both parties in the conversation, for example: what makes a student approach a teacher, what do students consider as ‘using a teacher as a resource’, how students evaluate information or a resource as useful, and what students expect from the interaction. This is expanded upon in Section 5.4.

On the other side of this interaction, teacher and guidance counsellor participants in this study described some of the questions students ask them. As described in 4.4.1.1, teachers’ opinions were often solicited.
This corroborates the information that students use teachers as resources; however, perhaps they may not consider these questions as interacting with resources. The other common themes of the questions that students asked their teachers were about post-secondary planning and fit in a career.

5.2 How Teacher and Guidance Counsellors Apply Their Knowledge

Two major findings arose from the analysis that described how teacher and guidance counsellor participants applied their knowledge in advising scenarios, and that there was a clear focus on making sure students were prepared academically for application to a post-secondary program. Discussion regarding student intentions after their post-secondary education was often brief. The engineering knowledge held by participants was very focused on the academic preparation, aptitude and enjoyment required. The requirement of engineers to be creative problem-solvers with an aptitude for design and communicating their work was rarely discussed. The description of a student who should consider engineering was one who had academic strength in and enjoyed mathematics, science and physics, as well as had the innate ability to set up a problem and the focus to solve a difficult math problem. The importance of career ‘fit’ discussions is particularly evident in the engineering education and career pathway. Students who are described by the characteristics the participants identified could be appropriate to pursue any number of STEM career pathways. Notably absent from the identification were creativity and design, both considered key elements of engineering.

5.2.1 Connection between Education and Career

The students were specifically surveyed about the resources they used to learn about university program; however, the questions posed to the teachers and guidance counsellors were designed to learn about their advising practices as a whole. The first question asked the participants to describe the environment in their classrooms and advising scenarios when students are learning about and applying to university. The second question inquired as to if they observed that their role changed at this time. The third question asked participants to describe the resources to which they refer when learning about both university
programs and career paths. The fourth question was not specific as to whether the request was about engineering as a post-secondary program, or a career path or profession. The fifth question specifically requested participants to consider an engineer.

The wording of Question 4 did not specify what the word ‘engineering’ referred to, as a result the open-ended question allowed participants to accurately describe their advising practices without presuming they advise on post-secondary and career paths. Through this approach, the tendency to advise students on post-secondary program selection prevailed over career path discussion. While perhaps understandable due to the immediacy of the need to apply to post-secondary programs, or the very possible instance that a student can change their mind about a longer term goal, there were very the nominal and brief mentions of career considerations in advising.

For guidance counsellors, discussions commonly centred on planning in high school for application to post-secondary program. This finding is in agreement with the literature [33], [41]. In describing a list of mock questions they would ask a student in an advising scenario, “what might you want to do?” was often a starting point. Oliver pointed out that students in as early as Grade 10 at least have an idea that they want to “get somewhere after university”. He recognizes the priority in planning is that “to get there, they have to get to a university”. Similarly, Molly outlines that the answer to the question “what do you want to do?” informs her of what high school pathway students should be in, and “opens the conversation”. Another guidance counsellor, Angelina, described students in Grade 10, “they’re really just at the beginning stages, of really trying to figure things out. They know that they need to start making decisions but they don’t know how to really begin”. This suggests that there is a need for guidance counsellors to be able to help students make the connection between where they are in high school, and where they want to go, and how they can get there.
There are students who are more prepared, Angelina identified that the questions from these Grade 10 students are more along the lines of “I know I want to ... for example be a teacher, so what do I need to take. So they want to know exactly the meat and potatoes to know what courses they need to get to there”. Either she, or the student in their questions, identifies discussion or interest in just the schooling needed to get there. A similar pattern was present in her advising experiences with senior level students. She observed that their questions were more specific, for example “I want to go to this school for this program, do I have everything I need? Or what can I do to help my application or things like that”. Again, the focus of the questions is on post-secondary education.

Oliver identified that he observed that more often than not at School B, “students come to us with a goal in mind, like ‘I want to do kinesiology’, ‘I want to do engineering somewhere’, ‘I want to be an athletic therapist’, like they have an actual job. They come to you wanting something and often times they’ll leave here, finding out that they can’t, that that’s not going to be that easy to get there. Because you have kids who want to be a mechanical engineer but they’re getting a 52 in Grade 10 math.”

This shows that these students have an awareness of jobs, but often do not know how to connect their current schooling to that career.

While the survey questions were designed to encourage students to consider resources they used to learn about the university program, eight students also identified career path information they found useful. Two of these students remarked wanting information about both academic and career planning to make their decision about university programming. The information about career planning identified by students were,
In this compilation of quotes, students show their interest in learning about career planning to make a decision about their future.

For students who were undecided, guidance discussions were described to focus on trying to get students to identify or learn about what they want to do. Oliver stated that it was challenging to get students talking about “what they want to do” or even “what they might want to do”. He identified his strategy was to “try to get them thinking about what courses they might have taken in school that they liked, or where do they think they might want to be in 10 years”. However, he acknowledged that oftentimes students do not have a response to that, “a lot of times there’s nothing there”. Angelina detailed smaller questions she used to probe about students’ values and the resources they have available. In discussing planning for the flexibility in courses they can choose to take in Grade 11 she was the only participant to make such a direct connection between high school course planning, post-secondary education planning and career planning. As the quote below shows, the connections are logistical factors (e.g. finances, location) involved in post-secondary and career decisions,

“So we’ll talk a little about what things might they choose to help plan for that and then also we talk about other things like ‘do you intend to stay close to home’ or ‘are you willing to go anywhere based on what you want to do’. And then we also talk to about finances, like ‘would you need financial support to go to school’, and what that might look like and ‘how does going further away affect that kind of decision thing’ and stuff like that.”

Angelina identified that there is a tool she is helping develop to guide “whole career life planning” discussions. The areas of discussion are: “who am I”, “what are my opportunities”, “who do I want to
become”, and “what’s my plan for achieving my goals”. These discussions were found to happen organically but with a varying degree of structure.

Arthur observed that over the course of high school, he does observe changes in students from Grade 9 to Grade 12 as they become self-aware and learn about their options, “they start to identify more clearly what their post-secondary pathway might look like connecting what they’ll do in university to what they might do as a career.” While he pointed out the connection between academics and careers, the students’ realization is still based in academic performance for entry into a competitive post-secondary program; a few of these students were observed to “take a more focused approach to their academic work”. but at a Grade 11 level Molly commented that she gives students a starting point: “what are your interests’, ‘what do you enjoy’, ‘which [courses] are you doing’, ‘are you the most successful in’”, then provides them with websites as resources and sets them on their way. She later identified that the research should be on “what it means to be in that job and what the, everything, job prospects and what it entails.” It was unclear whether she made it clear to students that their research should include these career-related queries; however, some of this research, ideally, was taught in the Grade 10 Careers course.

As mentioned in Section 3.5.2, the discussion around Careers class advising was considered differently because unlike classroom discussions, guidance appointments, and informal conversations there are marks associated to the work done in Careers. As mentioned by Gregory and Lily, they both observed that student behaviour changes when there are grades assigned. Sybill described a variety of attitudes towards Careers education in her classroom. She described some students go along with it and love Careers class, while those who do not, “they haaate it. They don’t like it. They go ‘I don’t know about myself’ even when you’re doing these tests. Some of them are just ... ‘I don’t know. ‘I don’t do anything well’, there’s no self-esteem.” Sybill also identified that it was “pulling teeth” trying to get some students to engage in the Careers class material. It was clear through the interview that her practice was to pose many questions to
students in attempts to get students thinking. In this encouragement, she described making the connection between “what do you think you want to do” with the self-discovery students did at the beginning of the course in considering “what [they] are good” at and “what [they] like”.

Due to the nature of the course and curriculum, the distinction between post-secondary education learning and careers is much clearer because of the assignments and units. Sybill identified some of the assignment students needed to do for the credit. She identified two things that students will have been exposed to: comparing two post-secondary programs, and researching a career. Additionally, as she identified that students would be exposed to the connection between their strengths and interests, and how they relate to what they might want to do both for further education and as a career. However, while all students will have taken Careers, it is apparent through the interviews that some senior students are unaware what information they need, and how to evaluate and use it in making a decision. Many students were observed to be focused on just the next step of education, have mismatched goals and abilities, or are simply misinformed.

There are a plethora of reasons why students do not appear to apply the learning they acquired, or should have acquired. The two overarching factors are engagement of the students and the Careers teachers. As the literature review showed, if teachers are uncomfortable or unfamiliar with the subject matter, their instruction is less effective [68]. Sybill observations agree with this finding, she pointed out that she “learn[s] and doesn’t mind talking about careers” while “some people don’t like to do it, [she’s] fine with it”. While this answer doesn’t exude enthusiasm as Lily did in her reasoning for always bringing her science jobs up in classroom instruction or discussion, “[because] I really enjoyed when I worked in science”, Sybill’s statement outlined that she is invested in the position because she learns about careers, and her discussion on her experience teaching Careers sounded well-intentioned.
As shown by the discussion on the disclaimers and self-identified limits of advising role, many teachers were hesitant to impose whether they think the student would be successful in a job apart from pointing out that they were not academically prepared. Three of the four guidance counsellors described that conversations they frequently had were with students who had misconceptions about what future education or career path they could pursue based on their performance in school. They all pointed out that this was a challenging conversation to have. While it was a part of their self-described advising role to not judge whether a student could be successful in their desired career path, many identified that it was within their role to discuss realities when “there is concrete evidence there, like if they’re not in the right pathway”, or if their marks, as they stand, simply will not earn them a successful application to a program with higher admission requirements. At this point, guidance counsellors identified that they discussed with students alternative pathways to a similar career, or strategies for improving their grades, or going back and upgrading their academic programming to enter the desired pathway. With this focus on academic preparation and planning, there appears to be a low awareness or priority to the other factors that influence whether a student would meet their goals in the further education or career path.

Comparing the findings of this study to Gati et. al.’s model of the ideal career decision-maker, it would appear that students are deviating from this model in a few areas. Recalling that an ideal career decision-maker is aware that there is a need to make a career decision, is willing to make the decision, and is capable of making the decision, a) based on an appropriate process, and b) that is compatible with the goals and resources of the individual; below is a summary of the findings highlight the potential gaps in student preparation.

