INVESTIGATING THE RELATIONSHIP BETWEEN INTERNET ATTITUDES OF COLLEGE STUDENTS AND THEIR STEM (SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS) CAREER PERCEPTIONS

Sita Periathiruvadi, M.Ed.

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APPROVED:

Tandra Tyler-Wood, Major Professor
Gerald Knezek, Committee Member
Anne N. Rinn, Committee Member
Rhonda Christensen, Committee Member
Michael J. Spector, Chair of the Department of Learning Technologies
Herman L. Totten, Dean of the College of Information
Mark Wardell, Dean of the Toulouse Graduate School
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Are our students just consumers of technology or do their interests in technology translate into positive perceptions about STEM majors and careers? This research aimed to describe the role of the Internet in undergraduate students’ academic and career perceptions in STEM areas. The purpose of the research was addressed in three parts. First, the attitudes of undergraduate students towards five functions of the Internet namely tool, toy, treasure, telephone and territory were described. Second, students’ STEM career-related perceptions were described in terms of their science and mathematics self-efficacy, outcome expectations, and attitudes towards a STEM career. Third, the relationship between the five Internet functions and the three STEM career-related perceptions was examined. The participants for this study were 566 undergraduate students from a large Southern university. The research design followed a mixed methods approach using multivariate analyses and content analyses. The findings of the research indicated that there was a small but meaningful relationship between undergraduate students’ Internet and STEM perceptions. In their daily lives, the students perceived the Internet more as a toy and a tool. For general career related purposes, they perceived the Internet more as a treasure and a tool. For STEM areas in particular, they perceived the treasure and toy dimensions of the Internet more relevant. Findings on the differences in students’ Internet and STEM career-related perceptions based on gender, major and enrollment in an Honors program are also discussed.
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CHAPTER 1

INTRODUCTION

The purpose of the research study was to explore how undergraduate students perceived the role of the Internet in their daily lives, and how students’ Internet attitudes were related to their career-related perceptions in science, technology, engineering and mathematics (STEM).

1.1 Key Objectives of the Study

This research study was conceived based on two central ideas: the need to improve the STEM workforce of the country and the need to examine the Internet as an evolving environment in today’s students’ lives. Trying to bridge these two areas, this research not only described the current state of perceptions about the Internet and STEM careers among college students, but also explored the relationship between these two perceptions. The objectives of this study were to:

a. document how undergraduate students perceived the role of the Internet in their daily lives

b. identify and describe undergraduate students’ perceptions about a STEM career in terms of their attitudes towards a STEM career, science and mathematics self-efficacy and outcome expectations

c. investigate how undergraduate students’ Internet attitudes were related to their STEM career-related perceptions

The model illustrated in Figure 1.1, articulates the variables and relationships that were examined. Eight variables were considered in this study. The five variables seen in the left side of the model (see Figure 1.1) namely tool, toy, treasure, territory, and
telephone referred to how students perceived the different functions of the Internet. The three variables in the right side of the model, namely science/mathematics self-efficacy, STEM career attitudes, and science/mathematics outcome expectations, were used to measure students' perceptions related to STEM areas and careers. The double-headed arrow mark connecting the two constructs, Internet attitudes and STEM career-related perceptions, denotes the third objective of the study, namely to examine the relationship between students' Internet perceptions and their STEM career-related perceptions.

Figure 1.1 Model of relationship between Internet and STEM career perceptions

1.2 Educational Significance

According to the PEW Internet and American Life Project [PEW] (2012), almost 85% of the adults in the U.S. use the Internet in their daily lives. Therefore, the influence of the Internet both as a cultural and technological factor cannot be overlooked (Morse, Gullekson, Morris, & Popovich, 2011). Morse et al. noted that although the use of the Internet is very prevalent, empirical research examining one’s Internet attitudes is still developing. A search for literature on Internet attitudes indicated that most studies in the
early 1990s focused on whether people’s Internet attitudes were positive or negative. With the increasing availability of the Web 2.0 and social media, there is a clear need to move beyond focusing on just the positive or negative inclination of students towards the Internet. Many recent studies have shifted the focus to examining one’s attitudes towards the Internet based on intensity (Hargittai & Hsieh, 2010; Livingstone & Helsper, 2007), different functions of the Internet (Chou, Yu, Chen, & Wu, 2009; Chou, Wu, & Chen, 2011), and intricate details of uses/misuses of the Internet (Guan & Subrahmanyam, 2009; Kuss, Griffiths, & Binder, 2013). By investigating how different dimensions of Internet use and attitudes affected students’ personal and academic development, this study addressed gaps in the literature on Internet use. In addition, this research also provided a general understanding about the role of the Internet in the lives of the current generation of students.

The future workforce needs to be both technologically literate as well as efficient problem solvers (Lamb, Vallett, Cheng, & Peterman, 2013). More importantly, improving the STEM education and the STEM workforce has been a top priority for educators, researchers, policy makers and other stakeholders for many years. Several concerns have been documented in the literature on STEM education including concerns about (a) the current state of STEM literacy in the nation, (b) the decreasing interest in science and mathematics content areas, (c) attrition in STEM programs in universities, (d) low enrollment of minority populations in STEM areas, and (e) the challenges in recruiting the future STEM workforce (Banning & Folkestad, 2012; Bybee, 2010; Heilbronner, 2011). The growing list of concerns has resulted in a spur of national research grants and initiatives. Scholars have tried to explain several factors influencing students’ STEM
perceptions at different stages of students’ lives. These factors could be broadly classified as person-related and external factors. As researchers (Fouad et al., 2010; Schaub & Tokar, 2005) have pointed out, although there are numerous research studies trying to understand the internal factors affecting one’s career choice, there is a pronounced need for research studies that relate the influence of the external environment on internal factors such as students’ attitudes, confidence, self-efficacy and self-concept in STEM areas.

This research considered three internal factors: students’ science/mathematics self-efficacy, science/mathematics outcome expectations, and attitudes towards STEM careers. The external factor considered in this study was the role of the Internet. Further, the study extended the current understanding on how students’ Internet attitudes affected their career related perceptions, particularly in STEM careers.

In addition to the above mentioned purposes, the current study also examined some group differences in STEM and Internet perceptions of college students. Often, researchers are interested in examining how various groups differ in their perceptions about objects and people. This study examined the differences in STEM and Internet-related perceptions between male vs. female students, STEM vs. non-STEM majors, and Honors vs. non-Honors students. The existing literature on these group differences is discussed in the second chapter.

1.3 Research Questions

The three objectives of this research study are addressed by specific research questions and hypotheses as follows.

1.3.1 Objective 1
Document how undergraduate students perceive the role of the Internet in their daily lives.

RQ1. What are undergraduate students' perceptions towards the different dimensions of the Internet?

RQ2. How are male and female undergraduate students different in their Internet attitudes?

Research hypothesis: There is a difference in Internet attitudes between male and female undergraduate students.

RQ3. What are the differences in how STEM and non-STEM majors perceive the Internet?

Research Hypothesis: There is a difference in Internet attitudes between STEM and non-STEM undergraduate students.

RQ4. What are the differences in Internet attitudes between undergraduate students enrolled in an Honors College and those not enrolled in an Honors College?

Research hypothesis: There is a difference in Internet attitudes between Honors and non-Honors college students.

1.3.2 Objective 2

Identify and describe undergraduate students’ STEM career-related perceptions.

RQ5. What are undergraduate students' perceptions toward a career in STEM (in terms of their science/mathematics self-efficacy, STEM career attitudes and science/mathematics outcome expectations)?
RQ6. How are male and female undergraduate students different in their STEM career-related perceptions (science/mathematics self-efficacies, STEM career attitudes and science/mathematics outcome expectations)?

   Research hypothesis: There is a difference in the STEM career-related perceptions between male and female undergraduate students.

RQ7. What are the differences in how STEM and non-STEM majors perceive STEM subjects and careers?

   Research hypothesis: STEM majors will report higher STEM career-related perceptions when compared to non-STEM majors.

RQ8. What are the differences in STEM career-related perceptions (science/mathematics self-efficacy, STEM career attitudes and science/mathematics outcome expectations) between Honors and non-Honors college students?

   Research hypothesis: Honors college students will report higher STEM career-related perceptions when compared to non-Honors college students.

1.3.3 Objective 3

   Investigate if and how undergraduate students’ Internet attitudes are related to their STEM career-related perceptions.

RQ9. What is the relation between undergraduate students’ Internet attitudes and their STEM career-related perceptions?

   Research hypothesis: There is a moderate positive relation between undergraduate students’ attitudes towards the Internet and their STEM career-related perceptions.
1.4 Definitions of the Variables

Attitudes, self-efficacy and outcome expectations were the constructs considered in the current study. The definitions of these constructs as used in this study are described below.

1.4.1 Science and Mathematics Self-efficacy

Bandura (1994) defined self-efficacy as a person’s judgment of his/her ability to perform certain activities. It is measured by “can do” and not “will do” (Lent & Brown, 2006). Based on Lent and Brown’s suggestions, the self-efficacy construct in this study was not measured as a unitary construct (i.e. general self-efficacy); instead students’ self-efficacy specific to the areas of science and mathematics domains was considered.

1.4.2 Attitudes towards a STEM Career

In the seminal article titled, The Measurement of Social Attitudes, Thurstone (1931) defined attitude as a liking or aversion towards/from an object or a person. In fact, Thurstone was a pioneer in developing one of the first instruments to measure attitude as a psychological construct. In his article, Thurstone recommended that attitudes should be measured in only those situations when the researcher believed that the participant might convey their true feelings about a construct. The definition of attitudes in the literature has undergone various interpretations. The definitions ranged from the cognitive aspects of one’s beliefs, opinions and views to affective characteristics of one’s like or dislike towards an object (Alrehaly, 2011). In this study, attitudes towards a STEM career were measured as a combination of both the affective and the cognitive aspects of one’s feeling about pursuing careers in STEM.
1.4.3 Science and Math Outcome Expectations

Outcome expectations were measured in terms of what students expected as consequences of performing well in science and mathematics domains (Fouad & Guillen, 2006). Lent and Brown (2006) defined outcome expectations as “the imagined consequence of a particular course of action” (p.17). Such outcome expectations might include expectations about personal, family, social or financial outcomes (Lent & Brown, 2006).

1.4.4 Dimensions of Internet Attitudes

For the purpose of the study, Internet attitudes were defined as “individual’s cognitions and feelings towards the Internet as a multi-function entity” (Morse et al., 2011). Students’ attitudes towards the Internet were measured across five dimensions of the Internet namely tool, toy, treasure, telephone and territory as shown in Figure 1.1. These five dimensions follow the 5T model of Internet use (Chou et al., 2009; Chou, et al., 2011) as listed below

i. Tool: The individuals perceive the Internet as a tool or a helper to assist with their daily activities. Examples include downloading content, searching for jobs, performing banking activities, buying or selling products, using an online calendar, and creating or designing websites.

ii. Toy. The individuals perceive the Internet as a toy - something to play with, to be entertained, to make them happy, or to avoid boredom. Examples include watching movies or videos, playing with online games or simulations, or any activities that amuse or help a person to relax.
iii. Treasure. The individuals perceive the Internet as a treasure of information and primarily use the Internet to seek information to do creative and interesting activities, to aid with learning or school work and also to become more aware of information around oneself.

iv. Telephone. The individuals perceive the Internet as a medium for communicating with other people and meet new people. Examples include using the Internet primarily for emailing, instant messaging, video/audio chatting or conferencing.

v. Territory. With the advent of collaboration tools and social media, individuals perceive that they have their own places in the Internet where they can share their views, express their emotions, and create a web-space for themselves. Examples include establishing one's online presence through websites and blogs, collaborating and exchanging views through wikis, having an avatar in virtual worlds with an online identity, or establishing a network through social media such as Facebook and Twitter.

It is important to note that most people view the Internet in many of these dimensions. Therefore the research study aimed to examine which of these dimensions was more prevalent among college students. This study did not restrict to an idea that a particular website would be classified as a unique dimension. For instance, *YouTube* is predominantly a video sharing website and perceived by most people as a source of entertainment (toy). However, people can use the YouTube website to watch “How-to” videos (tool), to communicate their ideas such as video responses and comments (telephone), to organize their videos and playlists (tool), or even to create their own video channels and establish their online presence (territory).
1.5 Limitations and Delimitations

There are a few methodological limitations to the current study. The generalization of the findings to all undergraduate college students in the United States is limited for the following reasons: a) the sample used in the study is a convenience sample, and b) the sample in this study consisted of a high percentage of female students when compared to male students. The noted difference is not a reflection of the population from which the sample was drawn. To correct for the difference in gender representation, the research employed a correlational analysis of the Internet and STEM variables. Care should be taken to avoid any causal interpretations from these findings because the study was not experimental or quasi-experimental in nature. In addition, the group comparisons were made with unequal groups. Although the underlying assumptions for the analyses were met, and unequal group sizes are common in correlational studies, future studies can confirm these findings using equal groups. Further, this study primarily examined the overall differences between groups based on gender, major, and enrollment in an Honors program. The interaction between gender, major and Honors enrollment was approached in a descriptive manner. Future studies can adopt a purposive sampling method to have equal number of participants in the interaction groups. Another approach would be to use a propensity score matching technique to examine differences of minority population such as the gifted college students. Content analyses were helpful in extending the quantitative findings, but the responses were very short as would be expected for open-ended questions in a survey. Detailed interviews could add a clearer picture on the role of the Internet in STEM career-related perceptions.
The research had some delimitation. The research approached the objectives form a model-building and model-extension perspective. The Internet attitudes scale based on the 5T model of Internet use needed several model re-specification changes resulting in only 20 useable items out of the original 43 items for measurement of Internet attitudes. The STEM areas were considered as a unitary concept although there is a wide range of careers in science, technology, engineering and mathematics. Only science and mathematics self-efficacy and outcome expectations were considered in this research. Replication studies can target students’ self-efficacy and outcome expectations in other STEM areas including engineering and technology. Future studies can also investigate more specific science and math content areas such as physics, chemistry, and statistics.