Oliver and Angelina identified that students know there is a need to make a decision, and through approaching teacher and guidance counsellors for advice, it would appear that students are indeed aware of the impending decision and some of the information they want. It was rarely commented upon whether
it was clear students were willing to make the decision; however, Charlie mentioned that some students take a ‘victory lap’, or graduate and work before embarking on a post-secondary education. He mentioned that he observed the reasoning was often to take more time to decide, or to pick up prerequisites. With this decision, some students were observed to realize they were unable to make an informed decision about a post-secondary choice, and required additional time or knowledge. While participants did not describe a decision-making process for students to follow, they emphasized considerations through describing their own decision-making experience. These considerations were often posed in the form of questions to check students’ thinking. In the final requirement of an ideal decision-maker, students’ goals are often a post-secondary degree, or a career they are unsure how to pursue. Resources of an individual were often discussed in the forms of financial restrictions and the effect location had on their decision.

From Gati et. al.’s model, the categories of difficulty likely to be encountered by these Ontario high school students as identified by the data analysis are summarized in Table 17 and Table 18. In both tables, ‘participants’ refer to the teachers and guidance counsellors participants unless otherwise stated.

Table 17: Lack of Information difficulty category, as described by findings

<table>
<thead>
<tr>
<th>Lack of Information</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge about the steps in the process</td>
<td>Lacking. Informal decision-making considerations provided</td>
</tr>
<tr>
<td>Information about the self</td>
<td>Present. Is a focus in guidance appointments and in the Grade 10 Careers course</td>
</tr>
<tr>
<td>Information about the various alternative occupations</td>
<td>Lacking. Acknowledged as a weakness of participant practice, or as outside advising role scope. Suspected to be limited in many parents of students</td>
</tr>
<tr>
<td>Information about the ways to obtain information</td>
<td>Strength. Participants were quick to identify sources with quality information (first-hand sources), or providing guidance to students in finding or using resources</td>
</tr>
</tbody>
</table>

(* Student participants also valued resources that provided additional resources for further research)

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7 A term for an additional year of high school after one’s Grade 12 year.
Table 18: Inconsistent Information difficulty category, as described by findings

<table>
<thead>
<tr>
<th>Inconsistent Information</th>
<th>Summary of Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unreliable information (unreliable, or contradictory)</td>
<td>Nominally discussed by participants</td>
</tr>
<tr>
<td>Internal conflicts (e.g. contradictory preferences)</td>
<td>Present in students in the form of mismatched goals and abilities</td>
</tr>
<tr>
<td>External conflicts (e.g. influence of significant others)</td>
<td>Present with regard to the influence of parents and friends, not an issue as participants frequently reserved judgement and actively withheld personal biases or views</td>
</tr>
</tbody>
</table>

The two categories that were described as ‘Lacking’ were identified as such as a result of the analysis of data collected in interviews. For the categories that appear to be ‘Present’, it is acknowledged that the topic was commented upon, but not at length. Information about ways to obtain information was identified as a ‘Strength’ because of the varied and detailed ways participants described themselves supporting students in getting information. Additionally, data collected from the student survey indicated some students found a resource particularly helpful when the resource would identify where to go for further information (e.g. post-secondary representatives providing printed information, or myBlueprint providing links to university websites).

While the ‘Unreliable information’ category was identified as ‘Nominally discussed by participants’, the idea of quality or reliable information was mentioned. Students identified the value of talking to current post-secondary students because of their first-hand experience, or the value of their first-hand experience in a co-operative education course. A few teacher and guidance counsellor participants recommended students approach the post-secondary institution as the source for the specific program or institution information. As quoted earlier, Angelina mentioned that it was easy to be led astray with information on the internet.

The identified missing part of students’ decision-making is their consideration of how their post-secondary program choices affect their pathway after post-secondary graduation. It appears that advising practices within the high school environment rarely encourage students to consider how their career goals
affect the program they choose. Also absent were considerations of suitability within an educational and career pathway apart from academic preparation, such as aptitudes or skills required. The selection of a post-secondary degree program may be higher priority in advising scenarios; however, goals after this program need to be considered in this decision, as well as the effects that getting that degree will have on one’s future.

Exemplifying the importance of these considerations is the current advising practices with students presenting an interest in pursuing engineering. While a university engineering program has many prerequisites and generally high academic performance required, this does not characterize the whole profession. With the observed focus in high school advising on academic pathway planning and preparation, a student may be academically prepared for and apply to an engineering program with little understanding of the design work, creativity, communication skills, and other professional considerations required.

5.2.2 Knowledge of Engineering
As demonstrated by Sybill’s description of a mock interaction with a student, a commonly held perception of engineering was the knowledge base required. Sybill indicated her response to students stating, “I’m interested in being an engineer” or “I want to be an engineer” was “oh, okay, because you like physics and math, is that it?”. This common connection was made by seven of the eight participants who provided characteristics in their response. One of the two participants who did not provide characteristics remarked that he was not approached with questions about engineering because he suspected students went to other teachers who had experience with engineering. The other participant indicated that she was careful not to impose her bias on what a student should pursue.

When participants had no personal experience in or no personal contacts involved in engineering, they described engineering solely in terms of the importance of academic strength in mathematics, and science
(particularly in physics), and brief conceptualizations of disciplines. Apart from one participant recognizing that accuracy in mathematics was important to the profession (with reference to accuracy in bridge design), and another drawing from his own experience in engineering education, the importance of mathematics, science, and physics was not fully described. One participant described mathematics and science, at a university level, in terms of the courses being prerequisites to application to a university engineering program. One participant identified Grade 12 university level physics as a prerequisite. All other references to the academic subjects were with regard to engineering requiring strong academic performance or enjoyment of the subject matter.

Few had a clear idea of what an engineering discipline was, as demonstrated the variation in responses. Descriptions of discipline were described with varying degrees of depth and accuracy. Of the eight participants who provided responses to the engineering questions (Questions 4 and 5), six stated an awareness of the divisions within engineering. Three participants attempted to list a number of them, but as shown in the following quotes by the hesitations, filler words and pauses, their initial confidence dwindled:

“You go from mechanical to computer, and (pause), civil, and suddenly you’ve got chemical too, and it’s, they’re kind of, all under this engineering umbrella”

“I know like for example I know that there is chemical engineering and a huge number of things but what those are? I have no idea”

“I at least know, well, there’s civil, there’s uh (pause) there’s civil, and there’s science engineer, that’s about all I really know about engineering.” A little later, chemical engineering was remembered.

Sybill and Arthur both identified further details about certain disciplines. Sybill identified related work and an employer (bridge work for a city as a civil engineer, or involvement in nuclear power plants as a chemical engineer) and Arthur described the remote job sites in mining engineering. Lily identified the overlap between the disciplines, while Gregory described them to be “very different” from one another.
Charlie had completed part of a university engineering program before switching to a science degree. He stated confidently that he would “certainly be able to explain typically what the standard disciplines involve” and had also “told students there are some, kind-of, fringe disciplines in engineering”; this was knowledge he had gained from his engineering education experience. Oliver, who had completed an engineering education and worked as an engineer for a few years before teaching, emphasized the importance of ability and enjoyment of mathematics, science and physics. The only mention of an engineering discipline he made was with reference to an engineering classmate who took civil engineering at a community college after quitting the university engineering program he was in. In the many descriptions given by participants, there was little agreement on responses describing engineering disciplines.

The two participants who identified ideas beyond academics did so mainly in reference to their personal contacts (e.g. friends or classmates) that pursued engineering. Lily described two stories about the work her engineer friends did or are doing. The stories appeared to give her awareness of the complex problems undertaken by engineers, and of the societal factors of engineering work. The characteristics of an engineer that she identified were not explicitly described as a result of these stories; however, her responses exhibit her understanding of the profession with regard to accuracy, communication, and approach to problem solving. Arthur, the only participant to mention the professional engineer’s license, did so in referring to classmates of his he knew to be active “P.Eng’s”. Findings show that personal contact with an engineer does not guarantee increased or better knowledge of the profession. Lily also identified that her brother graduated from engineering, but pointed out that she did not know what he did, and suggested that he was not strong at explaining his job and perhaps got frustrated trying to explain it.

While developing knowledge through interacting with personal contacts or friends who are engineers seemed to provide participants with a better understanding of the engineering profession and what qualities are required in an engineer, there were limits to this learning. This is not the only influence on
teachers’ knowledge, ideas and perceptions of engineering develop from other places. The personal interactions were not complete in providing information or in dispelling misconceptions. While Lily had additional insight into the engineering profession, a bias she held was that if she gets a student “who’s an incredibly outside the box thinker for just about everything”, she would recommend they “consider research” because researchers “have to be able to dream the possibilities”. Creativity is often identified as a key element in engineering design [101], [102], yet her relationship with engineers did not correct this misconception.

In addition to this limitation, the personalities of both the teacher and engineer, as well as their relationship (e.g. informal conversations between friends catching up) have a great effect on the learning outcomes for the teacher. These factors strongly influence the breadth and depth of knowledge that is shared (e.g. if the engineer enjoyed talking about their work, and if the teacher were interested and curious, a large amount of quality and detailed information could be shared). The personality of the teacher would affect the inclusion or application of the knowledge in instructional or advising practice.

5.2.2.1 CEAB Graduate Attribute Engineering Characteristics Analysis

In addition to the general analysis of the characteristics teacher and guidance counsellors identified as important to a potential engineering presented in Section 4.4.2.1.1, an analysis [103] was completed comparing these same traits with what the Canadian Engineering Accreditation Board (CEAB) identifies as attributes required of the graduates of university engineering programs. As described in Section 2.5.1, applicants to a university engineering program are not expected to enter the degree program with these traits; however, this analysis provides insight into the teacher and guidance counsellor knowledge of what characteristics are important of an engineer. The characteristic analysis framed by the CEAB graduate attributes contributes to the response to the sub-question of the second research question.

Question 5 was intended to explore the traits that participants recognized in students who should consider engineering. In addition to these traits that were mapped to the CEAB graduate attributes, a few
participants identified students who they did not think would be suited for engineering. As discussed in Section 4.4.2.1.1, many participants recognized the limit of their knowledge or their bias upfront, while still responding honestly to the question.

The most commonly identified attribute was a Knowledge Base for Engineering. Many participants identified the need for mathematics, science – specifically physics and chemistry, in a variety of capacities. The description of subject knowledge included strength of understanding, consistent performance, and enjoyment in the subject. Consistency, academic performance trends, and early recognition of strength in a subject were additional ideas that were expressed by teachers as indicators of students who might become engineers.

Individual and Team Work was identified by the work habits that participants observed. The ability to focus on a problem, and strong work ethic were two examples given. Additionally, one participant mentioned that students who were heavily involved in extracurricular activities (e.g.: “point guard on the basketball team or lead in the school play”) were frequently students who went into engineering.

Indicators of Professionalism or Impact on Society were identified as consistently accurate student work and its relation to the participant’s recognition of the complexity of the engineering profession and the importance of accuracy in it (e.g. that calculations lead to correct sizing of a bridge).