1.6 Summary

Chapter 1 introduced the purposes of this study, and presented the central ideas that guided the study. With the advent of the Web 2.0, the various functions offered by the Internet have expanded to new horizons. Often, today’s college students are considered tech-savvy and proficient in using new technologies. Does this tech-savvy behavior translate into effective use of the Internet functions for their academic and career development? Is there a relation between how the students perceive the different functions of the Internet, and their perceptions about science, mathematics and STEM related careers? Trying to answer these questions, the research study had three key objectives. This chapter outlined the three objectives and the corresponding research questions and hypotheses. By explaining Internet attitudes and STEM career-related perceptions of undergraduate students, and investigating the relation between
these two constructs, this study aimed to bridge the research literature on vocational psychology and cyber-psychology. This chapter also defined the three constructs that were examined in the research namely one’s attitudes, self-efficacy and outcome expectations.
CHAPTER 2
LITERATURE REVIEW AND THEORETICAL LENS

This chapter reviews the current literature to understand a) what we know about Internet attitudes and STEM career-related perceptions of college students from the existing literature in these areas, b) establish the context for the current research study as suggested by Randolph (2009), c) define and explain the variables of interest to this study, and d) synthesize the relationship between Internet attitudes and STEM perceptions of college students. Corresponding to the three main research objectives, the review of the literature will address three areas: Internet use and attitudes, STEM career-related perceptions, and the relationship between these two areas.

2.1 Internet Use and Attitudes

The Internet, which once started as a web of computer networks, is today an indispensable part of people’s daily lives. The prevalence of the Internet as a global village connecting people from different parts of the world was visualized as early as 1964 by McLuhan (The Living Internet, 2011). With the increasing prevalence of the Internet, the number of people using the Internet every day has also dramatically increased worldwide. According to the Internet World Stats (2013), the U.S. ranks second in the list of the top countries with the highest number of Internet users, thereby contributing to 10.2% of the worldwide Internet use. The other two countries with high number of Internet users include China and India, the most populous countries in the World. In the U.S., almost 85% of the adult men and women use the Internet in their everyday lives (PEW, 2012). This percentage is even higher among young people at 94-95%. A national level comparison of the main purposes for which people in the U.S.
use the Internet (PEW, 2012) indicated that 80% of the teens used the Internet for social networking, and 62% of the teens used the Internet for collecting information. In contrast, nearly 80-90% of the adults used the Internet to search for information and emailing others. Approximately 75% of the adults reported using the Internet for entertainment and fun.

2.1.1 Why Examine Internet Attitudes?

The Internet has changed the way we communicate, collect information and interact with each other. In particular, the information and communication technologies form an integral context for young people all over the world. Forzani and Leu (2012) described the Internet as both complex and interactive. Almost all the undergraduate students (98%) interviewed by Smith, Rainie and Zickuhr (2011) reported using the Internet, and a majority of these students (92-93%) had access to both broadband and wireless Internet connections. However, to be able to use the Internet effectively for learning, a student needs appropriate guidance and scaffolding at schools and universities. The interactive nature of the Internet offers students abundant opportunities to actively construct knowledge, and also provides adaptability to suit a student's learning style (Forzani & Leu, 2012). Internet attitudes are an essential component of Internet literacy because how students perceive the Internet influences their Internet usage. By carefully observing how young students use the Internet, and by transferring the positive on-line experiences to other aspects of their daily lives, we can encourage students’ academic and career development (Brown, 2012). Kuss et al. (2013) also noted that it is important to understand the different ways students use the Internet to
identify what experiences make them addicted to the Internet. Understanding students’ Internet attitudes is also a pre-requisite of Internet-based instruction (Wu & Tsai, 2006).

2.1.2 Research on Internet Attitudes

The research on Internet attitudes was at its peak in the late nineties and early 2000s (Tsai, Lin & Tsai, 2001). The research on the Internet during these years mainly focused on characteristics of the Internet and Internet literacy (Tuncer, 2012). Internet attitudes can be described as how people perceive the Internet based on their use, experiences, thoughts and the emotions they feel when using the Internet (Tuncer, 2012). Studying Internet attitudes is important because how people use the Internet has the potential to influence the educational and economic development of a society (Tsai et al., 2001). For students, the perceptions they hold towards the Internet can influence how they seek information, or how they interact with others online. Further, the Internet offers students an opportunity to improve their learning, and thereby influence their future career interests. Previous studies have shown that one’s attitude towards the Internet is positively related to how he/she uses the Internet (Duggan, Hess, Morgan, Kim, & Wilson, 2001; Durndell & Haag, 2002). Internet attitudes are also related to one’s confidence in using the Internet, beliefs about technology-related tasks, persistence in challenging tasks (Peng, Tsai, & Wu, 2006), and one’s job prospects and learning (Cheung & Huang, 2005). Studies examining Internet attitudes can be classified as studies focusing on:

- positive and/or negative views about the Internet (Durndell & Haag, 2002; Hong, Ridzuan, & Kuek, 2003; Tuncer, 2012)

- different functions of the Internet (Chou, et al., 2009; Chou, et al., 2011)
• problematic use of the Internet (Byun, et al., 2009; Guan & Subrahmanyam, 2009; Kim, Larose, & Peng, 2009; Kuss, et al., 2013)

People’s perceptions about the different functions of the Internet have been studied in terms of age (Levin & Arafeh, 2002; Chou, et al., 2011), gender (Chou et al., 2009; Chou et al., 2011; Imhof, Vollmeyer, & Bierlen, 2007; Jones, Johnson-Yale, Millermaier, & Perez, 2009), and personality characteristics (Amiel & Sargent, 2004; Swickert, Hittner, Harris, & Herring, 2002; Whitty & McLaughlin, 2007). Young school-aged students described the Internet as many things: a virtual textbook, a virtual library, a virtual tutor, a shortcut to studying, a virtual study group, a virtual guidance counselor, a virtual locker, a backpack and a notebook (Levin & Arafeh, 2002). These references highlighted how these students viewed the Internet. For college students, the primary purposes for using the Internet were for socializing, entertainment, and academic purposes (Jones et al., 2009). In another study about the Internet attitudes of 1061 college students in Taiwan, Chou and his colleagues (2011) found that college students considered the Internet predominantly as a tool to help with academic and daily life activities. The second dimension of the Internet that the Taiwanese college students valued more was using the Internet as a toy, not only because of the interesting nature of the Internet, but also because the Internet allowed them to relax and avoid boredom. The college students also perceived the Internet as a treasure of information and as a territory where individuals can create content and collaborate with other Internet users.

Social phenomena also seem to influence one’s Internet use. People who are satisfied with their social life viewed the Internet more as an instrumental or information seeking medium whereas people who have less face to face interaction and social
connections viewed the Internet as a social medium (Amiel & Sargent, 2004). Another study by Hamburger and Ben-Artzi (2000) found that for male subjects, participants who were more extraverted in nature preferred to use the Internet for leisure activities, while those who were high on neuroticism used the Internet less for information seeking for work or education. In contrast, female subjects who reported being high on extraversion and low on neuroticism were also high on using the social media and interaction functions of the Internet. These findings were to some extent contrasted by Amiel and Sargent’s (2004) study. In the latter study, the researchers found that extraverts did not seek leisure activities more than introverts. When using the Internet for communication, extraverts wanted to voice their opinion rather than listen to others. Extraverts also tended to use the Internet more as a tool. In contrast, people high on psychoticism reported high use of the Internet for leisure, and low use of the Internet as a treasure of information. The subjects who reported high neuroticism used the Internet as a treasure of information to mainly seek information to overcome insecure feelings.

2.1.3 Theoretical Frameworks to Study Internet-related Perceptions

Several frameworks have been employed to explain how people perceive and use the Internet. Such frameworks focus on one’s Internet attitudes, self-efficacy in using the Internet, perceptions about ease of the Internet and its usefulness, frequency of Internet use and the relationship of the Internet variables to a person’s academic, social and emotional development. Some prominent frameworks are the Technology Acceptance Model (Davis, 1989), the Uses and Gratification model (Blumler & Katz, 1974), and the T- frameworks (Tsai, 2004; Chou et al., 2009; Chou et al, 2011). A brief description of the three frameworks is explained in the following section.
2.1.3.1 Technology Acceptance Model

Research explaining technology use and attitudes has focused on users’ characteristics that influence technology use, and also the technology features that influences use and attitudes (Porter & Donthu, 2006). The Technology Acceptance model and the newer UTAUT (Unified Theory of Acceptance and Use of Technology) models are extensively used in the literature to explain how perceptions of usefulness and ease of Internet use influences one’s attitudes towards a technology, and also mediate the relationship between external factors and attitudes towards the technology (Venkatesh, Morris, G. Davis, & F. Davis, 2003; Davis, 1989). Porter and Donthu (2006) applied this model to study Internet use by adults. The findings in this study indicated that perceived usefulness and ease of use were strongly related to Internet attitudes which in turn were positively related to one’s Internet use. However, Internet attitudes in this study were measured using a 3-item scale to examine if the attitudes were positive or negative, and not about attitudes towards the various functions of Internet use.

2.1.3.2 The Uses and Gratification Model

In mass media research, a frequently used framework is the uses and gratification (U&G) model. Although this model initially focused on the effects of media on how people use the Internet, the focus has moved to what motivates people to use media in a certain manner. This theory insisted that people use media for different purposes, and placed importance on the needs and behaviors that satisfy their needs (Roy, 2009). Several studies have employed the U&G theory to explain gratifications from Internet use. The gratifications were initially understood as belonging to two categories: (a) process gratification: pleasure that one derives when using the Internet,
and (b) content gratification: pleasure from using the information from the media for practical reasons (Song, Larose, Eastin, & Lin, 2004; Swanson, 2012). Such gratifications include escape, interaction, entertainment, relaxation, social information, companionship, learning needs (Parker & Plank, 2000), virtual community, monetary needs, diversion (Song et al., 2004), social escapism, pass time, interaction control and information (Roy, 2009). For example, in a research by Papacharissi and Rubin (2000), 279 college students in a large Midwestern university were surveyed about students' motives to use the Internet. One of the findings from this study was that the five primary motives for using the Internet were interpersonal use, information seeking, to pass time, convenience and entertainment.

Shao (2009) employed the U&G Theory to explain the use of user generated media on the Internet. According to Shao, how people use the media depends on the motivation for use. The three uses and gratification can be summarized as follows:

i. People just consume information on the Internet (watch videos or read website content) when the gratification is information seeking and entertainment.

ii. People participate (share website links, write comments) when the gratification is to interact socially with others and be part of an online community.

iii. People produce their own content (create videos, upload images) when the gratification is to express themselves.

More recently, many studies have employed the U&G theory to understand why and how people use different social media websites including Facebook (Smock, Ellison, Lampe, & Wohn, 2011), Yelp (Hicks et al., 2012), and YouTube (Haridakis & Hanson, 2009). Based on these studies, an idea that is applicable to the current study is
that people perceive the social media in various ways such as gathering information, 
interacting with others, or expressing their views.

2.1.3.3 The T-Frameworks

In a seminal paper titled *Computer in the School: A tutor, tool, tutee*, three roles of the 
computer in schools were considered. The computer was perceived as a tutor to 
differentiate instruction for students, a tool to perform different tasks, and more 
importantly as a tutee where the students program the computer (Bull, 2009; Taylor & 
Robert, 2003). This idea was extended to the study of Internet attitudes by Tsai (2004) 
after interviewing 40 adolescents in Taiwan. Internet attitudes were categorized as 
Technology, tool, toy, tour/travel to capture the attitudes towards different functions of 
the Internet. The middle school and high school students who participated in Tsai’s 
study reported higher perceptions towards the technology and tool functions of the 
Internet. The Technology dimension denoted that the Internet was a technology to 
improve people’s lives. The tool dimension included the information, communication and 
trade functions of the Internet. The toy dimension denoted the pleasure and 
entertainment functions of the Internet, and finally the tour/travel dimension denoted the 
ability to travel different sites on the Internet. One issue with this framework was that the 
distinctions between the technology dimension and the other dimensions were not clear. 
Further, important motives namely the information and communication dimensions were 
not accounted for separately in this model. Chou and his colleagues proposed a 
different framework to clarify the distinctions between the different dimensions. In this 
framework, the four dimensions were tool, toy, telephone and treasure of information 
(Chou et al., 2009). This new 4-T framework was further extended to include the Web
2.0 dimension to this framework. Chou et al. noted that an extra dimension called territory was included to understand the students’ attitudes towards the read/write function of the Internet. The territory dimension included the creation of websites and blogs, and participation in online social networks. Chou et al. surveyed 2253 elementary students and found that the young students perceived the Internet more as a tool and a toy, and not much as a medium for communication. The 5T model of the Internet use by Chou et al. (2009) and Chou et al. (2011) was used in this study

2.1.3.4 The 5T Model of Internet Use

According to the 5T model (Chou et al., 2009), every individual perceives the Internet in one or more of these five dimensions. Some dimensions may be more appealing to some individuals than the other dimensions. For instance, a student who is interested in researching and finding new information about space might perceive the Internet more as a treasure of information. A person who loves to meet new people might perceive the Internet more as a telephone. Measuring how college students in this study perceived the Internet, and relating those perceptions with their attitudes and self-efficacies in STEM areas and careers will help to examine if perceptions about the Internet in one of these dimensions is more related to perceptions about pursuing a career in STEM areas.