In describing Problem Analysis, participants expressed ideas of how students approach problems and their drive to determine the correct solution.

Investigation and Life-long Learning ideas were interpreted similarly in more general terms, such as a curiosity in wanting to learn and questioning information given to them.
The only mention of *Communication Skills* was by a teacher with a science background who recalled a course she took that instructed how to “write for science”. She identified that students who “*innately can write well and get their scientific ideas across well, and the precision there too*” would stand out to her as ones who would excel in university science and engineering. She highlighted that writing for science was very different from Writer’s Craft (an elective Grade 12 university level English credit).

Molly and Oliver identified that it was easier to spot a student for whom they would not recommend engineering. Their examples of this were students who were unorganized or continuously struggled in mathematics. Molly and Arthur commented on a pattern that the students they would identify who were not suitable for engineering were the ones with the strongest marks in mathematics and physics courses. Molly clarified that the strongest performers often went into pure mathematics or sciences. Arthur mentioned that future engineering students had “*some strength in math and physics*” but were often heavily involved in extracurricular activities. As mentioned earlier, Lily described her bias as associating “*out-of-the-box thinkers*” as future researchers who needed to “*dream of possibilities*”. Most participants recognized, as a disclaimer, that they had biases and that there were things that students could change (e.g. work ethic, or grades) if a student truly wanted to pursue engineering.

Through the analysis, it emerged that participants identified traits that could map to 8 out of 12 of the graduate attributes. Apart from the comments regarding academic strength in mathematics, physics, chemistry or science overall, the other traits that were identified were not as straightforward to categorize. While some traits could fit within many of the attributes or were quite general, none of the traits identified were significantly incorrect. There were four attributes which no coded traits could be mapped to: *Design, Use of Engineering Tools, Ethics and Equity, and Economics and Project Management.*
There were ideas around how a student acquires and applies knowledge that would fit loosely at best in *Use of Engineering Tools*. The absence of this attribute, *Ethics and Equity*, and *Economics and Project Management* may be of less concern as they are more specific to the profession of engineering and are potentially out of scope of the current high school curriculum. However, the most significant absence is of the *Design* attribute. The only mention of creativity (which is typically identified as a key element of engineering design [101], [102]) was from the participant that identified that a creative dreamer should pursue research. This analysis shows that there are common ideas about the engineering profession; however, there are also areas that require visibility and correction.

Participants were generally able to confidently identify knowledge that was important to someone who could pursue engineering. They also consistently mentioned a trait that described how a student did or approached work. With less detail, participants identified characteristics that describe the professional aspects of engineering. The graduate attributes were sorted into these three categories, Knowledge, How Students Work and Professional Aspects, shown in Figure 11. The strength in mapping the coded traits to the attribute is represented by the definition of the text box around the attribute name; black identifies confidence, the feathered edges of the grey box shows the weaker mapping, and the lack of borders identifies that there were no coded traits to that attribute.
The findings presented inform how to ensure teachers are able to confidently describe the engineering profession. Many identified a trait related to Attribute 1 (students’ academic subject strength) and another between 2 and 7 (how students do and approach work); few identified more than two traits. Additionally, few identified any traits related to the professional responsibilities (described in 8 to 11) required of a professional engineer.

Apart from the attributes, the other themes that arose in the analysis indicated that participants recognized that they lacked knowledge to make educated recommendations for students, and some were much more ready to identify students who would not be suitable. For participants who lacked knowledge to identify engineering traits, they disclosed that they often give students a starting point (e.g. identifying there are different disciplines of engineering), then recommended individual research or to turn to guidance for
information. The brief descriptions given were often related to a lack of confidence in the participants’ knowledge and a fear of giving students’ incorrect information. It was common for participants to add a disclaimer to their responses that identified their bias, lack of knowledge, or lack of confidence in their knowledge about engineering or how to identify potential engineers.

The identification of students who probably would not be a good fit in an engineering program was often connected to lack of organization and work ethic in addition to academic weaknesses in mathematics and science. Many participants recognize that a knowledge base in scientific and mathematic concepts was important, a strong and focused work ethic is required, and that accuracy is important in the profession. Description of engineering characteristics also revealed that creativity was misplaced and aptitude for design was lacking in the participants’ ideas about engineering.

Perhaps it is overly optimistic to expect teachers and guidance counsellors to understand the specific professional responsibilities. It would be unrealistic to require teachers and guidance counsellors to know about every job and profession with such detail; however, the recommendation would be that they should hold a ‘sufficient’ understanding of the knowledge specific to engineering, and the work done by engineers. Specifically, this could include understanding the role of mathematics and science in engineering education and in the engineering profession; the problem solving, and design work done both individually and in a team; and the importance of being able to communicate one’s work.

It may be more reasonable to expect that these individuals have the broader idea that engineering is a complex profession with design as a core element, and an obligation to protecting the public and public interest in their work. While this analysis showcases that collectively participants were able to recognize many traits that would be an asset to a professional engineer, the fact that the traits only loosely mapped
to an incomplete list of attributes means that participants do not have a strong grasp of what a professional engineer is and does.

5.3 University Level Physics as a Prerequisite
When students are selecting their Grade 11 courses at the end of Grade 10, they are faced with the new option of taking any of Chemistry, Biology and/or Physics instead of Science. Depending on a variety of factors on the parts of both the student and teacher, students can elect to not enroll in Physics. In reviewing the prerequisites of Ontario university science, engineering and mathematics programs [104], university level Physics (course code: SPH4U) is rarely a prerequisite for many science-based post-secondary programs, with the exception being engineering programs. Many life science and health science programs, common preludes to application to medical school, require university level Biology and Chemistry. A few of these programs allow a choice of science and mathematics courses from a list of which Physics is included; however, many do not. Some other science majors recommend Physics, or allow a choice of science and mathematics courses from a list of which Physics is included. The list selection options make university level Physics avoidable even if students wish to apply to general science or even physics programs. While taking only Chemistry and Biology enables them to apply to many other science-based programs, engineering is wholly eliminated as an option without Physics.

5.4 Outreach Interactions between High Schools and Post-secondary Institutions
Participants often commented on their experience or their observations of student experience with outreach programs. In addition to the inclusion of outreach awareness in teacher and guidance counsellor participants’ instructional and advising practice, participants also shared suggestions and challenges they have encountered. As mentioned earlier, Mary suggested based on her experience with a similar college outreach program, that to increase teacher knowledge about engineering programs, visiting the campus and experiencing some of the classes and seeing “what goes on” would be beneficial in advising scenarios. Charlie also commented on the benefit of high schools and post-secondary schools working together to ensure that the high schools are preparing students adequately for the post-secondary courses.
While there are a number of variables that would affect this match (e.g. the variety of specialized mathematics courses available to first year university students in different programs). He recounted a time where a past student of his was studying for a university exam and contacted him for help. Charlie acknowledged that it was nice to have a university student come in. He pointed out, “it’s been so long since I was in first year undergrad and it was nice to see the questions that he was doing, so I can better judge the bridge going from Grade 12 to university.” The essence of his suggestion was for the university to provide high school teachers with an idea of the problems the students would be learning in first year, so teachers could see how the transition was going to work for the students. He suggested that there would be benefits to both the students and the university.

A challenge that participants encountered in accessing outreach was in the time to promote and follow-up, and the visibility of programs. As Peter mentioned earlier, his awareness of post-secondary programs were mainly of those with active outreach; those who sent information about their programming to the high school. Gregory and Lily acknowledged the flyers or emails for outreach programs run by universities. Gregory indicated that he pointed out the opportunities to students, but did not think he “promote[d] them very hard”, but he “certainly give[s] them a moment”. In addition to the announcements broadcasted to the school, which Lily acknowledged were not always listened to, she identified that School C had a list of students who self-identified as interested in being contacted about certain outreach opportunities. She also pointed out that some teachers will talk to students that they think would be interested, but she recognized the error in teacher impression of students, and a large number of students could be missed.

Both Lily and Angelina identified the importance and trend towards students’ self-advocacy. Lily’s observations support their recommendations for outreach programs to be visible and make it easy for students to self-identify as interested. Lily identified that due to the vast amount of opportunities and
communications about these opportunities, it would be advantageous to reach both the students and teachers when promoting programs or outreach opportunities. She mentioned that there is the chance that in just telling the teachers, there is a risk that the message will not get to the student.

The experiences with outreach interaction support recommendations for outreach visibility and recruitment. With a large volume of outreach programs contacting schools, teachers have found it difficult to promote and follow-up with students on these opportunities. The school board that School C belongs to encourages a ‘get the word out’ awareness of opportunities. With this mission, participant recruitment is conducted in the form of school-wide announcements, and teachers are contacted via email and flyers and have the responsibility of informing students. While school-wide announcements and classroom announcements are impersonal and as a result they are more likely to be ignored, there is also teacher error in reaching out and talking to students individually. Teachers’ understanding of the both opportunity and their perception of students could lead to misidentification of students who are candidates for participation, or missing appropriate students completely. Recommendations from these findings are presented in Chapter 7.

Throughout the interviews, teachers often had suggestions for resources that teachers can access, as well as resources that would provide information for both teachers and students. The student council of School C organized a career fair for medical professions. They approached a vast variety of people from the medical community to volunteer their time to hold small roundtable discussions in classrooms during one evening. The fair was well attended by both parents and teachers. This suggestion illustrates the interest in students and parents gaining a wider awareness of career options; an important part of becoming an ideal career decision-maker.
Another resource suggestion that would be beneficial for both teachers and students was an informative poster. An important observation from this suggestion is that the participant identified the information she perceived as important to disseminate. The desired information was about the engineering field in general, the individual disciplines, and the jobs available after university – specifically “what does my day-to-day job look like”. Her recommendations for description of post-secondary pathways and career information are supported by the findings of this research and by other acknowledgements of ‘useful information’ by other participants.

As briefly described in the analysis, it was found that presenting a lesson prepared by an external organization was unnatural and the participant suspected that a package like this was unlikely to be used. His suggestion was for current university students to visit classrooms to describe how they made their decision, any deviations from their original goal, and highlight the range of opportunities available for study. He pointed out the objective of the classroom visit would be to plant an idea and create some awareness and discussion of pathways his students might not have thought about. The content would improve the identified low awareness among high school students about career options, and would address a category of difficulty in the Gati et. al. ideal career decision-maker model. Additionally, the findings from the student survey analysis indicated that students found value in interaction with a first-hand source due to the ability to get personal questions answered; this further supports the recommendation for current university students to visit classrooms to describe their experience with making a post-secondary decision, and in their program.

The final recommendation identified by participants was for universities to provide opportunities for teachers to visit university faculties to understand how the subjects they teach appear and are applied in further education. It is unclear if this opportunity currently exists anywhere, or if the opportunity is not actively promoted. If it exists, as identified by participants time could be a barrier to accessing the
opportunity. This recommendation would assist teachers in gaining more knowledge about post-secondary pathways and career paths which participants recognized as useful for advising, and for identifying how topics in high school courses relate to further education and future work.

5.5 Effect of Proximity to Post-secondary Institution
The effects of proximity to post-secondary institution were designed to be investigated through the selection of school boards and schools for participation. While the initial intent was to observe the impact on knowledge of the participants, few effects of this element were observed; however, different implications were identified. School C was farthest from a university, but that did not impede the opportunities to visit the campus to see a lecture. This distance did have an effect on thesis research course partnerships. For students who had to travel frequently to the university, this required a method of transportation (e.g. a ride or a vehicle). This posed an obstacle for some students taking advantage of this thesis course. Participants from School B discussed the proliferation of post-secondary students who have a presence around the school in assisting or running outreach programs. The proliferation of post-secondary students assisting in or running outreach programs puts high school students in regular contact with another resource. One participant mentioned he believed that this contact was where some students formed their ideas of engineering work, as a result of both the extra-curricular activity as well as through interactions with the post-secondary students.

5.6 Limitations
There are some inherent limitations to this research design and, where possible, they were acknowledged and their effects were minimized.

5.6.1 Word Selection used in the Study Title
While the focus was on university-bound students, learning about how the general population of Grade 12 students used resources was also of interest. When requesting that the Grade 12 first period classes be contacted for participation in the study, the pathway (e.g. university, college) was not specific for this
reason. There were a number of first period classes that were college pathway courses, and there is a possibility that there were students enrolled in a mix of university and college level courses. While 11 students with explicit college post-secondary plans responded to the survey, there is a possibility that the relatively low survey response rate was due to students self-selecting out of participating due to the specification of ‘university-bound’ in the study title.

Perhaps as a result of knowing the title of the study, throughout the interview the references to engineering were higher than expected. Teachers referred to engineering, used engineering in an advising example, or referred to an interaction with a student about engineering. It is possible that this presented a skewed view of the frequency participants were involved in engineering-related advising scenarios; however, a benefit to recalling engineering-related advising scenarios or discussions with students is that this added the rich information available in the interviews.

5.6.2 Study Timeline
The timeline for the study indicated that survey data collection was intended to be “immediately after university application submissions” (mid-January) with the intent that the students’ experiences would be more recent and there would be less recall bias. However in practice, the schedules of the schools were taken into account. The principal of School B indicated that most students submit their applications in early December, so to reduce recall error and omission the surveys were distributed prior to the late-December Holiday Break. The contact at School A made a similar statement and surveys were distributed in the same week. It is suspected that the effect of the impending Holiday Break was distracting for students and may have contributed to the low response rate. Contact with School C was not made until mid-January, when students had exams for their first semester classes. Data collection was not completed until the second week of February which was a moderate amount of time after the application deadline and after student had studied and written multiple exams. It is expected that the recall and reflection of students suffered in quality due to this timing.
5.6.3 Instrument Design: Survey

An inherent limitation of using a survey for data collection is that there is no opportunity for follow-up to ask for clarification of their answers. The data collection relies solely on the students’ interpretation of the questions, and there was no designed opportunity for follow-up or probes for clarity. As mentioned in Section 4.3.1, a limitation of using paper copies of the survey is that there was no way to ensure students fill out all parts of the survey as there is with an online survey. The benefit is that while data may not be complete, students may be frustrated with many prompts to correct errors (empty textboxes) that they may choose not to complete the survey at all. However, this lack of data validation meant that some text fields were left blank and the amount of quality data and explanation decreases.

5.6.4 Participants

In addition to the likelihood that student participants self-selected out of participating due to the title, self-selection bias was also present with recruiting teacher and guidance counsellors as participants. There was no incentive offered for participation in the study. To raise awareness of the study within the teachers and guidance counsellors who were targeted for study participation, they were emailed an invitation to drop by a classroom or the lunch room at lunch time to learn more about the study. All teachers who visited this informal information session filled out a survey. Successful correspondence resulted in the 10 interviews. Participation in the interview portion was truly subject to self-selection bias.

In the nature of phenomenological research, as participants are asked to described their lived experiences as they have interpreted and made meaning from it recall bias existed. Participants often responded to a question and provided some details that answered a later question. This was used to mitigate the effects of the recall bias. Instead of refraining from asking the question they had partially responded to, the lead-in, ‘you may have alluded to this question a bit’ was used to acknowledge they were listened to, but also to pose the direct question that inquired to the partial idea presented previously. In this way, triangulation was employed to compare answers and description given in response to two different questions.
5.6.5 Researcher as the Instrument

There is an inherent limitation in qualitative research due to the role of the researcher as the instrument. The researcher collected the data with limited experience in qualitative interviewing and analysis of the data was subject to interpretation as a result of the personal experience and bias described in Section 3.3. An introductory course on qualitative research methods was completed to assist in conducting this research. This provided some training in interviewing to enhance the rigor of the study [92]. The researcher gained additional experience interviewing through a volunteer position at Career Services. Training for the position prepared the volunteer to interact one-on-one with a university student to learn about their experiences and assist them in recording them effectively on their resume. Through reflecting on both this experience and added experience in qualitative interviewing over the course of the study, the researcher became more aware of how to probe participants to describe their experiences in more detail. As a result, detail present in the interviews generally increased over the duration of the study.

In addition to the limitation present in data collection, the researcher’s interpretation of the responses also affected the analysis. Qualitative research analysis requires the researcher to use creative and critical thinking faculties to make thoughtful judgements about data that is significant and meaningful. These decisions are made based on the researcher’s “intelligence, experience and judgement” [92].
Chapter 6
Conclusions

In this study, high school students were surveyed and their teachers and guidance counsellors were interviewed to learn about the resources and support available to high school students in learning about post-secondary and career options. The Grade 12 students were surveyed on the types of resources that they used to learn about post-secondary programs. The students also were asked to identify what made resources helpful. The teacher and guidance counsellor participants described their experiences interacting with, and advising students on post-secondary and career exploration. Participants also discussed their knowledge of engineering as a post-secondary study program, profession and field in general.

The findings presented are directly applicable to the situations of the individuals who participated in the study. Based on the commonalities from the three schools, it is likely that many of the findings are also applicable to public schools in Southern Ontario. With the context provided in the analysis, some findings may have relevance to locations within Canada. When applying the findings, consideration should be given to the demographic and academic description of the schools provided in Section 3.5.

Participants from two school boards in Ontario, one from Eastern Ontario and one from Southwestern Ontario, described many common resource usage patterns and advising practices. This study found that many students use multiple resources to learn about post-secondary programs. Students who identified multiple resources as most helpful recalled using the resources for different purposes, for example to find both broad and detailed information, or for both academic planning knowledge and career planning information.
Corroborated by findings from both the survey data and the teacher interview data, students do use their teachers as resources for career information. About a third of the students surveyed indicated referring to a teacher as a resource, and over two-thirds of the teacher and guidance counsellor participants gave examples of questions students asked them. The examples showed that student wanted to know what and where the teacher studied, and about the teacher’s experience. Students also sought information from teachers about how to become a [job title] and the teacher’s opinion on whether the student would be a good fit or could be that [job title].

The common advising practice of participants was focused heavily on academic planning; specifically pathway planning for high school to ensure students had the appropriate post-secondary program prerequisites for applications and mediating students’ goals and capabilities. While this responds to the more immediate need to get to a post-secondary program, findings show that little consideration of the alignment of students’ career goals after further education was included in this advice. Many teachers identified that students needed to take responsibility for their learning and conduct research on their options on their own. Some also commented that is not in their role to judge whether a student could pursue a path unless there was academic performance or pathway evidence that they would not be able to apply to post-secondary programs.

In exploring teacher and guidance counsellor knowledge of engineering, post-secondary programs and career knowledge, commonalities also emerged. It was observed that many participants relied on their own experiences, or the experiences of personal contacts when including industry applications in their instructional practice or in identifying decision-making considerations in their advising practices. Participants were generally confident in stating that strength and interest in mathematics, science and physics were important characteristics of a student who could become an engineer. Apart from the broad mention of the knowledge base required in engineering, participants mentioned patience, focus and drive
to find a correct answer in how students do their school-work as another indicator of a student who should consider engineering. Generally, participants that enjoyed discussing careers and had personal contacts who were engineers had slightly more insight into professional nuances (e.g. that accuracy is important in the profession), and one participant connected this knowledge with their identification of students who should consider engineering. Teacher and guidance counsellor participants were open in acknowledging their bias, lack of knowledge about engineering, weakness of practice and perceived limits to their advising role.

Without substantial initiative on the part of teachers, their ability to gain additional knowledge about engineering, post-secondary programs and career paths was challenging. It was identified that, apart from new or specialized programs, there was little visibility about what actually goes on in a university program. Participants identified that reaching out to these institutions for answers to specific questions was often informative. Many participants outlined that more knowledge on post-secondary programs and career paths, including engineering-specific ones, would be helpful in being able to bring awareness of these options to students. In describing the specifics of what information they would find helpful both for themselves and their students, many participants outlined general ideas for resource development. The findings from this study were found to substantiate the recommendations participants made.

In agreement with the literature, teachers and guidance counsellors are recognized by students as resources for information on post-secondary planning, opinions on programs, and student fit in a program. The knowledge that these individuals refer to in their advising scenarios was shown to be developed largely from online resources, inquiries to post-secondary resources, and personal or personal contacts’ experiences. Advising practices were heavily focused on academic preparation and planning with little consideration or knowledge of other influences that affect whether the student would be appropriate in that education or career path.
Knowledge of engineering, as a university program, as a profession, or as a field, held by participants was limited to strength and interest in mathematics, science and physics, and included conflicting surface knowledge of disciplines. Key engineering elements such as design, problem solving, aptitude for creativity, and project-based work were not mentioned in depth or relation to identifying students who could pursue engineering. This may suggest that students who may be more suitable for further study in pure mathematics or sciences could be inappropriately encouraged to study engineering. The academic advising focus and limited knowledge about what other skills and aptitudes would make a student a strong candidate for an engineering program or career path highlight areas that require focus in future work.
Chapter 7

Recommendations

Based on the common practices and themes that emerged from the findings of this study, the following are recommendations to facilitate student and teacher awareness of post-secondary programs and career paths, particularly in engineering.