2.1.4 Gender Differences in Internet Attitudes

Gender differences in attitudes towards the Internet can be attributed to basic societal gender differences or being affected by negative stereotypes related to women and technology (Amiel & Sargent, 2004; Hamburger & Ben-Artzi, 2000; Jones et al., 2009; Tsai et al., 2001). A review of gender differences in the Internet attitudes (Chou et
al., 2009; Tsai, 2006) indicated that the findings from studies on Internet attitudes have shown contrasting results with some studies indicating differences between male and female students’ Internet attitudes while others suggesting that the difference is diminishing as a result of equal access to the Internet for both male and female students. In a study of Internet attitudes among 753 high school students, Tsai et al. (2001) found that both male and female adolescents perceived that the Internet was a very useful tool and there were no statistically significant gender differences in students’ perceptions about the usefulness of the Internet. However, male students reported higher frequency of using the Internet, and also reported less anxiety, and more confidence in using the Internet when compared to their female counterparts. The years of experience using the Internet also affected students’ Internet attitudes and confidence. In another study by M.J. Tsai and C.C. Tsai (2010), 1080 middle school students were surveyed about students’ use, experience and confidence in using the Internet. The findings showed that the female students and male students did not differ in their confidence or experience of using the Internet. However, female students tended to prefer the communication aspect of the Internet while the male students were more likely to use the Internet for exploring information.

In another study, Hargittai and Hsieh (2010) were interested in examining the typology of social networking use among college students. The participants were surveyed about their frequency of use and the number of social networking sites of which they were a part of. Based on these responses, the participants were classified as one of the four SNS typologies namely Dabblers, Samplers, Devotees and Omnivores depending on the intensity and frequency of Internet use. Female college
students were more likely to be *Omnivores* (people who use more than one social networking site and more frequently) as they reported more intense use of social networking websites than male students. In Tsai's study (2006), female students in middle school and high school conceptualized the Internet more as a technology, while male students in middle school conceptualized the Internet more as a tool and toy when compared to female students. Further, younger male students in Chou et al. (2009) reported higher perceptions of the Internet in terms of tool, toy, treasure and telephone than female students. However, there was no difference in how the students perceived the territory function.

Jones et al. (2009) examined the use of the Internet by college students from 29 U.S. higher education institutions. The findings of this research study indicated that male students reported more experience with the Internet when compared to female students. When asked about the number of years of experience, 66% of male students compared to 56% of female students reported using the Internet for more than 10 years. Female students preferred using the Internet for social communication, followed by academic-related usage. In contrast, male students reported using the Internet primarily for entertainment, then for social communication followed by academic related use. Male and female students reported similar use of the Internet as a tool for file sharing. Although male and female students reported no differences in their inclination to own a blog, female students reported updating their blogs more frequently (Jones et al., 2009). Overall, the male students reported higher frequency and duration of Internet use than female students. Female students used the Internet more for communication and academic-related activities than male students (Jones et al., 2009). Female students
were also more likely to use mainstream information resources such as search engines and library websites whereas male students were more prone to explore a variety of information sources (Jones et al., 2009). Some of these gender based differences in students’ Internet attitudes were not found in a study that involved Asian students. Chou, et al. (2011) found that Taiwanese college students showed gender based differences in their Internet attitudes based on how students considered the leisure and communication dimensions of the Internet. However, there were no differences in how male and female college students perceived the tool, treasure and territory dimensions of Internet.

2.1.5 Major-based Differences in Internet Attitudes

One of the differences that the current study examined was the differences between STEM and non-STEM majors in how they perceived different dimensions of the Internet. Wu and Tsai (2006) investigated Internet attitudes of college students enrolled in science and technology programs. The overall Internet attitudes of STEM majors were found to be positive especially in how the STEM majors perceived the usefulness, ability to independently use the Internet, and individual comfort in using the Internet for daily activities. The STEM majors also reported higher frequency of Internet use. Of the STEM majors, no gender based differences were reported for student perceptions about usefulness, affection and frequency of Internet use. However male students reported higher self-efficacy in using the Internet for both general and communicative purposes. In a recent study by Hargittai and Litt (2011), the use of Twitter, a micro-blogging tool by college students was examined. Twitter allows users to post brief messages called tweets and allows them to follow messages posted by other
people who have similar interests. The college students in this study reported using Twitter to mainly follow messages on entertainment and celebrity news. One finding that is relevant to the current study was that students who reported liking science and research topics were less likely to be Twitter users. Studies focusing on how STEM majors use the Internet are still emerging. The current study addresses this gap in the literature.

2.2 STEM Education and Career Constructs

Concerns about the decreasing pipeline to the STEM workforce, and the dwindling interest in science-related areas as early as in middle school have been topics of nationwide importance (Banning & Folkestad, 2012; Bybee, 2010). For more than five decades, several efforts have been undertaken to improve the STEM education and the STEM workforce (Tytler & Osborne, 2012). However, there are several issues that still need to be addressed to improve the state of STEM education and encourage more students to pursue STEM careers. The review of the literature presented in this section is organized as follows. First, a brief discussion about what entails STEM education and why it is important to focus on the STEM workforce is outlined. This is followed by a discussion of the descriptive and research-based articles in this area. The empirical research on STEM career-related perceptions can be classified as research articles describing the relation between various constructs related to STEM career and achievement, differences in perceptions at various age-levels and among different groups of subjects, and interventions that have been found to be effective to improve STEM-related perceptions and achievement.

2.2.1 What is STEM?
The acronym STEM encompasses four content areas namely science, technology, engineering and mathematics. These STEM areas were grouped together based on certain characteristics such as inquiry, design, and analysis for solving problems (Bybee, 2010). Although each of the four areas in STEM has its unique character and history, these areas are dependent on and reinforce each other (Froschauer, 2010). STEM education can be understood as four disciplines being treated as a dynamic fluid study designed to connect the curriculum to real world issues. Therefore, we can conclude that some essential goals of a STEM curriculum are to develop critical and analytical thinking skills among students, and help them relate the curriculum to solve real world problems (Brown, Brown, Reardon, & Merrill, 2011).

2.2.2 The Need for Research on STEM Education and Careers

Why study STEM education and career development as a separate area? As mentioned earlier in Chapter 1, the need to improve the STEM education and the STEM workforce pipeline is a growing concern for the U.S. (Bybee, 2010). Several national level initiatives such as corporate-university-school partnerships and active participation from all stakeholders including parents, teachers, and community members to improve STEM education are encouraging (Froschauer, 2010). However, some issues need to be addressed in order to improve the state of STEM education and the STEM workforce. One issue is that STEM education is not well understood. In Brown et al.’s (2011) study, 29 college students enrolled in a STEM leadership graduate program interviewed administrators, and their peer teachers about STEM specifically to examine if they were able to define what STEM education is and how they perceived the importance of an integrated STEM education. The findings indicated that although the
administrators and teachers thought that STEM education was important for all students, there was no clear vision of how to implement STEM education. Another issue is at the college-level where there is a need to address the issue of attrition and avoidance among college students. According to the National Center for Education Statistics (2009), nearly 3 in 10 physics majors failed to graduate. These numbers are alarming mainly in STEM fields, because the number of students entering STEM areas is lower compared to other fields. The number of female students pursuing and graduating is even smaller in most STEM majors. Both social indicators such as lack of a welcoming atmosphere, and personal indicators such as lack of self-efficacy have been cited as reasons for women’s attrition from STEM majors (Soldner, Rowan-Kenyon, Inkelas, Garvey, & Robbins, 2012). To address these issues, and encourage more students to pursue careers in STEM domains, it is important to understand the influence of various factors affecting students’ attitudes and confidence in pursuing a STEM major and career.

A review by Patterson (2011) on studies focusing on high school students’ career development has shown that the research on career development has focused on five areas namely awareness about a career, the relevance of a career, student self-efficacy in the career-related area, engagement and involvement in STEM subjects, and career information. The main findings from this review indicated that:

i. Students have limited understanding about careers in STEM, and by creating early expectations about STEM careers through career exploration programs can help improve their understanding about STEM careers.
ii. When students perceive science content as relevant to their lives, it improves their interest in science, and thereby influences their choices of careers in STEM fields.

iii. In addition to person-related factors, external support in the form of support from parents, peers, mentors and teachers influence career interests (Diemer, Wang, & Smith, 2007; Rogers, Creed, & Glendon, 2008).

iv. Classroom experiences such as group work instead of lectures, hands-on activities and field work, interaction and internships with role models in the field have also been found very effective.

The current study considered three STEM-related perceptions, namely students’ science/mathematics self-efficacy, outcome expectations as a result of performing well in science and mathematics, and students’ attitudes towards a career in STEM. These three STEM constructs were identified based on the social cognitive career theory by Lent, Brown and Hackett (1994).

2.2.3 Social Cognitive Career Theory

Derived from the social cognitive theory by Bandura (1994), the Social Cognitive Career Theory (SCCT) model, and the importance of self-efficacy and outcome expectations in career development has been extensively researched for the past 25 years (Betz & Hackett, 1983; Betz & Hackett, 1986; Ferry, Foaud, & Smith, 2000; Lent, & Brown, 2006; Rogers et al., 2008). The development of social cognitive career theory by Lent et al. (1994) was aimed at testing specific hypotheses on relationship between various constructs related to career interests and intentions. The social cognitive career theory places importance on both personal (self-efficacy, outcome expectations,
interests), and external (contextual support and barriers) variables. The main tenets of this theory are that when a person believes in his/her abilities, and expects positive outcomes, he/she develops interest in that career and intends to pursue that career. Further, background variables such as gender and ethnicity, and environmental variables such as parents and school also influence a person’s beliefs in his/her abilities (self-efficacy) and expectations (Bryant, Zvonkovic, & Reynolds, 2006; Fouad et al., 2010; Lent et al., 2003; Lent & Brown, 2006). People often eliminate choosing some careers when they have faulty beliefs about their abilities and they are unsure about the outcomes they expect from a career. By modifying these faulty beliefs and expectations, people can be encouraged to pursue careers where the demand is high (Lent & Brown, 2006).

2.2.4 STEM Career-related Perceptions

The environment that the current study aims to understand is the role of the Internet, primarily on what learning and social support this medium provides to influence one’s personal career-related perceptions such as attitudes, self-efficacy and outcome expectations. Although the aim of the current study is not to test the individual hypotheses of the SCCT theory, the current research examines three key personal constructs suggested by the SCCT model as related to career development in STEM domains. These constructs are science/mathematics self-efficacy, science/mathematics outcome expectations, and attitudes about STEM careers. Numerous studies examining the relationship between attitudes, self-efficacy, achievement, and career aspirations have been performed both at the K-12 level and college level (Emmioglu & Capa-Aydin, 2012, Kraus, 1995; Weinburgh, 1995). Following is a review of the existing literature on
these three STEM career-related constructs. The literature on these STEM perceptions is extensive; therefore to maintain brevity, and to obtain an overall idea of the relationship and effect of one STEM construct on another, several meta-analyses were consulted if available. A meta-analysis is a quantitative method used to combine the findings of several related studies to suggest an overall combined effect (Borenstein, Hedges, Higgins, & Rothstein, 2011). The literature was also examined to understand the causes and effects of self-efficacy, attitudes, and outcome expectations i.e. what factors influence these constructs, and in turn how do these constructs influence an individual’s decision to pursue a career in STEM.

2.2.4.1 Attitudes towards STEM Majors and Careers

A majority of the studies have focused on the relationship between students’ attitudes and their achievement both at the K-12 school level and college level. A longitudinal study by George (2000) examined the Longitudinal Study of American Youth national data which tracked students’ attitudes and achievement towards STEM areas. Approximately 400 students were tracked as they progressed from seventh grade through eleventh grade. A longitudinal analysis of this data indicated that students’ attitudes towards science decreased as they progressed from middle school to high school. Kraus (1995) performed a meta-analysis of 88 studies that examined the correlation between attitudes and behaviors towards various objects and construct. The findings of this meta-analysis indicated that the relation between attitudes and behaviors showed statistically significant effect, however the practical effect was found to be small ($r = 0.38$). Another meta-analysis by Weinberg (1995) focused more specifically on the relationship between attitudes and achievement in science across different age groups.
The findings across 18 studies done from 1970 to 1991 indicated that the correlation between attitudes towards science and achievement was moderate ($r=0.50$), and that this correlation for certain science subjects such as biology were slightly higher especially for girls.