Students often sought out teachers with subject knowledge, or personal backgrounds which they perceived as in line with their own interests. For information on university life, students approached teachers who they knew had attended many to solicit their opinion on each one and on university life in general. They also approached specific subject teachers for the teacher’s opinion on whether the student would be a good fit for a program or career path. Teachers who lacked background on topics of student interest (e.g. went straight into teaching, or science teachers without an engineering background) were generally not approached with these same questions. It is suspected that students learn about these backgrounds informally; few teachers identified that they stated their educational or occupational background to students apart from in reference to a story they told. Knowing this reliance on teacher background, it would be helpful for more organized or formal disclosure (for teachers who felt comfortable sharing) of teacher experience and background so students could easily see who they could approach for specific information.

Findings from this study also support recommendations for dissemination of information, or a venue for this dissemination. With students associating easily with technology, staff profiles on a secure webpage would be a comfortable resource for students to use. Students have also identified valuing resources that provide guidance for accessing further information. As a result, links to the educational program teachers completed, or to companies for which teachers have worked for could be a valuable feature. Students also
valued interaction with human resources as it allowed them to get personal questions answered. This supports the suggestion for more formal information sessions offered by staff members, perhaps over the lunch period, with a question and answer session at the end. The interactive feature could also be accomplished informally on the students’ initiative to approach staff members.

It is recommended that in seeking recruitment, outreach programs should make it easy for students to self-identify as candidates and for teachers to identify students. The type of information in recruitment should be carefully considered and prioritized. The limited knowledge of engineering held by students, teachers and guidance counsellors should also be considered when recruiting. The information should be in accessible language to those at a high school level; for example, based on the student questions of engineering, and the responses to engineering-focused questions, jargon (e.g. ‘disciplines’) should be avoided. The goal of the opportunity should be clear, as well as who should consider participating (e.g. “If you’ve heard the word ‘engineering’ and want to learn more…” or “If you’re curious as to how math and science are applied in the real-world…”).

Findings indicate the importance of career-planning in high school. Student participants recognized that they wanted information about how to embark on a specific career path and they wanted to know if they would be a good fit. Findings showed that these were questions students asked of their teachers. It was also shown that teachers were not generally prepared to give this detailed information and would refer students to guidance counsellors. For fear of misleading a student, neither teachers nor guidance counsellors indicated that they would tell students whether or not they could pursue that career path. While it is described in detail as future work in Chapter 8, it is recommended that students’ need for career ‘fit’ information or guidance be included in high school. In the context of engineering, teachers and guidance counsellors should be informed of the different knowledge and skills required, or at least that there is more to engineering than the disciplines, and mathematics and science. If, as it was suggested by
participants, detailed advising and guidance on career path selection and career considerations in post-secondary program decision-making is too demanding of the currently over-extended roles of teachers and guidance counsellors, then students must be made aware of these aspects. It is recommended that the connection between post-secondary program selection and career paths be made (or further emphasized) in Grade 10 Careers class. The connection should be reiterated in guidance appointments and through discussions in the classroom. With the awareness of these considerations, students will be more informed about the decisions they have to make, and as suggested by many teacher and counsellor participants, students can then conduct further research on their own.

A tool whose design is informed by the findings that could support this individual research could be integrated into myBlueprint.ca. Many students identified the value of online resources as well as myBlueprint.ca in particular. To facilitate student research, a section or page could be created that prompts students to record their findings. The following design is based on current findings as well as some opinionated suggestions. With the comparison of the findings with the ideal career decision-making model, the following design addresses the lack of information about alternative, provides some guidance with regards to decision-making, and prompts students to reflect on the types of information they get and who influences this decision. Some questions will focus on their learning about their post-secondary program options, further questions will focus on their investigation into career options. In addition to questions about the program and career path in general, there should be questions prompting students to reflect on how their personality, aptitudes and values align with these choices. Further research will better inform the questions; however, an initial list of suggestions could include:

- Post-secondary focus:
  o What post-secondary program are you considering?
  o What interests you about the program? (e.g. course material, hands-on opportunities, career prospects, etc.)
  o What high school courses are prerequisites?
  o How does your current academic performance compare with the application requirements?
What are similar programs that you could apply to? Consider programs with similar prerequisites, more achievable or challenging requirements, or programs that could lead you to your career goals in a different way.

Reflect on your responses to the questions above, do you require more information? Consider booking an appointment with guidance for help.

Career focus:
- What career plans do you have?
- What interests you about them?
- What does an entry level job look like? What does an intermediate level job look like? What are the options for advancement?
- What skills/traits are necessary to succeed in these jobs?
- Reflect on your responses to the questions above, do you require more information? Consider talking to a few people who are employed in the career path you are interested in, if you require help making a connection, reach out to people in your life for assistance.

Alignment
- How will the program help you achieve your career goals?
- Is there further study or additional qualifications required to pursue your career goals?
- Considering your skills and knowledge, what will be a strength for you in pursuing this career goal? What will pose a challenge?
- If you require further information, consider booking an appointment with your guidance counsellor, or contacting the career services office at a post-secondary institution you are considering.

With these questions as a starting point, this tool could be used by students on their own if they are sufficiently motivated, or they could be used by guidance counsellors to facilitate appointments.

An additional recommendation informed by the study findings, designed with some creative liberty, and requiring further research for refinement would be a series of short videos with an interactive component.

As career exploration is a part of the curriculum in Grade 10 Careers, as well as in Grade 11 and 12 mathematics and science, these classrooms could be targets for this suggestion. A short video (1-2 minutes) would be shown in class. An engineering student and a professional engineer would give an introduction to the possibilities in engineering. The video would describe the key elements of engineering, and mention the variety in disciplines, and of opportunities for work. Students would be given the link perhaps via email or included on a worksheet. It should spark an interest such that students will want to check out the video on their own time. The end of the video would have a question that would appear on
the video, similar to a “Choose your own adventure” book, for example: “What surprised you most about engineering?” A few options would be available for students; clicking on an option would lead to the student to another video, and so on. Figure 12 shows the initial structure of the series of videos.

![Diagram of video structure](image)

**Figure 12: Structure of the interacted and informative videos.**

While it may appear that a multitude of videos would be required, this would not be the case if the questions at the end of the videos are carefully designed for multiple referrals to the same video. An example of this is shown in the far right column of Figure 12. Other questions that could be posed are: “What would you like to learn more about?”, or “What did you find most interesting about the video?” If students get sufficiently involved in the videos, ones at the end of the series could provide direction for acquiring additional information, such as the Engineers Canada website, or contact information of an individual that could answer specific questions. Through initially showing the video in class, this resource provides a general awareness of engineering to a large number of students. If designed well, it should help students self-identify as someone who should investigate this pathway on their own time. The resource also helps guide students in finding further information from controlled sources.
Both suggestions for these resources exemplify how the findings from this study can be used to inform resource development. Important factors of useful resource identified by students have been included, and utility for classroom teachers and guidance counsellors has also been considered. Some creative liberties were taken to describe facets that would need further research in support of the design.
Chapter 8

Future Work

The recommendations for future work arose from reflection upon the research design and from analysis of the data. For continuation of this research, it is recommended that the data collection instruments be revised, acknowledging the observations below as those similar to those that arise as a result of a pilot study. Further questions arose as a result of analyzing the data; they are discussed in the context for suggestions of future work.

8.1 Instrument Refinement

In reviewing the data collection instruments, namely the student survey and the interview protocol, the following refinements are suggested. An inherent limitation of surveys is that there is no opportunity to follow-up with participants about their answer. From the responses gathered, it was clear that student interpreted the questions differently which resulted in data that was less detailed or less contextual than desired. A partial cause of this lack of detail was due to limitations involved with using paper surveys. There was no way to ensure students filled out all text fields that would provide additional information about the resource they used. In asking students about what resources they ‘used’ there was no definition in the survey question, nor did a question ask them to describe how they defined ‘using a resource’. With data students provided, it is not clear how students categorized this use. It is unknown whether student considered casual questions of their teachers about their personal experience as ‘using them as a resource’.

With regard to the interview protocol, the order of the questions was found to be logical; however, additional interviewing experience would help gather more rich-information in the future. Over the course of conducting the interviews, experience was gained that helped develop an awareness of where clarification or additional detail in the participant’s response would be valuable. Confidence in conducting
an interview in conducting the study in the future would increase the quality of the data collected. As a result of inexperience and nervousness, some questions were stated then, due to a pause in the interview, deviated from the exact intended question; for example, an open-ended question turned into a polar (yes-no) question. Experience or practice interviewing would lead to better follow-up questions and patience in staying true to the original wording of the question; resulting in improved collection of rich information.

8.2 Questions for Further Investigation

Questions arose from the analysis of the data and the discussion of the findings. The findings from this study identifies some of the information students want, how and what resources they use to learn about post-secondary programs, and provides substantial insight into the current advising practices of those individuals who support high school students within their school environment.

8.2.1 Learning from Student Participants

There is additional information that would be valuable to gather from student participants. Many students’ responses to “what resources were most useful, and why?” identified providing “insight”, and “gave me all the information I needed” as the useful feature. As no further detail was provided, a question arises about what information do students think they need. It is unclear if students are missing a consideration actually needed in their decision-making. With this knowledge, further assessment of whether high school students are equipped to make an informed decision can be made.

Teachers frequently identified that they bring stories of their personal experience or experiences of their personal contacts into the classroom. They identified their intentions of sharing the story and their perception that students enjoy hearing them. It would be of interest to learn what the student experience is with these discussions: do they get out what the teacher intends; if not, do they find value in hearing about these experiences? Is there a reflective aspect that a retrospective study would identify but a study with students currently experiencing it would not? With information about how these discussions are received by students, teachers’ could select or structure stories to make them more useful for students.
8.2.2 Student Interactions with Resources

As it was recommended earlier that future work should include learning about what students define as ‘using a resource’. Findings from this study indicated that it would be valuable to conduct further research into student use of two resources in particular: post-secondary representatives and teachers. Interactions with post-secondary representatives were frequently described as most helpful a number of times. It would be valuable to learn about the questions students ask them and about the information students expect from these interactions. This would support the post-secondary representatives in preparation for student questions.

It was clear from the literature review that teachers are frequently identified in the top three individuals that students refer to for career-related information. The findings showed that 15 student participants recognized learning about post-secondary programs from their teacher, however, only 1 student identified that the teacher was the most useful resource to which they referred. It is recommended that future work investigate how to ensure students find the interaction useful. For students who identified their teacher as a reference, further investigation is recommended into what the students want to know, and why they picked that teacher to talk to. Some insight from this was obtained from the interviews with the teachers; however, insight into the conversation from the students involved would be valuable. Similar to the recommendation about student interactions with post-secondary representatives, it is recommended that future work learn more about what students expect from the interaction and what information they want from their teachers.