A meta-analysis on mathematics attitudes and achievement also revealed a positive relationship. For instance, in a more recent cross-country meta-analysis study, Emmioglu and Capa-Aydin (2012) selected research studies on college students which used the *Survey of Attitudes towards Statistics* scale and included findings on the correlation between statistics attitudes and achievement. Seventeen studies that were conducted from 1997 to 2011 in eight different countries including the United States were shortlisted for inclusion in the meta-analysis. The findings indicated different trends for studies in U.S. versus those from non-U.S. countries. The relation between attitudes and achievement, especially how college students felt about the subject area and their competence was more related to students’ statistics achievement scores. This relation was more pronounced for students in the United States. Students’ perceptions about how much they valued the importance of statistics and the difficulty of the subject had very small relation to their academic achievements in both U.S. and non-U.S. countries. However, Gungor, Erylmaz, and Fakioglu (2007) found that college students’ attitudes towards physics had a minimal effect on physics achievement scores. Therefore, we can conclude that how students feel about a science or mathematics subjects likely influences their achievement in these content areas. There is, however, still some contrast on how strong such an influence is on the student’s achievement.

Attitudes have also been reported as a reason for attrition from STEM majors. Mayo
(2007) found that the undergraduate students who left a STEM program had identical academic achievement to those who stayed in the program. The students reported an aversion towards the program during the first year.

As Tytler and Osborne (2012) suggested, the study of attitudes towards science-related areas has covered several concepts such as students’ general attitudes towards science, their attitudes about scientists, their attitudes about science that they experience in school, and interests in science-related careers. There seems to be a contrast in students’ interests and beliefs about doing well in science versus intentions to pursue a career in science-related areas (Archer et al., 2010; Kitts, 2009). In addition to improving efforts in improving students’ attitudes, self-efficacy and outcome expectation in individual STEM content areas, there seems to be another important issue in improving STEM workforce. Students seem to believe that they can “do science” but do not want to enter STEM careers (Kitts, 2009; Weisgram & Bigler, 2006). Therefore, in the current study, the overall attitudes of students towards a STEM career were measured instead of attitudes towards individual content areas.

The attitudes towards a STEM career are measured in terms of related person-related cognitive factors such as students’ interests, and their perceptions about the relevance of STEM careers. Tyler-Wood, Knezek and Christensen (2010) reviewed several instruments measuring students’ attitudes towards the STEM areas. They found that most instruments focused on specific areas, and there was a clear need to measure overall attitudes towards a STEM career. In their series of studies with various groups of participants, they found that people who have already chosen STEM career paths reported higher attitudes towards STEM careers. In contrast, middle school
students and undergraduate teacher education candidates reported slightly above average attitudes towards STEM careers. Tyler-Wood et al. noted that undergraduate students enrolled in pre-service teacher programs were not very different than middle school students in how they perceived STEM careers.

2.2.4.2 Self-Efficacy and Outcome Expectations in Science and Mathematics Areas

Although many studies have focused on self-efficacy and outcome expectations on science and mathematics areas separately, the current study measured the self-efficacy and outcome expectations for science/mathematics areas together. Ackerman (2003) suggested a few trait complexes such as social, clerical/conventional, science/mathematics and intellectual/cultural traits. Of these, the science/mathematics trait complex is seen as a combination of skills sets including mathematics reasoning, spatial abilities, realistic and investigative interests. Self-efficacy and outcome expectations are important constructs that drive one’s behavior, and also have a considerable impact on a student’s academic and career development (Betz & Hackett, 1983; Betz & Hackett, 1986; Lent et al., 1994; Lent, Brown, & Hackett, 2000; Lent & Brown, 2006).

A majority of studies that have examined STEM self-efficacy have also examined outcome expectations of students in STEM areas. Self-efficacy denotes one’s belief about his/her ability to perform a task (Bandura, 1994). This construct has an important role in the social cognitive career theory, developed by Lent et al. (1994), such that it not only influences one’s interests and choices in a STEM career directly, but also mediates the effect of other external factors on career interests and choices. In addition to one’s self-efficacy in science/mathematics areas, another STEM variable considered
in this study is a student's outcome expectations i.e. the consequences that the student expects out of doing well in science and mathematics. As illustrated in the section on students attitudes towards science and mathematics, several studies have examined the relation between students' self-efficacy and achievements in science and mathematics. For instance, in a recent study, Sawtelle, Brewe, and Kramer (2012) found that for undergraduate students in an introductory physics course, physics self-efficacy was positively related to physics achievement.

Vocational psychology has focused on social and cognitive variables in trying to explain one’s career development for many decades. Several studies have applied the social cognitive career theory model with different samples of participants, and have found that self-efficacy and outcome expectations influence an individual's career interests and choice goals (Blanco, 2011; Ferry et al., 2000; Fouad et al., 2010; Lopez, Lent, Brown, & Gore, 1997). The SCCT model was tested with 1208 students in computing majors (majors in computer science, computer engineering, and information technology) (Lent, A.Lopez, F.Lopez, & Sheu, 2008a). The STEM majors in this study reported high self-efficacy and outcome expectations. They reported slightly above average interests in their major areas. The findings indicated that the model could explain 40% of the variance the students’ career interests. Self-efficacy was found to be a strong predictor of the students’ career interests for both male and female students. External support and barriers influenced self-efficacy which in turn affected the students’ career interests and intentions. STEM majors reported high self-efficacy, and above average outcome expectations and interests in another study by Lent et al. (2008b). The students' outcome expectations did not have any influence on career interests and
goals. In a related study by Blanco (2011), 1036 undergraduate Spanish psychology majors were surveyed about their self-efficacy, interests, outcome expectations, career goals and mastery experiences in statistics. The non-STEM majors in Blanco’s study reported slightly above average self-efficacy, outcome expectations and interests is the mathematics content area. The findings from this study supported the SCCT in that, students’ self-efficacy and outcome expectations directly impacted their interest in statistics. This showed that the students who believe in their statistics abilities expect higher outcomes from doing well in statistics, and such self-efficacy and expectations improve their interests. The students’ outcome expectations also had a strong impact in their intentions to pursue a career in statistics-related fields. Students who were enrolled in an introductory psychology courses in two large U.S. universities were surveyed about their self-efficacy and outcome expectations by Byars-Winston and Fouad (2008). The undergraduate students in this study reported high self-efficacy in mathematics and science and slightly below average outcome expectations.

2.2.4.3 Science/Mathematics Perceptions of STEM and Non-STEM majors

Although several studies (Blanco, 2011, Byars-Winston & Fouad, 2008; Lent et al., 2008a, Lent et al., 2008b) have examined STEM perceptions of STEM and non-STEM majors in different studies, there seems to be very little empirical research comparing the STEM perceptions of STEM and non-STEM majors in the same study. Gogolin and Schwartz (1992) compared 101 non-science majors with 81 science majors. The STEM majors in this study reported higher attitudes towards science than the non-STEM majors. Based on the findings from previous studies where STEM majors and non-majors have participated, we can hypothesize that STEM majors have
high self-efficacy and above average to high outcome expectations in science and mathematics areas (Lent et al., 2008a; Lent et al., 2008b). Findings on non-STEM majors (Blanco, 2011; Byars-Winston & Fouad, 2008) show that they might have above average to high self-efficacy and average outcome expectations. The current study will be a valuable addition to the literature on STEM and non-STEM majors as it compares these two groups in a single study.

2.2.5 Gender Differences in STEM Perceptions

As early as eighth grade, it has been observed that boys not only report liking science and mathematics more than girls, but also report more confidence in their science and mathematics abilities (Fouad et al., 2010). Fouad et al. also noted that this difference in attitudes widened as students move into high school and college. Often, researchers are concerned with why more women fall through the STEM pipeline when compared to men in the STEM pipeline. Many researchers seem to agree that this is not much a difference in ability, but more related to women’s beliefs, interests, attitudes and the experiences they encounter in their surrounding environment (Fouad et al, 2010; Trocivia, 2012; Tyler-Wood et al., 2010).

Su, Round and Armstrong (2009), in their meta-analysis on gender differences in career preferences among adults, found that a high percentage of males preferred to work with things while a high percentage of females preferred to work with people. They also found that men showed stronger interests in science and mathematics than women. The magnitude of this difference was found to be moderate. The studies on gender differences in attitudes towards science have shown mixed results. Such differences were also noted at the K-12 education level in Weinburgh’s (1995) meta-
analysis across 18 studies. The findings indicated that male students had more positive attitudes towards science when compared to female students. However, the relationship between attitudes and achievement in science was similar for both boys and girls, and was found to be a moderate relation. Female students seem to have an equal or higher preference towards some science areas such as biology whereas mathematics and physics areas are still dominated by male students (Miller, Blessing, Schwartz, 2006; Osborne, Simon, & Collins, 2003).

Kan and Akbas (2006) observed the attitudes and self-efficacy of 819 students from ten different high schools in Turkey. The authors found that attitudes and self-efficacy of students towards Chemistry contributed to the student’s chemistry achievement scores. Although the authors noted that the effect was highly significant, the effect sizes observed in their study was small but positive. They also found that boys reported more positive attitudes and higher self-efficacy scores in science than the girls in this study. In another study, Miller et al. asked several high school students to rank various courses based on their interest. The male students selected mathematics and science courses more than the girls, primarily in the areas of algebra, geometry, and chemistry. The female students preferred English and Spanish courses more. A similar level of preference towards biology was noted. When these students were asked to list their favorite courses, a majority of the male students indicated that they liked mathematics/physical sciences, while female students’ interests were distributed across all the subjects. Only one-third of the female students listed science or mathematics subjects as their favorite subjects. Consistent with earlier studies, when asked about
their future majors, gender differences were noted such that male students indicated choice of science majors more than the female students.

Many students tend to perceive that mathematics and science are male-type subjects while English and arts are female-typed (Malin & Makel, 2012; Miller et al. 2006). This trend was observed as early as in elementary education. Malin and Makel analyzed the essays of gifted elementary students on important issues facing the countries. The male students in this study focused on “things” as seen by the issues they mentioned such as terrorism and safety. In contrast, the female students were more interested in “people” - environmental and animal welfare. Similar to these trends in attitudes, the male students also tend to have high outcome expectations in male-type fields and females have higher outcome expectations in female-type fields (Malin & Makel, 2012). This trend was also observed in high school female students surveyed by Miller et al., (2006).

Such stereotypes were not observed with adult women in a qualitative study by Torcivia (2012). In a recent study by Park, Young, Troisi, & Pinkus (2011), undergraduate students enrolled in introductory psychology courses were exposed to cues related to romantic and intellectual images. The students’ interests in STEM areas and their preferences towards a STEM major were measured before and after this intervention. Although no gender differences were found in the initial test of interests and preferences, after viewing images that showed romantic scenarios and setting, the female students showed less interest in STEM. These findings indicated that women tend to consider their personal goals more important than their career goals, especially in STEM careers. A similar finding was found in a study by Diekman, Clark, Johnston,
Brown, and Steinberg (2011) where undergraduate students were surveyed about their communal goals (helping others, working with others, etc.) and agentic goals (mastery, success, power, etc.) and their preferences towards three types of careers namely STEM careers, other male stereotypical careers, and female stereotypical careers. The students who reported more agentic goals reported higher preference for STEM and other male-stereotyped careers.

Torcivia (2012) investigated the experiences of five women enrolled in a computer science program. These women were non-traditional students returning to school to pursue a major and a future career in STEM. Torcivia conducted detailed interviews with these women to understand why some women succeed in STEM careers, while many don’t. The findings from these interviews revealed four themes. The resilience of these successful women helped them to overcome obstacles in pursuing a career in STEM. Although, they had lost their self-efficacy to do well in STEM areas at some point in their life, their resilient attitudes encouraged them to re-enter the STEM fields. Another influencing factor was the need for a support system to encourage women to pursue their STEM career aspirations. An interesting finding, contrary to the gender typing mentioned in Malin and Makel (2012), was that none of the women perceived that STEM fields were not for women, and did not perceive the gender stereo-typing of STEM fields. Gender stereotyping was also not observed in Kitts’s (2009) study with middle school and high school students. In this study, 2535 students from 27 school districts were surveyed about their science perceptions. The findings indicated that girls reported higher self-efficacy in science, felt science was
interesting and also reported that their parents would be proud of them if they chose science careers.