Another recommended topic for further work is to investigate the agreement between the information that students identify as important to acquire to make decisions, and the information that students should be considering to ensure satisfaction and fit in their post-secondary program and career path. The findings from this study that students were describing the information they wanted broadly, as a result it is recommended that future work allow the opportunity to probe for clarity in responses.


8.2.3 Resource Development

With the many recommendations for improved outreach interactions presented by participants in Section 5.4, it would be valuable to find out more about the existing interactions between teachers and guidance counsellors and post-secondary institutions. The findings from this study provide an initial foundation for the design of future work and resource development. Participants’ recommendations for outreach were that it be easy for both teachers and students to identify students who should participate, to tell students as much of the information directly, and provided specific information about engineering disciplines, career paths, and examples of day-to-day engineering work. Further investigation into the information students need when selecting a university program and career path is recommended to ensure the participants’ recommendations for information agree. When enough research supports development of resources, the intended audience for the information disseminated through the resource should be consulted on what would be useful and what would not. This will help ensure the utility of the resources (particularly for the artefact type, but also for information presentations, etc.) for the teachers’ advising practices or from which students can learn.

An additional consideration required in development of resources for teachers is that two participants quickly or emphatically identified the internet or websites as their preferred or only source for post-secondary or career information. While all other participants identified that they referred to multiple resources, many did identify the internet as a resource with many benefits. Websites were often explored with students during guidance appointments due to their ability to compare programs for students, and speed of information return.

8.2.4 Whose Responsibility Is It?

In learning about current advising practices and perceived limits to the advising role, the teacher and guidance counsellor focus was clearly on academic preparation and planning, and non-imposing career exploration. However, inclusion of career pathway awareness and planning in advising scenarios or
resource development is supported by the findings of the student survey analysis. Teachers and guidance counsellors have also identified that they did not think it was their role to recommend a post-secondary program or a career for the student. This disclaimer was stated throughout many interviews but when mentioned in response to Question 5, further inquiry into the wording of the question was reviewed. While the question was intended to learn about what traits teachers associate with engineering, many participants initially stumbled on the question, “How do you recognize a student who could become an engineer?” A consistent clarification was then stated, “How would you describe a student who should consider learning more about engineering?”, but participants were still hesitant to identify traits. While the question was designed to not call attention to the correctness of their knowledge or practice but to encourage them to describe their experiences and observations based on a reflection of a scenario, it is possible that teachers were not confident in their knowledge or did not interpret the question as it was intended. As a result, it is recommended this question be revised to be even clearer or rewritten to collect the intended data in detail.

The findings identify a potential gap in the information students are using to make their career decisions. To optimize the number and types of students applying to a university engineering program, high school students must be information-literate career decision-makers; they must know what information is needed, know where to get information, and how to evaluate and use it. Some of the barriers identified as affecting students applying to a university engineering program are centered on lack of knowledge and inconsistent information. For example, lacking an understanding about what knowledge, skills, and aptitudes are essential to complete engineering work means that students are unable to fully or accurately apply the Gati et. al. recommended “knowledge of the self” to their ideal career decision-making.

With students having developed a low understanding or misconceptions of engineering early on, and with few opportunities to learn more within the high school environment, it raises the following question:
Whose responsibility is it to make sure students are considering how their chosen post-secondary program relates to their intended future career path?

If students are left to pursue this on their own, there are several clear concerns that would arise. Students were found to rely significantly on the internet as a source of information for post-secondary programs. With the variation of quality with online sources, students must be knowledgeable and able to evaluate the information found. While the literature review shows that some parents may be well-positioned to advise their students on the cohesiveness of their child’s personality and abilities, low parental awareness of alternative careers or specifics of an engineering career path may result in limited advice.

This leaves teachers and guidance counsellors as the next resource that students turn to for information. Most participants indicated that they thought it was outside of their advising scope to identify a career path for students. It was observed that it was common practice for teachers and guidance counsellors to pose questions to students in their advising scenarios. These questions often led students to consider factors about themselves and their personal situation to assist the students in selecting a post-secondary program. Perhaps this practice of asking the important questions is how these individuals can support students in considering if they are well-suited for both the post-secondary education and the resultant career path. In this way, teachers and guidance counsellors would not be imposing direction but ensuring students are considering the necessary information to make an informed decision. Further investigation is recommended into whether students are considering this post-secondary-to-career connection sufficiently or if they require further support.

8.2.5 Expanding the Participant Population

Finally, this study was focused on a specific population of three schools in two school boards in one province. It is recommended that future work expands this study for a more complete picture of the state
of accurate information available about the engineering profession in Ontario, and then to further learn about this topic across Canada.
References


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[48] Harris Interactive and Microsoft Corporation, “STEM Perceptions: Student & parent study parents and students weigh in on how to inspire the next generation,” 2011.


[63] M. E. Spencer, “Engineering Perspectives of Grade 7 Students in Canada,” Queen’s University, 2011.


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Appendix A

Clearances and Approvals

A.1  General Research Ethics Board Clearance
A.2  General Research Ethics Board Clearance Amendment
A.3  The Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans Course on Research Ethics
A.4  Letter of Approval from School Boards
September 12, 2014

Miss Allison Chong
Master's Student
Department of Mechanical and Materials Engineering
Queen's University
73 Division St.
Kingston ON, K7L3M1

Dear Miss Chong,

RE: Amendment for your study entitled: GMECH-026-14 Evaluating Engineering Career Resources Available to Ontario University-Bound High School Students; ROMEO# 6012713

Thank you for submitting your amendment requesting the following changes:

1) To remove the multiple-choice survey question: “Each school year, how many students do you interact with regarding career advice? Options: 0-5, 5-10, 15+, whole class”;

2) To insert the multiple-choice survey question: “What is the nature of the career advising interactions? (Please check all that apply): Options: One-on-one advising, Address the whole class, Invite professional to guest speak, Class-wide outreach activities, Other (please describe)”;

3) To replace the current three letters of information for teacher participants with one letter explaining all three parts;

4) Data collection tools, Educator question revised (v. 2014/09/10);


By this letter you have ethics clearance for these changes.

Good luck with your research.

Sincerely,

[Signature]

Joan Stevenson, Ph.D.
Chair
General Research Ethics Board

c.: Dr. David Strong, Supervisor
A.2 General Research Ethics Board Clearance Amendment

May 06, 2014

Miss Allison Chong
Master’s Student
Department of Mechanical and Materials Engineering
Queen’s University
Kingston, ON, K7L 3N6

GREB Ref #: GMECH-026-14, Romance # 6012713
Title: "GMECH-026-14 Evaluating Engineering Career Resources Available to Ontario University-Bound High School Students"

Dear Miss Chong:

The General Research Ethics Board (GREB), by means of a delegated board review, has cleared your proposal entitled "GMECH-026-14 Evaluating Engineering Career Resources Available to Ontario University-Bound High School Students" for ethical compliance with the Tri-Council Guidelines (TCPS) and Queen’s ethics policies. In accordance with the Tri-Council Guidelines (article D.1.6) and Senate Terms of Reference (article G), your project has been cleared for one year. At the end of each year, the GREB will ask if your project has been completed and if not, what changes have occurred or will occur in the next year.

You are reminded of your obligation to advise the GREB, with a copy to your unit REB, of any adverse event(s) that occur during this one year period (access this form at http://services.queensu.ca/romeo_researcher and click Events - GREB Adverse Event Report). An adverse event includes, but is not limited to, a complaint, a change or unexpected event that alters the level of risk for the researcher or participants or situation that requires a substantial change in approach to a participant(s). You are also advised that all adverse events must be reported to the GREB within 48 hours.

You are also reminded that all changes that might affect human participants must be cleared by the GREB. For example you must report changes to the level of risk, applicant characteristics, and implementation of new procedures. To make an amendment, access the application at http://services.queensu.ca/romeo_researcher and click Events - GREB Amendment to Approved Study Form. These changes will automatically be sent to the Ethics Coordinator, Gill Irving, at the Office of Research Services or gillir@queensu.ca for further review and clearance by the GREB or GREB Chair.

On behalf of the General Research Ethics Board, I wish you continued success in your research.

Yours sincerely,

[Signature]

Joan Stevenson, Ph.D.
Chair
General Research Ethics Board

c. Dr. David Strong, Faculty Supervisor
A.3 The Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans

Course on Research Ethics

Certificate of Completion

This document certifies that

Allison Chong

has completed the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans Course on Research Ethics (TCPS 2: CORE)

Date of Issue: 7 January, 2014
May 22, 2014

Allison Chong
Faculty of Engineering and Applied Science
45 Union Street, Room 300
Queen’s University
Kingston, ON
K7L 3N6

Dear Allison:

Re: “Evaluating Engineering Career Resources Available to Ontario University-Bound High School Students”

I am responding to your request to conduct a research project for the study “Evaluating Engineering Career Resources Available to Ontario University-Bound High School Students” from Queen’s University in the Limestone District School Board. I have reviewed your materials, and approval is granted.

May I emphasize that in accordance with our Administrative Procedure 291: External Research participation in this research is entirely voluntary by the schools involved. Also, it is understood that for all research projects, the names of schools and students will not be identified in your final report, and schools and students have the right to opt out of this project at any time.

Best of luck on your research. I would appreciate a copy of your report when it is completed.

Sincerely,

[Signature]

Norah Marsh
Superintendent of Education
NM/ss

cc Brenda Hunter, Director of Education
Secondary Principals, Secondary Schools

Our Students, Our Future
October 06, 2014

Dear Ms Chong,

Your project, entitled "Evaluating Engineering Career Resources Available to Ontario University-Bound High School Students" has been approved by Learning Support Services at the Thames Valley District School Board. Please ensure that all members of your research team who will be assisting with data collection involving students have an up-to-date criminal record check. Information about the study will be sent to school principals and those who are interested in having their school participate in the study will be asked to contact you directly.

The continued willingness of our faculty to participate in research studies is greatly enhanced by pertinent feedback of findings. Please find attached the Thames Valley District School Board Study Completion Form. Once you have completed your research in our board, please complete this form and submit it to Dr. Steve Killip. This form should be submitted within two years of receiving approval. It is also suggested that direct feedback be provided to the school(s), staff, students, and/or families involved in the study.

All the best with your research. Please feel free to contact me if I can be of further assistance.