Gender differences in science/mathematics self-efficacy have been extensively studied for the past two decades. Self-efficacy is considered as an important influence on one’s career choice and interest in the social cognitive model of career choice (Betz, 2000; Britner & Pajares, 2001; Britner & Pajares, 2006; Byars-Winston & Fouad, 2008; Cordero, Porter, Israel, & Brown, 2010; Lent & Brown, 1986; Lindley, 2006; Zeldin & Pajares, 2000; Zeldin, Britner & Pajares, 2008). A majority of these research studies at the college level has shown that male students reported higher self-efficacy in subject areas such as mathematics and science. In one study by Byars-Winston and Fouad (2008), male undergraduate students from two mid-western universities in the U.S. reported higher self-efficacy and outcome expectations in mathematics and science than their female peers. However, the effect of this difference was found to be very small. Similar findings were also found by Lindstrom and Sharma (2011) as male undergraduate students enrolled in physics courses reported higher self-efficacy in physics when compared to the female college students. In another study by Bonitz, Larson and Armstrong (2010), undergraduate majors in non-STEM areas were surveyed about their job-related interest and self-efficacy in three areas: information technology, teaching and sales. Male undergraduate students reported higher self-efficacy and interests in information technology compared to female students. In contrast, female students reported more confidence and interest in teaching. No gender differences were noted for a job in sales. No differences in science self-efficacy was noted in Mills, Blue and Yezieerski (2013)’s research with 88 undergraduate students
enrolled in four colleges in the U.S. Forty one of these participants were from single-sex (women’s college) and the remaining participants were from a coeducational college. The findings from this study indicated that there were no differences between male and female students in their physics self-efficacy. However, women enrolled in the coeducational college reported lower self-efficacy in physics when compared to women in single-sex college.

Discussions on self-efficacy often focus on the sources of self-efficacy as suggested by Bandura (1994). Zeldin and Pajares (2010) performed two qualitative studies to examine the reason for gender-based differences in self-efficacy in science and mathematics areas. They interviewed 15 women and 10 men with careers in STEM fields to understand the role self-efficacy played in their career development. Their findings indicated that for women, social persuasions from family, friends and peers, and vicarious experiences often in terms of encouragement they have received from people around them. In contrast, for men, past accomplishments and experiencing success and mastery was found to be the most dominant influence on self-efficacy. Similar findings were also observed for undergraduate STEM majors by Sawtelle et al. (2012).

2.2.6 External Influences on STEM Career-related perceptions

Examination of contextual support, barriers and other external factors was added to the initial model of SCCT which initially considered only the influence of internal cognitive constructs on career interests, choice and goals (Lent & Brown, 2006). In the SCCT model, Lent and Brown (2006) described two types of environmental influences namely proximal and background influences. The proximal influences are the
supports/barriers that the students face while making career-related decisions and the distal influences are the background characteristics such as gender, ethnicity and one’s environment. Contextual supports and barriers (social and financial) were found to indirectly affect students’ career choices through their self-efficacy (Lent, Paixao, Silva, & Leitao, 2010). To understand the external supports and barriers for students to pursue careers in science and mathematics, Fouad et al. (2010) conducted interviews of more than 100 individuals from different stages in their education including middle school, high school, post-secondary students. Further, focus groups interviews were also conducted with a group of students, their mothers and their teachers and instructors. These interviews revealed five broad themes of barriers and supports: parents/family, school/institution, finance/environment, social, and internal factors. Further, the investigators observed that the supports and barriers differed based on the gender, content area and level of education. When asked about supports and barriers in mathematics majors and careers, teachers were reported as the top support or barrier in female students’ career development. Female students in middle school, high school and college reported that they perceived their teachers as important support/barrier in their mathematics education. In contrast, for male students, not having a role model at the middle-school level was perceived as the most important barrier and teacher’s support was the most supportive factor for selection of a mathematics careers. At the high school level, male students perceived having clear career goals as the most supportive and their teachers’ lack of inspiration as the most negative factor.

At the college level, the most positive influence was teachers, and the most negative influence was lack of opportunities outside the college. When asked about
support and barriers to science majors and careers, for middle and high school female students, the top support was the teachers, while at the college level; the top support was the student’s own interest. This trend was also noted for male students. This trend showed that interests were perceived as more important than other external supports/barriers by students at the college level. Middle school male and female students perceived their parents as more important supports/barriers when compared to the students at high school and college. Overall, the students perceived more barriers than supports as they moved from middle school to college. In another study by Byars-Winston and Fouad (2008), parental support had more influence on students’ outcome expectations than on student self-efficacy in science and mathematics courses.

In addition to the influence of teachers and parents, the impact of peers and friends has also shown to have an impact on career-related perceptions. For instance, in a study by Robnett and Leaper (2012), 486 high school students from five schools in California were surveyed to examine how much support from friendship groups contributed to the students' STEM career aspirations and choices. The students were asked to rate on a scale of 1 to 6, how much they would like to have a career in a STEM such as becoming a scientist, engineer or working a computer-related career. The findings indicated that even after controlling for the influence of students' interest and motivation, the influence that peer groups had on these student's career interest was very significant. Although there were differences in STEM career interests between boys and girls, it was noted that when girls are in a group that is primarily female and not supportive of STEM careers, female students are less likely to be interested in STEM careers.
2.3 Internet and STEM-related Constructs

As mentioned earlier, the Internet is an important context in students’ day to day activities, both personal and academic. This section includes a description of findings from the research literature on the role of the Internet in the academic and career development of students. A search for literature examining the relationship between attitudes towards the different functions of the Internet and STEM perceptions indicated that research in this area is still in its infancy. Li and Tsai (2013) noted that most studies examined the impact of technology on student’s achievement or academic outcomes. Only a few studies focused on affective outcomes.

2.3.1 Impact of Technology Use on Achievement

Several studies have examined the impact of using technology in the curriculum on students’ academic achievement including science and mathematics areas (Cheung & Slavin, 2013; Christmann & Badgett, 2003; Park, Kahn & Petrina, 2009; Rakes, Valentine, McGatha, & Ronau, 2010; Slavin, Lake & Groff, 2009). Cheung and Slavin conducted a meta-analysis of 75 studies to find the effect of technology on mathematics achievement of students, and concluded that technology had an overall positive but small effect on mathematics achievement (effect size of 0.15). This meta-analysis included 56,886 K-12 students from both elementary and secondary studies. The impact of technology on mathematics achievement was higher for students in the elementary school when compared to the students at the high school level. However, this difference in effect was found to be small. Computer aided instruction and technology integration has also been found effective in K-12 science education (Park et al., 2009). Integrating technology in the curriculum could also motivate more students to
pursue careers in STEM (Cole, 2011). In a NSF funded project titled *Middle Schoolers Out to Save the World*, students used online communication tools to collaborate on learning about real world issues such as energy conservation, economics and climate change. Students who participated in this research study viewed technology as more appealing, less boring and more exciting (Knezek, Christensen, & Tyler-Wood, 2011).

Such extensive research on the benefits of using technology for improving academic achievement including science and mathematics areas, and the wide spread views about the technology interests and abilities of the current generation students raises an important question. How are these technology skills related to students’ academic and career development? A review of research on the role of the Internet in STEM education and careers indicated that the influence of the toy (fun/entertainment) function of the Internet has been given more attention than the other functions of the Internet. The next few sections explain prior research relating various functions of the Internet to STEM-related perceptions.

2.3.2 Using the Internet as a Treasure for Influencing STEM Perceptions

The Internet offers numerous opportunities to increase awareness and interest in science and mathematics related topics. Access to information about interesting facts and current scientific developments can sustain students’ interest in such science and mathematics projects. Several people surveyed in Horrigan’s (2006) study reported using the Internet as the primary source of information to learn about a scientific topic, whether looking for the meaning of a science term, checking scientific claims, asking a question on a science topic or completing a scientific assignment. Convenience was reported as a key reason for using the Internet for looking up scientific information. The
online information also allowed adapting instructional materials according to learner-
levels (Li & Tsai, 2013).

Information seeking skills have also been found to be related to effective use of
the Internet for STEM literacy. Being able to search for information on the Internet and
evaluating the information are important skills to improve science and mathematics
literacy (Halverson, Siegel, & Freyermuth, 2010; Tsai, Hsu, & Tsai, 2011). In Tsai, Hsu,
and Tsai's (2011) study, students were required to perform an online search for
information about science. The students who spent more time on defining the
information for which they were looking and the students who used sophisticated skills
for evaluating the information on the Internet showed higher ability in searching for
science information. The scientific information that people sought on the Internet also
seemed to have an influence on their STEM perceptions. People who sought scientific
information on the Internet were more likely to believe that science had a positive
impact on society, and were also more likely to report having higher levels of
understanding science (Horrigan, 2006). Several websites have vast information about
future careers in STEM. Some examples include FunWorks, Virtual Learning
Experiences for Youth, and Girls Communicating Career Connections (Pillai, 2010).
Such extensive information from the Internet can help students become more aware of
various STEM careers, which in turn can positively influence their STEM perceptions.

2.3.3 Using the Internet as a Toy for Influencing STEM Perceptions

Extensive research has shown that games have a positive influence on students'
thinking skills, self-efficacy about learning, intrinsic motivation, spatial ability, inductive
reasoning and communication skills (Baek, 2008; Cherney, 2008; Ketelhut, Nelson,
Many of these skills can help students to become successful in STEM careers. For instance, spatial ability was positively related to STEM career success (Cherney, 2008). In Cherney’s study, students reported an increase in their spatial ability after participating in online games. This increase was more pronounced for female students.

Games have also been found to have a positive effect on students’ interests and perceptions about STEM careers (Wyss, 2013). The role of games has received more attention in science and mathematics education in the recent years (Joiner, et al., 2011). Kara and Yesilyurt (2008) found that the use of edutainment (education with entertainment) improved students’ attitudes towards biology. Kano et al. (2008) also found that the use of animations had a positive impact of students’ motivation and interest in science. Recent developments of immersive virtual environments involved 3D spaces and human-computer interactions (Barab & Dede, 2007). Using such immersive environments has helped students to get a first-hand experience of abstract physics concepts such as relative motion (Kozhevniko, Gurlitt, & Kozhevnikov, 2013). Multi-user environments (MUVES) have also found to be effective in improving students’ perceptions about science (Barab & Dede, 2007; Ketelhut, et al., 2010). Simulations and visualizations seem to be frequently used and were also very effective in science education (Li & Tsai, 2013). Such simulations included 2D/3D visualizations, virtual reality, animation and virtual laboratory. All the studies that investigated these virtual environments seemed to agree that simulations and visualizations helped students in understanding the nature of the scientific process, and illustrated abstract concepts (Swan & O’Donnell, 2009, Huk, 2006).
Providing multiple opportunities to practice and offering a safe environment to explore is important to encourage students to pursue interests in STEM content areas and careers. An environment where students can have fun with science and mathematics will encourage them to not be afraid of any failures they might face in STEM areas and encourage them to persist in their education (Marshall, Glenn, McLaren, & Veal, 2011). When students get immersed in online games and simulations that involve problem solving and exploration of new strategies, students enjoy the “playing” nature of learning science and mathematics. For instance, CyberSurgeons, a simulation on clinical trials and research helped students to assume roles of various experts and improved their interests in solving science problems (Calinger & Piecka, 2011). Another multi-user virtual environment called River City promoted inquiry based science education (Ketelhut et al., 2010). Virtual worlds and simulations not only allowed active interaction, but users also created objects and actively collaborated with others within the simulation (Barab & Dede, 2007). Turkay (2010) reported that an online simulation project, Science through Second Life improved science interests in a majority of the students who participated. Even those students, who reported no increase in science interests, felt that the science lesson using simulation was fun. The students also reported that they learned more content than from traditional science lessons. Online simulations can motivate students to play with big ideas thereby making understanding abstract concepts and applying those concepts easier (Franklin et al., 2009). In addition to online games, videos also had an influence on students’ STEM perceptions (Jones & Cuthrell, 2011). Even non-science majors reported an increase in science interests when YouTube videos were integrated in a science lecture (Eick &
King, 2012). The non-science majors reported that they found the online videos entertaining, and also felt that the use of videos made the science content more interesting and relevant.

2.3.4 Using the Internet as a Territory for Influencing STEM Perceptions

Social media can be a great venue to improve STEM engagement in schools and colleges. The territory function of the Internet allows the students to learn about science and mathematics from online experts and/or collaborate with others who have similar interest in STEM areas. Some areas where social media websites have been found effective are listed below:

- Social media websites such as Facebook and Twitter have shown an improvement in engagement among undergraduate students (Coldwell, Craig, & Goold, 2011; Tiernan, 2013).
- Social networking tools also allowed collaboration and sharing of knowledge (Hoffman, 2009; Ng & Latif, 2011).
- Students were also provided with numerous opportunities to network with others, and even personalize the Internet to match their learning and career needs (Lee & McLoughlin, 2010).

In a recent study, Ng and Latif (2011) examined the impact of using social networking websites such as blogs and Facebook in an undergraduate mathematics course. The students who showed a high level of participation in the social networking websites reported higher sense of community, satisfaction in learning mathematics, and commitment to stay in STEM majors. Kouper (2010) concurred that social media such as blogs and wikis also allowed scientists to educate the general public of their
research, interact and collaborate with other scientists, students, and teachers to explore and share ideas in science and mathematics.

In addition to the various collaboration opportunities, the territory function of the Internet also offers students social support to pursue careers in STEM (Brown, 2012; Yamauchi et al., 2011). A network of caring and trusting relationships to develop confidence and a strong learning identity is essential to encourage students, especially, talented and high achieving students to pursue STEM education (Marshall et al., 2011). Social support from like-minded peers, faculty, counselors, and mentors is vital to both academic and social well-being of students. What kind of support do students receive from the Internet? Brown (2012) examined a scenario where students used Twitter to compete in designing the best cardboard boat. When students faced difficulty, they could tweet the problem, and get responses from subject matter experts from anywhere in the world. In another series of studies by Yamauchi and colleagues, popular social media such as Twitter and Facebook were used to connect young adolescents to working professionals (Yamauchi et al., 2011). Students worked on individual study projects about their future career, tweeted questions, and results, and responded to tweets from professionals. In the second study (Yamauchi et al., 2012), students used Facebook groups to carry out group projects and collaborate with facilitators. Volunteer supporters collaborated with students asking and answering questions of academic and career interests. The students were also encouraged to ask questions to the public and to the volunteer supporters, and compile the responses in their final projects.

Participating and having an online presence can also improve one’s self-efficacy in science and mathematics. For instance, when a student has many followers in
Twitter, the student would be more committed to his/her subject of interest which would in turn encourage more effort into his/her work. Chen (2007) suggested creating not just a website with information on STEM careers, instead create a web-based community including videos of role models explaining their daily career-related activities, discussion forums, blogs of STEM professionals, and literature database for references. Many of the components in such a web-based community are offered by the territory function of the Internet.

2.3.5 Using the Internet as a Tool for Influencing STEM Perceptions

The Internet can extend science learning from classrooms to homes by offering many tools to understand, analyze and interpret scientific findings. Informal learning beyond the classroom can make STEM education more accessible (Franklin et al., 2009). In addition, personalized learning opportunities with meaningful student research activities can also increase students' STEM interest and achievement (Anastopoulou et al., 2012). Emerging tools on the Internet allow for accelerating up research activities, sharing research results, performing open research with the public, providing extensive collaboration on scientific topics, and even promoting near real-time scientific research (Williams, 2008). Other tools such as e-portfolios allow students to engage in activities that the students could successfully complete and in turn, enhanced the students' confidence in learning. As Brown (2012) noted, when students created websites or e-portfolios, they experienced a sense of task completion through these activities. Career e-portfolios allowed students to showcase their learning skills, explore careers, and connect their learning experiences to the competencies they might need for their future careers (Bonsignore, 2004).
A wide range of online tools including learning management system tools, freeware, and commercial tools can be used to improve students’ academic motivation (Sanchez-Elez et al., 2013). Wolter et al. (2012) employed a software tool called CaseIt in the science curriculum that allowed students to engage in case-based learning. The use of the online software allowed students to investigate the application of scientific knowledge to solve real-world problems. The participants in Wolter et al.’s study included 105 students from undergraduate science courses. The software tool increased students’ perceptions of science as a career and as an area of study. The use of the tool also improved students’ self-confidence in science content. Other tools that have had an impact on students’ STEM learning were the online concept mapping tools as these tools enabled meaningful and active learning in science and mathematics (Martinez, Perez, Suero, & Pardo, 2012; Nesbit & Adesope, 2006).

2.3.6 Using the Internet as a Telephone for Influencing STEM Perceptions

Students use the communication function of the Internet extensively for their personal, social and academic use (Uddin & Jacobson, 2013). In Uddin and Jacobson’s research, students reported using email for academic communication regarding coursework in spite of the emergence of social media which also provide communication functions. In particular, women use the Internet mainly for communication (Fallows, 2005). In Fallow’s study, women not only reported using email more than men, but also reported being satisfied about the role of email in maintaining their relationships.

The Internet affords a wider audience irrespective of place restrictions. Communication with online mentors has received much attention in career development
research. Tele-mentoring using the Internet in programs such as MentorNet (www.mentornet.net) allowed students to find mentors in the STEM disciplines. Online experiences can counteract negative face to face experiences such as lack of opportunities and unfavorable conditions (Brown, 2012). For example, students in rural areas who often face difficulty in finding mentors in STEM areas can benefit from online mentors. DirenZo, Weer, and Linnehan (2013) analyzed longitudinal data collected from 453 students who participated in an online mentoring program. The mentoring program followed a one year curriculum focused on improving young people’s self-esteem and helping the students explore various careers. The findings showed that the e-mentoring program was effective in influencing the students’ career-based self-efficacy. In another study, Mertz and Pfleeger (2002) examined issues in the mentoring of women and minorities in computer science and noted that one of the main issues in traditional mentoring is the need for frequent and regular interactions. Through online mentoring, STEM mentors can also provide social support which is essential for women to succeed in traditionally male dominated careers in STEM (Brown, 2012). In Brown’s study, obtaining online feedback through email and web postings was found to have a positive influence on students’ academic self-efficacy.

Although technology communication could be impersonal to some extent, with the emergence of new communication methods such as video notes, Skype and Google Hangout, communication could be made more personal (Kitsantas & Dabbagh, 2011; Morgan, 2013). If mentors and mentees preferred more candid and objective communication, other options such as online forums or email have been found to be useful for communication purposes (Leck, Elliot, & Rockwell, 2012).
2.4 Honors Students

This section discusses why the Honors students are considered as a separate group of interest, who these students are, and what experiences do they encounter in an Honors program setting. The section also reviews existing research findings on Internet and STEM career-related perceptions of this special group of students.

2.4.1 Who are Honors Students? Why Study Them as a Separate Group?

Some of the research questions examined if and how the Honors and non-Honors students differed in their Internet and STEM career-related perceptions. In the current study, the Honors students were considered as a distinct group for several reasons. First, the research on Honors students is emerging and the current study can contribute to the growing literature. Second, gifted college students have some unique characteristics, and comparing them with non-Honors students can shed some light on how similar or different they are when compared to average ability college students. Although not proved empirically, it is widely believed that the attitudes and achievements of talented and high achieving students do contribute to a university’s thriving atmosphere. Further, empirical research on gifted education at the K-12 educational level is abundant; however there were not many empirical findings on the social, academic and emotional development of gifted college students (Rinn & Plucker, 2004). Most published articles on gifted college students included commentaries and descriptive articles that have been key forces in bringing attention to the needs of the gifted college students. Researchers studying gifted college students (Rinn, 2004; Rinn & Plucker, 2004) further emphasized the need for more empirical research on gifted
college students as there is not much understanding about this group of students when compared to other minority groups on campus.

As in the K-12 level, gifted college students can be considered as those students who perform or have the potential to perform at a high level of accomplishment (NAGC, 2010). Recent efforts to define giftedness have also placed much importance on the psycho-social needs of gifted students (Subotnik, Olszewski-Kubilius, & Worell, 2012; Rinn et al., 2011; Rinn, 2012). Of the various psycho-social variables that are deemed important by most researchers in the gifted education, attitudes (passion, interest) and self-efficacy have been posited as important to students’ academic achievement and career aspirations (Rinn, 2012). Following prior research studies that Rinn and Plucker (2004) pointed out in their review of gifted college students, the current research study considers the Honors students as a subset of gifted college students. The Honors students might either belong to an Honors program or an Honors College at a university. When an Honors program is at the university level, it is referred to as an Honors College (National Collegiate Honors Council [NCHC], 2013). The Honors College offers a venue for students to explore enrichment opportunities across different programs in the university.

Admission to most Honors Colleges is considered prestigious because the selection process is very competitive. To be admitted in an Honors College, most universities consider a wide range of criteria including SAT scores, grade point average scores (GPA) in high school, extracurricular activities, and community services to name a few. However it should be noted that not all gifted and talented students might have applied to the Honors program in spite of meeting most requirements (Rinn & Plucker,
Honors Colleges consider enrichment as an important outcome to their students (NCHC, 2013). The students in an Honors College are usually provided with opportunities to enroll in smaller classes, and participate in interdisciplinary courses. The Honors students are also offered many opportunities for experiential learning including internships, and study abroad opportunities (Hamilton, 2004). These students are high achieving and some of them might have come from gifted programs at the K-12 level. The Honors programs in most universities allow high achieving and/or gifted college students to engage in a challenging learning environment as they simultaneously satisfy requirements for their undergraduate programs in different majors (Rinn, 2004). Belonging to an Honors program has its own merits and some disadvantages. As Rinn (2004) pointed out, developing a social identity and having other high achieving peers around can counteract the stigma of being gifted or talented.

How most students experience college depends on their prior experiences. Such prior experiences are even more important for gifted college students as they come with a unique set of needs and experiences (Subotnik et al., 2012). Gifted students give high importance to both the academic and social environment of a university (Rinn, 2005). Academic self-concept of gifted college students has been found to be related to not only their academic achievement but also their career aspirations (Rinn & Cunningham, 2008). It is often misunderstood that gifted students are good in decision making or find it easier to select a major or career. However researchers have often indicated that high intelligence does not necessarily translate into high social and emotional development for gifted students (Cross, 2005; Neihart, Reis, Robinson & Moon, 2002). One issue that is frequently cited in the literature is the issue of multi-potentiality or the ability to excel
in more than one area (Rinn, 2005). Consider a scenario where a gifted college student has to decide between a STEM and a non-STEM major. If the gifted college student is highly talented in both majors, factors other than the student’s abilities come into play. Such factors include his/her self-efficacy, outcomes he/she expects, and attitudes towards a major and a future career. Rinn and Plucker (2004) suggested that having gifts in more than one area might help gifted college students to succeed in both areas, but might not help them develop advanced skills in either of the areas. More specifically, some findings from the review of gifted literature by Rinn (2005) have relevance to the current study. Rinn (2005) reviewed the literature that compared Honors and non-Honors students and noted the following differences between these two groups of college students:

i. Honors students strive more for perfection.

ii. Honors students are more likely to pursue graduate studies.

iii. Honors students are more autonomous, and have higher self-concept.

iv. Honors students reported higher career aspirations.

Based on these differences between the Honors and non-Honors college students, the current research study hypothesized that Honors college students will perceive Internet and STEM areas differently when compared to their peers.

2.4.2 STEM Perceptions of Gifted College students

Rysiew, Shore, and Leeb (1999) discussed several issues related to the career development of high achieving students in colleges. Gifted college students might expect an ideal career that matches their abilities and interests. Having been a high achiever most of their academic lives, gifted college students might face the pressure to
choose a high prestige or high income career. This pressure can originate from either the gifted students or from their parents. In a large-scale research study, Kerr and Colangelo (1988) examined the college plans of 76,951 academically talented high school students. The students in this study selected their choices of majors from a list of 196 academic major programs. Kerr and Colangelo’s findings from this study showed that engineering and health sciences were the popular major choices among the highly talented students. Some gender differences were observed in specific subject areas as a majority of the male students chose engineering and physics whereas a majority of the female students indicated a preference for biology. One of the STEM-related variables that the current study examines is undergraduate students’ outcome expectations. Research findings indicate that high achieving individuals are more likely to be dissatisfied with their jobs and even quit their jobs if their expectations were not met (Perrone, Tschopp, Snyder, Boo, & Hyatt, 2010). Heilbronner(2013) found that for high achieving individuals, the top three factors that influenced STEM occupation choices were one’s interests, the need for a challenging career and the individual’s belief about his/her talent. Prestige and convenience were rated very low by the gifted students in Heilbronner’s study.

In Shushok’s (2008) study in a large Mid-Atlantic university, two groups of students, 79 Honors students and 69 non-Honors college students, were compared on several student outcomes after accounting for prior group differences such as their SAT scores and high school GPA. A College Student Experience questionnaire was used to collect data on students’ interaction with faculty, their satisfaction with different aspects of their learning environment, and the gains the students perceived in specified areas.
Some findings of Shushok’s study are relevant to the current study. One such finding was that Honors students were three times more likely to discuss their career plans and aspirations with a faculty member when compared to non-Honors college students. Honors students were also more likely to discuss social and political issues with their peers outside the classroom when compared to non-Honors college students. These trends were more pronounced for male Honors students when compared to their male counterparts in the non-Honors programs. Gender differences in gifted college students’ career development suggest that gifted female students, although more talented in a field, might not choose or might decide to leave male-dominated majors to assume more responsibility in their families. Gifted females might feel additional pressure in trying to excel in both work and family responsibilities (Reis, 1998). Self-concept is also cited in the literature as contributing to gender differences in science. Even as early as elementary education, gifted girls perceive that their academic proficiency is in verbal areas while gifted boys perceived that their strengths were in mathematics areas (Olszewski-Kubilius & Turner, 2002).

In a recent study by Heilbronner (2013), high achieving adults who participated in a national-level science talent search competition during their high school years were surveyed to examine various factors influencing their STEM perceptions and career paths. The participants reported high academic ability as indicated by their SAT scores. High achieving male respondents reported higher SAT-Mathematics scores than the high achieving female respondents. When asked about their choice of majors, there were more male participants who chose STEM majors, especially in areas such as engineering and physics, and more female participants selected majors in areas such
as biology. These participants cited several reasons as influencing their choice of a STEM career. Participants believed that their academic experiences in college, such as challenging yet meaningful courses, and hands-on activities improved their interests in STEM. Male participants also reported higher self-efficacy in STEM areas. When asked about their confidence to do well in female friendly STEM areas such as biology and chemistry, no differences in STEM self-efficacy were noted.

2.4.3 Gifted and the Internet

A review of technology use in gifted education by Periathiruvadi and Rinn (2013) suggested that empirical research in this area is still emerging. The authors reviewed articles on technology in gifted education using the national gifted education standards in the areas of learning and development, assessment, curriculum planning, learning environments, programming and professional development. Although most of the studies focused on K-12 gifted education, a few findings from their review fit into the discussion about different dimensions of Internet/technology use. A majority of research findings in this area examined the impact of technology as a tool – online assessments, online courses and hypermedia. For instance, in a study on gifted high school students’ technology use, Kahveci (2010) found that these students had positive attitudes towards technology tools and believed that using technology was relevant to their learning. In another set of studies, online assessments and computer-based assessments were used as tools to assess gifted students’ strategic thinking skills, and task focus skills (Periathiruvadi & Rinn, 2013). Other technology schools that have been found to be effective with the gifted students include online graphing tools for mathematics achievement (Gadanidis, Hughes, & Cordy, 2011) and e-publishing for fostering
creativity. In a related study, Gentry, Flower and Nichols (2007) found that the Internet offered a great way for individualizing instruction for gifted students. Liu’s (2004) research on using hypermedia as a scaffolding tool also supported the use of technology as an effective tool for learning.

Other research studies have examined the influence of online programs for gifted students. An online enrichment program in engineering was investigated by Chan et al. (2010) and was found to be effective in improving higher thinking skills and social skills of gifted adolescents. Online mentoring was offered as part of this enrichment program. The gifted adolescents liked the online mentoring but also preferred more face-to-face meetings with their mentors. Wallace (2009) found that younger gifted students reported that they liked online courses and believed that their interests in the content area also improved as a result of taking such online courses. Similarly, Olszewski-Kubilius and Lee (2004) found that gifted adolescents reported liking online courses that enabled them to learn advanced topics at a self-structured pace. However, these students still preferred to use textbooks and written materials in addition to online course materials. Even at the middle school level, the gifted students enjoyed online discussion forums in their mathematics class. Students also enjoyed using wikis to convey their views and get feedback from their peers. In another research study conducted by Yun, Chung, Jang, Kim & Jeong (2011), online games were used to understand the social and emotional development of gifted adolescents. The gifted students in this study played an online game called Ultimatum. Findings from this study indicated that although the gifted students scored high in strategic thinking, they showed lower social and emotional skills when compared to their non-gifted peers.
With research on gifted college students, in general, still emerging, not many studies have examined Honors college students’ use of the Internet. However, the potential of the Internet and computer technology in gifted education is well recognized. In a national forum titled *Honors in the Digital age*, scholars in the field of Honors education discussed the importance of information literacy for Honors students to provide more enrichment opportunities in the curriculum (NCHC, 2013). Interdisciplinary studies where Honors students were participants were consulted to understand how Honors students used the Internet. In one such study, Teske and Etheridge (2010) administered a survey called *isKills* developed by the Educational Testing Service (ETS) to university freshmen. The university where this study was conducted had 480 students in the Honors College with almost an equal number of students in STEM and non-STEM programs. The online assessment was a performance assessment closely aligned with the national standards of Information Literacy Competency for Higher Education. Instead of multiple choice answers, students were required to perform tasks testing their information literacy skills. The researchers found that the Honors students passed the test at twice the rate when compared to other freshmen’s scores nationwide. A detailed analysis of the results indicated that the Honors students performed better in tasks that required them to assess the use and relevance of websites. However when the Honors students were asked to evaluate and judge websites, or present and organize information, their performance did not differ from other college students. These findings indicated that the Honors students were better prepared to work with information technology, but still needed guidance to achieve mastery.
There is also a criticism that Internet can be detrimental to gifted students’ thinking, creativity, and socio-emotional development. Fisher (2011) discussed why teachers and parents should be cautious about using the Internet. Fisher argued that the Internet might deteriorate the problem solving and creative skills of gifted students by encouraging more surfing and roaming of hyperlinks rather than reflective thinking. However, the benefits of the Internet outnumber such detrimental effects. With proper training and scaffolding, the Internet will be a helpful resource to gifted and talented students.

2.5 Summary

Chapter 2 included a discussion of supporting literature related to Internet attitudes and STEM constructs. This discussion was followed by a brief discussion of the theoretical frameworks and findings from the existing research. The literature review was organized as four main sections. The first section focused on the existing literature on how students used the Internet, and how the students perceived the different functions of the Internet. Various theoretical frameworks on Internet attitudes were consulted, and the 5T framework was chosen for this study as it enabled the examination of attitudes towards the different dimensions of Internet use.

The second section described the need for understanding students’ perceptions about STEM areas. The Social Cognitive Career Theory guided the selection and discussion of students’ attitudes, self-efficacy and outcome expectations in STEM areas. The third section reviewed the literature that related the students’ Internet attitudes and their STEM career-related perceptions. The review indicated that the research on the role of the Internet in influencing career-related perceptions including
STEM career-related perceptions is minimal. The review also indicated that some of these Internet dimensions (e.g. the toy dimension) have received more attention in STEM education than others (e.g. the territory and telephone dimensions). Finally, an additional section on Honors students and gifted college students was included in this chapter. This section presented a discussion of the experiences of Honors college students, and synthesized the literature on STEM perceptions and Internet use of gifted college students including Honors students. Differences based on gender and enrollment in a STEM or a non-STEM major were also described in the corresponding sections on Internet use and STEM perceptions. Overall, the review of literature guided the objectives for the current study and served as a base for framing the specific research questions.
CHAPTER 3
RESEARCH METHODS AND DESIGN

The research study employed a mixed methods design to understand how undergraduate students perceived the Internet, and how students’ Internet attitudes were related to students’ perceptions about a STEM career. The mixed methods design included:

a) quantitative methods to measure and examine the relation between two key constructs: Internet attitudes across five dimensions namely tool, toy, treasure, territory and telephone, and STEM career-related perceptions namely science/mathematics self-efficacy, science/mathematics outcome expectations, and STEM career attitudes, and

b) qualitative methods of content analyses to extend the findings from the quantitative methods about the constructs of interest.

The following sections describe the mixed methods research approach, research design, data collection techniques, and data analyses used to address the research questions.

3.1 Mixed Method Research Design

A review of the literature on Internet use by undergraduate students and their perceptions toward STEM careers (as discussed in Chapter 2) guided the questions for this research. The overarching research objectives mentioned in Chapter 1 signify and paint a picture of the purpose of this research. The first two objectives focus on obtaining descriptive information to understand the students’ perceptions about the two key areas: Internet and STEM careers. These two objectives guided the way to the third
research objective which aims to understand the relationship between Internet attitudes and STEM career-related perceptions. Often researchers are interested in relationship studies to explain and find patterns of how different areas, constructs or aspects of the world are related to each other (Fraenkel, Wallen, & Hyun, 2011). By examining the relationship between different dimensions of Internet attitudes and students' career-related perceptions; we will learn how this important phenomenon called the Internet can be used to improve career related perceptions of undergraduate students.

Best practices for conducting research suggest that the research questions should guide the research design, and subsequently the methods used for data collection and data analysis (Fraenkel et al., 2011). To answer the research questions, a mixed methods research design (see Figure 3.1) was chosen.

![Figure 3.1 Research design](image)

**Figure 3.1** Research design
The mixed methods research design used in the current study was “validating the quantitative data model triangulation” (Creswell & Clark, 2010, p.65). This research design is a type of triangulation research design and generally denoted as QUAN+QUAL (Tashakkori & Teddlie, 2003). In a triangulation research design, the researcher tries to collect different but complementing data using both quantitative and qualitative methods to explain the overall picture of how different variables of interest in the study are related. The research design in this study involved collecting both quantitative and qualitative data using a web-based survey instrument. Although the responses collected in open-ended questions in the survey might not provide rigorous qualitative data, the open-ended responses helped in understanding the quantitative data better, and even address areas that the quantitative measures failed to capture (Creswell & Clark, 2010). For instance, although the measures used in this study captured the students’ attitudes about the Internet and STEM careers, the qualitative responses offered an understanding of how exactly this phenomena of the Internet was perceived in comparison with other factors that influenced the students’ career-related perceptions. Such open-ended questions also unearthed any dimensions that were not covered by the quantitative measures.

Cresswell & Clark (2010) recommended that certain factors be determined on a research design for any given study. These factors include deciding when to perform the data collection and analysis, deciding whether the study was predominantly quantitative or qualitative, and determining when the two methods were mixed to synthesize the results.
The considerations made for the current study are given in Table 3.1.

Table 3.1  

*Design Considerations*

<table>
<thead>
<tr>
<th>Design considerations</th>
<th>Design for the research study</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <strong>What is the timing of data collection and analysis for quantitative and qualitative data?</strong></td>
<td>Concurrent timing of data collection using a web-based survey for both quantitative and qualitative data collection.</td>
</tr>
<tr>
<td>2. <strong>How much importance or weight do the quantitative vs. qualitative methods have?</strong></td>
<td>Unequal weightage (More weight to quantitative data). Reasons: Survey methodology was more appropriate to quantitative data collection. The research questions required predominantly quantitative data analysis. Moreover, practical reasons including the researchers’ expertise with quantitative methods and the committee’s expertise also contributed to the unequal weightage.</td>
</tr>
<tr>
<td>3. <strong>How will the mixing of methods happen in the study?</strong></td>
<td>Mixing of methods happened during interpretation of results.</td>
</tr>
</tbody>
</table>

### 3.2 Data Collection

Before collecting data, the population to be studied was decided based on the topic of interest and accessibility of the population. Additional considerations included deciding the sample size required for generalizing the results of the study, and methods
to administer the survey and collect data. The following sections describe these various considerations made before collecting the data.

3.2.1 Accessible Population

The target population of interest for this study was undergraduate college students enrolled in U.S. universities. As Fraenkel et al. (2011) suggested, for practical feasibility, the accessible population for this study was undergraduate students in a large Southern university. The participants had the essential computer skills to participate in an online survey. The following information was obtained from the fact books available on the university’s website. When considering the total number of students enrolled at the university, the percentage of undergraduate students ranged from 77% to 79% for the past three years. The percentage of male and female undergraduate students was approximately 52% and 48% respectively for the past three years. The student enrollment indicated that 33% of the students majored in Arts and Science, 15.1% of the students majored in Business and 11.2% of the students majored in Education. The percentage of students in the Honors College was approximately 5% of the students in the university. Of the Honors students, the percentage of male and female students was approximately 58.2% and 41.8%, respectively. The STEM and non-STEM majors in the university were approximately represented in the ratio of 1:4.

3.2.2 Sample Considerations

The minimum sample size requirement has been a topic of debate in social sciences research. For survey research, a general recommendation is to survey at least 10% of the accessible population to be able to generalize the results of the study to the
population (Mertler & Charles, 2004). In the event of inability to meet this requirement, the researcher should clearly note the limitations of the study and caution about the generalization of study results. Mertler and Charles further noted that if the population is very large (exceeding 5000) a sample size of 400 participants would be sufficient to adequately represent the population. However, in addition to the sample size, the researcher should also ensure the appropriateness of the sample. Further, the quantitative analyses used in a study also have minimum sample size requirements. This research study involved multivariate analyses and discriminant analyses to examine the differences in Internet attitudes and STEM career-related perceptions based on gender, major, and enrollment in an Honors College. The study also used a canonical correlation analysis to examine the relation between Internet attitudes and STEM career-related perceptions. To calculate the minimum number of participants required, and to avoid both Type I and Type II errors, power analysis and sample size calculation was performed using GPower3 software. An apriori power analysis for 2 groups and 5 response variables (F-test (MANOVA) with $f^2 = 0.10$, $\alpha = 0.05$ and $\beta = 0.95$) yielded a total sample size of 204.

A suggested minimum sample size for MANOVA analyses was calculated such that the number of cases in a group must be larger than the number of dependent variables. In addition, at least a minimum of 20 cases per group is recommended by most researchers (Hair, Black, Babin, & Anderson, 2010; Meyers et al., 2012; Stevens, 2009). The MANOVA analyses were followed by descriptive discriminant analyses to identify the constructs resulting in group differences. A recommended sample size for the smallest group in a discriminant analysis is 20 times the number of predictors. For
the Internet attitudes-related discriminant analyses, the condition was satisfied because the smallest group size was greater than 100 (20* number of variables i.e. 20*5). Similarly, for the STEM perceptions, this condition was satisfied because the smallest group size was greater than 60 (20* number of variables, i.e., 20*3). For canonical correlation analysis, a minimum of 20 participants per observed variable is suggested (Statsoft Inc., 2013). Based on this suggestion, the study needed at least (8*20 = 160) participants. Overall, a minimum sample of at least 200 undergraduate students was deemed adequate for the current study. After data collection, the sample size for the study (566 undergraduate students) met the minimum sample size requirements.