Sincerely,

Steve Killip, Ph.D.
Manager - Research and Assessment Services
Thames Valley District School Board

cc M. Deman, Superintendent of Student Achievement
**Appendix B**

**Letters of Information and Consent**

<table>
<thead>
<tr>
<th>B.1</th>
<th>Letter of Information for Principal</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.2</td>
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<td>B.3</td>
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</tr>
<tr>
<td>B.4</td>
<td>Letter of Information and Consent for Students</td>
</tr>
</tbody>
</table>
B.1 Letter of Information for Principal

Letter of Information

EVALUATING ENGINEERING CAREER RESOURCES AVAILABLE TO ONTARIO UNIVERSITY-BOUND HIGH SCHOOL STUDENTS

This research is being conducted by Allison Chong under the supervision of Professor David Strong in the Faculty of Engineering and Applied Science at Queen’s University in Kingston, Ontario. This study has been granted clearance according to the recommended principles of Canadian ethics guidelines and Queen’s policies. The <School Board> has also approved this study.

What is this study about? The purpose of this research is to investigate how support resources in high schools assist students in their discovery of engineering as a potential career path. The two research questions driving this study are: 1) how do students use the resources available to them to learn about careers and the required educational training for these careers, and 2) how do teachers and counsellors apply their knowledge of engineering when advising students on engineering programs and career paths.

The study will utilize data from two sources (a) grade 12 university-bound students and (b) science, math, careers teachers and guidance counsellors. The grade 12 students will be surveyed to learn what resources they rely on to discover university majors and career paths. The science, math, career teachers and guidance counsellors will be interviewed to gain insight on the skills and aptitudes they recognize are valuable in an engineer, and how they guide students in learning about engineering.

What will this study require? If you agree to participate in this research, your involvement would be an integral part of the study as you will be asked to help aid in the recruitment of students and teachers. I will be mailing a package of letters of information and consent for your first period grade 12 class teachers to distribute to their students. The students in your school (provided their guardians give consent) will first complete an online questionnaire (5 minutes maximum) on their own time.

In the second part of the study, I will mail a package of letters of information and consent to be distributed in the in-school mailboxes of grade 12 science and math teachers, grade 10 careers teachers and guidance counsellors. If they agree to participate, they will complete a brief questionnaire that will assist with interview participant selection. I will be selecting a maximum of eight teachers and guidance counsellors for individual interviews, one of which may be from your school. Interviews will be conducted at your home school after school hours, will last a maximum of one hour, and will be recorded in digital audio files.

Is participation voluntary? Your participation, as well as the teachers’ and students’, is completely voluntary and choosing not to participate will not result in any adverse consequences. There are no known physical, psychological, economic, or social risks associated with this study. Further, the students, teachers and guidance counsellors are free to choose, without reason or consequence, to refuse to answer any questions. They may withdraw from the study at any time with no negative consequences. If the students withdraw from the study, they may choose to have their data removed.

What if I have concerns? Any questions about study participation may be directed to Allison Chong at allison.chong@queensu.ca or at 416-456-4780 or her supervisor Professor David Strong at (613) 533-2606 or strongd@queensu.ca. Any ethical concerns about the study may be directed to the Chair of the General Research Ethics Board at (613) 533-6081 or chair.GREB@queensu.ca.

Again, thank you. Your interest in participating in this research study is greatly appreciated.

This study has been granted clearance according to the recommended principles of Canadian ethics guidelines, and Queen’s policies.
B.2 Letter of Information for Teachers (student survey distribution)

Letter of Information

EVALUATING ENGINEERING CAREER RESOURCES AVAILABLE TO ONTARIO UNIVERSITY-BOUND HIGH SCHOOL STUDENTS

This research is being conducted by Allison Chong under the supervision of Professor David Strong in the Faculty of Engineering and Applied Science at Queen’s University in Kingston, Ontario. This study has been granted clearance according to the recommended principles of Canadian ethics guidelines and Queen’s policies. The <School Board> has also approved this study.

What is this study about? The purpose of this research is to investigate how support resources in high schools assist students in their discovery of engineering as a potential career path. The two research questions driving this study are: 1) how do students use the resources available to them to learn about careers and the required educational training for these careers, and 2) how do teachers and counsellors apply their knowledge of engineering when advising students on engineering programs and career paths. The study will utilize data from two sources (a) grade 12 university-bound students and (b) science, math, careers teachers and guidance counsellors. The grade 12 students will be surveyed to learn what resources they rely on to discover university majors and career paths. The science, math, career teachers and guidance counsellors will be interviewed to gain insight on the skills and aptitudes they recognize are valuable in an engineer, and how they guide students in learning about engineering.

What will this study require? If you agree to participate in this research, your involvement would be an integral part of the study as you will be asked to distribute and collect the consent forms. The students in your class (provided their guardians give consent) will first complete an online questionnaire (5 minutes maximum) on their own time.

Is participation voluntary? Your participation as well as the students is completely voluntary and choosing not to participate will not result in any adverse consequences. There are no known physical, psychological, economic, or social risks associated with this study. Further, the students are free to choose, without reason or consequence, to refuse to answer any questions. They may withdraw from the study at any time with no negative consequences. If the students withdraw from the study, they may choose to have their data removed.

What if I have concerns? Any questions about study participation or a request to withdraw from the study may be directed to Allison Chong at allison.chong@queensu.ca or my supervisor Professor David Strong at (613) 533-2606 or strongd@queensu.ca. Any ethical concerns about the study may be directed to the Chair of the General Research Ethics Board at (613) 533-6081 or chair.GREB@queensu.ca. Again, thank you. Your interest in participating in this research study is greatly appreciated.

This study has been granted clearance according to the recommended principles of Canadian ethics guidelines, and Queen's policies.
B.3 Letter of Information and Consent for Teacher and Guidance Counsellor

Letter of Information

EVALUATING ENGINEERING CAREER RESOURCES AVAILABLE TO ONTARIO UNIVERSITY-BOUND HIGH SCHOOL STUDENTS

This research is being conducted by Allison Chong under the supervision of Professor David Strong in the Faculty of Engineering and Applied Science at Queen’s University in Kingston, Ontario. This study has been granted clearance according to the recommended principles of Canadian ethics guidelines and Queen’s policies. The <School Board> has also approved this study.

What is this study about? The purpose of this research is to investigate how support resources in high schools assist students in their discovery of engineering as a potential career path. The two research questions driving this study are: 1) how do students use the resources available to them to learn about careers and the required educational training for these careers, and 2) how do teachers and counsellors apply their knowledge of engineering when advising students on engineering programs and career paths. The study will utilize data from two sources (a) science, math, careers teachers and guidance counsellors and (b) grade 12 university-bound students. The grade 12 students will be surveyed to learn what resources they rely on to discover university majors and career paths. The science, math, career teachers and guidance counsellors will be surveyed and interviewed to gain insight on the skills and aptitudes they recognize are valuable in an engineer, and how they guide students in learning about engineering.

What will this study require? This research is composed of three parts: (1) a teacher survey, (1a) a teacher follow-up interview and (2) a student survey. The first two parts will involve your direct participation in the study, in the third part, your involvement would be an integral part of the study as you will be asked to distribute and collect the consent forms from the students. If you agree to participate in this research, your involvement in any part of the research would be greatly appreciated. The voluntary involvement for each of the parts is described below: (1) Teacher Survey: In Fall 2014, you will first complete an online questionnaire (5 minutes maximum). At the end of the questionnaire, you will have the option to volunteer for a follow-up interview. From the responses provided to the questionnaire, I will select and contact four teachers and four guidance counsellors for individual interviews, based on the educational and occupational background and career advising experiences described in the survey responses. (1a) Teacher Interview: Interviews will be conducted at your school will last a maximum of one hour, and will be recorded in digital audio files. Those who are selected for interviews will be giving another letter of information and consent form. (2) Student Survey: At the beginning of January, you will be asked to distribute and collect the consent forms from the students. The students in your class (provided their guardians give consent) will complete an online questionnaire (5 minutes maximum) on their own time.

Is participation voluntary? Your participation, as well as the students’, is completely voluntary and choosing not to participate in any or all parts will not result in any adverse consequences. There are no known physical, psychological, economic, or social risks associated with this study. Further, all participants are free to choose, without reason or consequence, to refuse to answer any questions. Participants may withdraw from the study at any time with no negative consequences. If a participant withdraws from the study, they may choose to have their data removed.

What if I have concerns? Any questions about study participation or a request to withdraw from the study may be directed to Allison Chong at allison.chong@queensu.ca or my supervisor Professor David Strong at (613) 533-2606 or strongd@queensu.ca. Any ethical concerns about the study may be directed to the Chair of the General Research Ethics Board at (613) 533-6081 or chair.GREB@queensu.ca.

Again, thank you. Your interest in participating in this research study is greatly appreciated.

This study has been granted clearance according to the recommended principles of Canadian ethics guidelines, and Queen’s policies.
Consent Form for Teacher Survey
“EVALUATING ENGINEERING CAREER RESOURCES AVAILABLE TO ONTARIO UNIVERSITY-BOUND HIGH SCHOOL STUDENTS”

Name (please print clearly): ______________________________________

1. I have read the Letter of Information and have had any questions answered to my satisfaction.

2. I understand that I will be participating in the study called Evaluating Engineering Career Resources Available to Ontario University-Bound High School Students. I understand that the purpose of this research is to gain insight on the skills and aptitudes teachers and guidance counsellors recognize are valuable in an engineer, and how they guide students in learning about engineering. I understand that my participation in this study will entail a maximum of 65 minutes of my time involving: an online questionnaire (5 minutes maximum) and if selected, an audio-recorded interview (maximum 60 minutes).

3. I understand that my participation in this study is voluntary and I may withdraw at any time. I understand that every effort will be made to maintain the confidentiality of the data now and in the future. Only experimenters in the Engineering Education Laboratory will have access to this area. The data may also be published in professional journals or presented at scientific conferences, but any such presentations will be of general findings and will never breach individual confidentiality. Should you be interested, you are entitled to a copy of the findings.

4. I am aware that if I have any questions, concerns, or complaints, I may contact Allison Chong; allison.chong@queensu.ca; or her supervisor Professor David Strong at (613) 533-2606 or strongd@queensu.ca. Any ethical concerns about the study may be directed to the Chair of the General Research Ethics Board at (613) 533-6081 or chair.GREB@queensu.ca.

I have read the above statements and freely consent to participate in this research:

Please sign one copy of this Consent Form and return to Allison Chong

Retain the second copy for your records.

Signature: ___________________________ Date: _________________
B.4 Letter of Information and Consent for Students

Letter of Information for Students

EVALUATING ENGINEERING CAREER RESOURCES AVAILABLE TO ONTARIO UNIVERSITY-BOUND HIGH SCHOOL STUDENTS

This research is being conducted by Allison Chong under the supervision of Professor David Strong in the Faculty of Engineering and Applied Science at Queen’s University in Kingston, Ontario. This study has been granted clearance according to the recommended principles of Canadian ethics guidelines and Queen’s policies. The <School Board> has also approved this study.