3.2.3 Web-based Survey Administration

For the mixed method design, a concurrent mixed methods sampling procedure was used in this study (Teddlie & Yu, 2007). This sampling method involved simultaneously collecting data for both the quantitative and qualitative strands using a survey with open-ended questions. A web-based survey software called Qualtrics was used to administer the survey. The Qualtrics database was chosen as it was available for free for students and faculty in the researcher’s institution, and support was available if the participants faced any technical issues in completing the survey. Permission was obtained from the university to email the survey link to the university students’ list-serv. This method of data collection allowed random collection from the students in this university. However, students receive numerous emails covering official, academic and informal information, and response rates might be lower using this email method of data collection. To improve the response rate, emails were sent to randomly selected professors’ email addresses from the university website. The emails contained the
explanation of the study and the researcher offered to meet them in person if more
details were needed. Five professors agreed to share the survey website link with their
students. To improve response rate in surveys, the researcher mentioned the time it will
take to complete the survey, potential value to participants and the research community,
and provided a small incentive (Mertler & Charles, 2004). The time and month of survey
administration was also planned to not interfere with holidays and examinations in the
undergraduate classes (Tyler-Wood, personal conversation). When students clicked the
survey link in the email, the link directed them to the Qualtrics website where the survey
is loaded. The Qualtrics website saved the survey responses in a database which could
be only accessed by the researcher. Once the deadline for data collection was reached,
the data was downloaded from Qualtrics database in the form of SPSS and Microsoft
Excel files.

3.2.4 Participants

The sample for this study consisted of undergraduate students from a large
Southern university. The initial data screening showed that of the 979 students who
submitted their surveys, there was some participant attrition after the demographic
section which left 813 useable surveys. Because only undergraduate students were
considered for this research, 639 surveys were acceptable. Of these undergraduate
students, 566 students were in the age range of 18 to 25 (traditional college age), and
were included for the final data analysis. 75% of the students were females. The
ethnicity distribution was observed as 56% Caucasian, 16% Hispanic/Latino, and 14%
African American. Approximately one-third of the participants were first generation
students, and 30.5% of the participants indicated that their parents were born in a
country other than the U.S. The student majors were categorized as STEM and non-STEM majors based on the STEM-designated degree program list (United States Immigration and Customs Enforcement, 2011). A majority of the participants were enrolled in a non-STEM (70%) and a non-Honors (80%) program. The mean GPA score of the participants was 3.25 (on a 4.00 scale). The participants were equally distributed across the four years of study in college. The participants were enrolled in Psychology (24.1%), Communication studies (13.4%), Business (9.6%), and Biological Sciences (8.4%). A vast majority of the students (95%) reported having used the Internet for more than 6 years. Of these students, 54% have used the Internet for about 6 to 10 years, while 41% have used the Internet for more than 10 years. When asked about the device used for accessing the Internet, 66% reported using their laptops, 22% used their smartphones, and 10% reported using desktops. 54% of the students reported using the Internet for more than 10 hours per week for academic use, whereas 31% reported using the Internet for more than 10 hours for personal use.

3.3 Measures Used in the Study

The web based questionnaire had four sections to obtain data on demographics, Internet attitudes, STEM career-related perceptions and open ended questions. Each section is listed below followed by a brief description of the instruments used.

1. The demographic section collected information about the student’s gender, ethnicity, year in school, major of study, achievement information, and membership in an honors college.
2. The second part of the questionnaire measured Internet use and Internet attitudes. The questions were taken from the Internet Attitudes scale by Chou et al. (2009) and Chou et al. (2011).

3. The third part of the questionnaire contained questions about students’ STEM career related perceptions. The questions were obtained from the Science/Mathematics Self-Efficacy scale by Ferry et al. (2000), the STEM Semantics survey by Knezek, and Christensen (2008), and the Mathematics and Science Outcome Expectations scale (Ferry et al.).

4. The final part of the survey contained three open ended questions asking participants about factors that influenced their perceptions about their future careers including STEM careers and the role of the Internet in shaping such career-related perceptions.

3.3.1 Internet Attitudes Scale

The Internet Attitudes scale (Chou et al., 2009; Chou, et al., 2011) measured Internet attitudes of individuals in terms of five dimensions namely tool, treasure, toy, territory, and telephone. In this research, the five dimensions that were originally suggested in the 5T model (Chou et al., 2009) were included (see Table 3.2). The Internet Attitudes scale has been validated in previous studies with Asian students by Chou et al. (2011) and Chou et al. (2009). A confirmatory factor analysis in Chou et al. (2011) using Structural Equation Modeling indicated that the data fit the hypothesized model of Internet dimensions well.

The goodness-of-fit measures for the scale were reported as follows: RMSEA, SRMR, CFI, and PNFI were found to be 0.064, 0.071, 0.966, and 0.918, respectively.
These values were close to the recommended values for the four goodness of fitness measures (0.05, 0.06, 0.95 and 0.95, respectively, for RMSEA, SRMR, CFI and PNFI) (Byrne, 2008) and therefore the scale was considered as a good measure of the Internet related attitudes.

Table 3.2

*Five Dimensions of Internet Attitudes*

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Sample items from the survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tool</td>
<td>Students were asked to rate the extent to which the Internet was a good tool for their learning. Another question asked them to rate the extent to which the Internet was a helper in their daily activities.</td>
</tr>
<tr>
<td>Toy</td>
<td>Students rated the extent to which the Internet was their favorite toy or a playmate, the extent to which the Internet was interesting, helped them relax and helped them avoid boredom.</td>
</tr>
<tr>
<td>Treasure</td>
<td>Students’ rated their perceptions of the Information from the Internet in broadening their knowledge, and the extent to which the information contributed to the human society.</td>
</tr>
<tr>
<td>Telephone</td>
<td>The items required the students to rate statements on the time they spent online to communicate with real world friends or friends whom they have only met online.</td>
</tr>
<tr>
<td>Territory</td>
<td>Student rated statements that referred to the Internet as a good place to express their emotions, to exchange opinions among friends, or to keep a personal diary.</td>
</tr>
</tbody>
</table>
3.3.2 STEM Semantics Survey

The STEM Semantics survey (Knezek & Christensen, 2008) was used for measuring undergraduate students’ perceptions about a future career in STEM. The STEM Semantics survey had five subscales to measure attitudes towards five areas namely science, mathematics, technology, engineering and overall attitudes towards a STEM career. The internal consistency ratings for the five subscales were found to be in the range of 0.88 to 0.93 in earlier studies (Knezek, Christensen, & Tyler-Wood, 2011; Periathiruvadi, Knezek, Tyler-Wood, & Christensen, 2012). This instrument could be considered a reliable instrument according to DeVellis (1991). This measure used a semantic differential scale where questions were in the form of adjective pairs and participants were required to choose one of the options in a continuum between the adjective pairs (Mertler & Charles, 2004).

For the purpose of the study, only the subscale measuring overall STEM career attitudes was used. The validated version of the STEM Semantics survey included five items for the STEM Careers subscale. A recent version of the survey added five more items to the STEM Careers subscale. These five new items are yet to be validated. This research used all ten items of the subscale and validated the subscale with 10 items as explained in section 4.2.1.2 in Chapter 4. The items of the STEM career subscale asked the participants to rate how they perceived a career in STEM on a 7-point semantic scale. Some examples of the semantic adjective pairs used were boring/interesting, easy/hard, appealing/unappealing and so on.
3.3.3 Mathematics/Science Self-efficacy Scale

Mathematics and science self-efficacy was measured using a scale developed by Ferry et al. (2000). The items in this scale measured how confident college students felt about performing tasks that were generally encountered in the mathematics and science domains. Ferry et al. used this scale to measure science and mathematics self-efficacy of 791 undergraduates in a large Mid-Western university. In their study, the internal consistency reliability for the scale was found to be 0.84. Questions from this scale included:

“I feel confident that with proper training, I could figure out the amount of wall paper needed to cover a room”.

“I feel confident that with proper training, I could earn an A in a science course”.

Each question was measured using a Likert scale ranging from Strongly Disagree (1) to Strongly Agree (5).

3.3.4 Mathematics/Science Outcome Expectations Scale

Students’ outcome expectations about doing well in science and mathematics areas were measured using a measure developed by Ferry et al. (2000). Ferry et al. used this scale to measure the outcome expectancies did college students in a large Mid-Western U.S. university have about pursuing careers in science and mathematics. The internal consistency reliability for the scale was found to be very good (Cronbach’s $\alpha = 0.81$) in their study with college students. For this study, questions measuring outcome expectancies of undergraduate students was included in the form of a 5-point Likert scale ranging from “Strongly Disagree” to “Strongly Agree”. Questions used for this study included:

“If I get good grades in science, then my friends will approve of me."
If I learn mathematics well, then I will be able to do lots of different types of careers”.

The questions in this scale examined what students expected from doing well in science and mathematics areas. The questions also included students’ expectations about how their performance and involvement in science and mathematics courses can influence important outcomes such as obtaining recognition from friends, feeling good about themselves, and being able to pursue different careers.

3.3.5 Open Ended Questions

Open ended questions were included in the survey to allow the respondents to provide descriptive comments to the questions. Such questions did not restrict responses based on prescribed answer choices (Bryman, 2008; Mertler & Charles, 2004). The purpose of including open-ended questions in this study was two-fold. First, the qualitative responses helped to identify any issues that were not addressed by the quantitative data collection. Second, the responses to these open ended questions allowed for triangulation of responses from both the quantitative and qualitative data collected. For instance, a correlation analysis between Internet attitudes and STEM career-related perceptions might quantify the relation between the two constructs, and identify which dimension of Internet attitudes was more related to STEM career attitudes. Whereas, the qualitative data collected using open-ended questions can help determine a more thorough picture of the relationship between the two constructs. The web-based survey included three open-ended questions. These questions surveyed the participants about factors influencing their future career-related perceptions, factors influencing their perceptions about a STEM career, and the role of the Internet in influencing career choices and interests.
3.3.6 Validity and Reliability

The validity of the measures used in the research was important to ensure that the researcher measured what he/she intended to examine for the study (Mertler & Charles, 2004). The measures used in the study have been found to be valid and reliable as noted earlier. The content validity of the web-based survey was also judged by experts in the study of online education and STEM education. The response validity was verified by reviewing the responses of the participants to check if there were any identifiable patterns of responses. The internal structure of items in each measure was also checked by the researcher. The set of questions included in the data collection for this study was checked to ensure that those questions would not cause any negative effects on participants. For the open-ended questions, the source of information was also checked for authenticity.

The reliability of the instruments in previous studies that used the instruments was mentioned earlier for each instrument. Because this was a cross-sectional research study, test-retest reliability could not be checked. Instead, confirmatory factor analyses were performed for each construct of interest. Internal consistency reliability estimates were checked using Cronbach’s alpha reliability estimates. Cronbach’s alpha is a type of split-half reliability where the questions in a measure are divided into two halves and the correlation between the two sets of scores is calculated. The higher the Cronbach’s alpha, the higher is the reliability of the instrument (Mertler & Charles, 2004).

For the open-ended questions in the survey, the credibility of the qualitative text information was ensured by recording memos and notes during the content analyses. Further, intra-rater reliability was calculated for the initial and second level coding done
by the researcher. The reliability estimates were calculated by dividing the number of codes matched by total number of codes in each category as suggested by Chambers & Chiang (2012). The reliability estimates ranged from 0.84 to 0.97, which can be considered acceptable.

3.4 Summary

This chapter outlined the research design, sampling process, and data collection methods used in this study. The research questions guided the design and data collection process. The sample for this study was 566 undergraduate students enrolled in a large Southern university in the United States. In the mixed methods research design, the quantitative data collection and analyses were given more weightage. The qualitative information was used to support the results from the quantitative data and to extend the research findings. A web-based survey created using Qualtrics software was used to collect both quantitative and qualitative data using validated measures and open-ended questions respectively. This data was exported in the form of SPSS and excel files. The quantitative data and qualitative data were analyzed separately using SPSS and NVivo software. The next chapter discusses in detail the various steps involved in the data analysis and the findings for each research question.
CHAPTER 4
DATA ANALYSIS

4.1 Analysis Methods

This chapter includes a description of the quantitative and qualitative data analysis methods used in this study. A brief description of the methods used in this study is followed by a description of findings for each research question. SPSS software (PASW version 18.0) was used to perform descriptive and multivariate analyses. Lisrel version 9.1 was used to perform missing data analyses and confirmatory factor analyses for the Internet and STEM career-related constructs. To analyze the qualitative data from the responses to the open-ended questions in the survey, NVivo 10 software was used. Table 4.1 lists the different analysis methods used to answer the nine research questions of this study.

4.1.1 Quantitative Methods

SPSS (PASW) Version 18.0 was primarily used to perform the quantitative data analyses. The quantitative data analysis methods used in this study were governed by a general linear model of analyses (GLM) such that all parametric analyses are correlational in nature, have a $r^2$ type effect size, aim to maximize the shared variance between variables, and often indicator variables are grouped together to form latent variables or constructs (Sherry & Henson, 2005). As seen in the Table 4.1, the study used multivariate analyses including multivariate analysis of variance (MANOVA) and a canonical correlation analysis (CCA) to analyze the quantitative data on the Internet and STEM career-related perceptions.
### Table 4.1

**Analysis for Research Questions**

<table>
<thead>
<tr>
<th>No.</th>
<th>Research question</th>
<th>Data analysis method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>What are undergraduate students’ perceptions towards the different dimensions of the Internet?</td>
<td>Higher order confirmatory factor analysis, descriptive analyses</td>
</tr>
<tr>
<td>2</td>
<td>How are male and female undergraduate students different in their Internet attitudes?</td>
<td>Multivariate analysis of variance (MANOVA) followed by a descriptive discriminant analysis (DDA)