What is this study about? The purpose of this research is to investigate how support resources in high schools assist students in their discovery of engineering as a potential career path. The two research questions driving this study are: 1) how do students use the resources available to them to learn about careers and the required educational training for these careers, and 2) how do teachers and counsellors apply their knowledge of engineering when advising students on engineering programs and career paths.

The study will utilize data from two sources (a) grade 12 university-bound students and (b) science, math, careers teachers and guidance counsellors. The grade 12 students will be surveyed to learn what resources they rely on to discover university majors and career paths. The science, math, career teachers and guidance counsellors will be interviewed to gain insight on the skills and aptitudes they recognize are valuable in an engineer, and how they guide students in learning about engineering.

What will this study require? If you and your parents/guardians agree to participate in this research, you will complete an online survey (taking no longer than 5 minutes).

Is my participation voluntary? Yes. Although it be would be greatly appreciated if you would answer all material as frankly as possible, you should not feel obliged to answer any material that you find objectionable or that makes you feel uncomfortable. You may also withdraw at any time with no effect on your standing in school.

What will happen to my responses? All electronic files will be password protected. We will keep your responses confidential. Only experimenters will have access to this information. To help us ensure confidentiality, please do not put your name anywhere in the survey. The data may also be published in professional journals or presented at scientific conferences, but any such presentations will be of general findings and will never breach individual confidentiality. Should you be interested, you are entitled to a copy of the findings.

What if I have concerns? Any questions about study participation may be directed to Allison Chong at allison.chong@queensu.ca or at 416-456-4780 or her supervisor Professor David Strong at (613) 533-2606 or strongd@queensu.ca. Any ethical concerns about the study may be directed to the Chair of the General Research Ethics Board at chair.GREB@queensu.ca or 613-533-6081.

Again, thank you. Your interest in participating in this research study is greatly appreciated.

This study has been granted clearance according to the recommended principles of Canadian ethics guidelines, and Queen's policies.
Consent Form
“EVALUATING ENGINEERING CAREER RESOURCES AVAILABLE TO ONTARIO UNIVERSITY-BOUND HIGH SCHOOL STUDENTS”

Name (please print clearly): ______________________________________

4. I have read the Letter of Information and have had any questions answered to my satisfaction.

5. I understand that I will be participating in the study called Evaluating Engineering Career Resources Available to Ontario University-Bound High School Students. I understand that the purpose of this research is to learn what resources they rely on to discover university majors and career paths. I understand that my participation in this study will entail a maximum of 5 minutes of my time involving an online questionnaire.

6. I understand that my participation in this study is voluntary and I may withdraw at any time. I understand that every effort will be made to maintain the confidentiality of the data now and in the future. Only experimenters in the Engineering Education Laboratory will have access to this area. The data may also be published in professional journals or presented at scientific conferences, but any such presentations will be of general findings and will never breach individual confidentiality. Should you be interested, you are entitled to a copy of the findings.

4. I am aware that if I have any questions, concerns, or complaints, I may contact Allison Chong; allison.chong@queensu.ca; or my supervisor Professor David Strong at (613) 533-2606 or strongd@queensu.ca. Any ethical concerns about the study may be directed to the Chair of the General Research Ethics Board at (613) 533-6081 or chair.GREB@queensu.ca.

I have read the above statements and had any questions answered. I freely consent to participate in this study.

Participant’s Signature: ____________________________ Date: ______________

E-mail address: ___________________________________

Please check the boxes below to indicate understanding.

☐ I am granting permission for my child to provide responses to this questionnaire.

Guardian’s Name: ____________________________ Date: __________________________

Guardian’s Signature: ____________________________
Appendix C

Data Collection Instruments

C.1 Educator Survey Questions
C.2 Student Survey Questions
C.3 Subject Teacher/Guidance Counsellor Interview
## C.1 Educator Survey Questions

<table>
<thead>
<tr>
<th>Question</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is your educational background prior to teaching? (open-ended)</td>
<td>To gather data to select the broad range of participants.</td>
</tr>
<tr>
<td>What is your occupational background prior to teaching?</td>
<td></td>
</tr>
<tr>
<td>- Straight into teaching</td>
<td></td>
</tr>
<tr>
<td>- Workplace experience prior to teaching: (please briefly and generally describe) (open-ended).</td>
<td></td>
</tr>
<tr>
<td>What classes do you teach? (grades and subjects)</td>
<td></td>
</tr>
<tr>
<td>What is the nature of the career advising interactions? (Please check all that apply):</td>
<td>To gather data to select the broad range of participants, specifically seeking information on whether they would be a data rich source.</td>
</tr>
<tr>
<td>- One-on-one advising</td>
<td></td>
</tr>
<tr>
<td>- Address the whole class</td>
<td></td>
</tr>
<tr>
<td>- Invite professionals to guest speak</td>
<td></td>
</tr>
<tr>
<td>- Class-wide outreach activities</td>
<td></td>
</tr>
<tr>
<td>- Other (please describe)</td>
<td></td>
</tr>
<tr>
<td>Would you be interested in being contacted further for an interview to discuss your experience with advising about engineering? If so, please fill out your preferred contact email.</td>
<td>To determine participants for potential follow up.</td>
</tr>
</tbody>
</table>
C.2 Student Survey Questions

<table>
<thead>
<tr>
<th>Question</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. What resources did you use to learn more about what university program you wanted to apply to? (check all that apply, please include details where prompted)</td>
<td>To learn about the types, and amount of resources students refer to when needing career help.</td>
</tr>
<tr>
<td>□ Internet searches – example(s) of website: ___________________________</td>
<td></td>
</tr>
<tr>
<td>□ Career guidance tool – name of program: _____________________________</td>
<td></td>
</tr>
<tr>
<td>□ Teachers – subject: ________________</td>
<td></td>
</tr>
<tr>
<td>□ Guidance Counsellor – (circle one) self-booked or recommended appointment?</td>
<td></td>
</tr>
<tr>
<td>□ University Open House</td>
<td></td>
</tr>
<tr>
<td>□ Family</td>
<td></td>
</tr>
<tr>
<td>□ Students currently enrolled in program</td>
<td></td>
</tr>
<tr>
<td>□ Professional in the field (how did you set up this contact?)</td>
<td></td>
</tr>
<tr>
<td>□ Others: (please list)_________</td>
<td></td>
</tr>
<tr>
<td>2. What resources did you find most helpful (and why)? (Written response)</td>
<td>To learn what qualities make resources helpful to students</td>
</tr>
<tr>
<td>3. What post-secondary plans do you have? (name of university/college program, or job field)</td>
<td>To allow for grouping of responses by post-secondary choices</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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C.3 Subject Teacher/Guidance Counsellor Interview

I am conducting a research study on the support graduating students have in high school when they are learning about and deciding on university programs, specifically engineering.

I have a few questions to guide our conversation today. The interview should take about 1 hour.

I’d like to remind you of 3 points from the Letter of Consent:
- Your participation in this study is voluntary and you may withdraw at any time
- None of the data will contain your name or the identity of your place of work. To protect your identity a pseudonym will replace your name on all data files and in any dissemination of findings. Every effort will be made to maintain the confidentiality of the data now and in the future
- Should you be interested, you are entitled to a copy of the findings.

Provide contact information of the interviewer

I’d like to audio record the interview, so I can capture the discussion accurately and won’t be scribbling notes while we’re talking, is this alright with you? You are entitled to a summary of your comments to ensure you are reflected appropriately. Do you have any questions before we get started?

<table>
<thead>
<tr>
<th>Question</th>
<th>Purpose of Question</th>
<th>Purpose of Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tell me a bit about what the atmosphere in your classrooms is like when students start learning about and applying to university.</td>
<td>To ease into the interview, and set the tone and context for the rest of the interview questions.</td>
<td></td>
</tr>
<tr>
<td>How does your role as a teacher change when grade 12 students are applying to post-secondary programs?</td>
<td>To learn about the career advising role of subject teachers</td>
<td>What role do subject teachers and guidance counsellors play in advising students about university programs and career paths?</td>
</tr>
<tr>
<td>What resources do you use to prepare for student questions about university programs and career paths?</td>
<td>To gather data about the resources that they refer to.</td>
<td>What influences a teacher’s knowledge base?</td>
</tr>
<tr>
<td>When a student approaches you asks about engineering, how do you respond?</td>
<td>To gather data about how teachers explain engineering to students</td>
<td>How do teachers disseminate engineering information to students?</td>
</tr>
<tr>
<td>How do you recognize a student who could become an engineer?</td>
<td>To learn how educators identify students who should consider engineering (attributes, academics, etc.).</td>
<td>What do teachers perceive are traits that would be useful to an engineer?</td>
</tr>
</tbody>
</table>

Is there anything else you’d like to add? Thank you very much for your time.
Appendix D
Additional Data

Table 19: Frequently identified useful resources

<table>
<thead>
<tr>
<th>Resource</th>
<th>Number of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>University Open House</td>
<td>6</td>
</tr>
<tr>
<td>Internet Searches</td>
<td>5</td>
</tr>
<tr>
<td>University Reps</td>
<td>3</td>
</tr>
<tr>
<td>Current Post-secondary Students</td>
<td>3</td>
</tr>
<tr>
<td>myblueprint.ca</td>
<td>3</td>
</tr>
<tr>
<td>School Websites</td>
<td>3</td>
</tr>
<tr>
<td>Family</td>
<td>3</td>
</tr>
<tr>
<td>einfo.ca</td>
<td>2</td>
</tr>
<tr>
<td>Father</td>
<td>2</td>
</tr>
<tr>
<td>University Visits to School</td>
<td>2</td>
</tr>
<tr>
<td>Guidance Counsellor</td>
<td>2</td>
</tr>
<tr>
<td>Ontario Colleges Website</td>
<td>2</td>
</tr>
<tr>
<td>Visiting Campus</td>
<td>2</td>
</tr>
<tr>
<td>University Fair</td>
<td>2</td>
</tr>
<tr>
<td>Co-op</td>
<td>2</td>
</tr>
<tr>
<td>Talking to People in Job</td>
<td>1</td>
</tr>
<tr>
<td>University Viewbooks</td>
<td>1</td>
</tr>
<tr>
<td>Work Friends</td>
<td>1</td>
</tr>
<tr>
<td>Teacher</td>
<td>1</td>
</tr>
<tr>
<td>Ontario University Info Website</td>
<td>1</td>
</tr>
<tr>
<td>Peers</td>
<td>1</td>
</tr>
</tbody>
</table>
Appendix E

Additional References From Antony

Antony [61] utilized references that were unable to be located. The bibliographic details from [61] are listed below:


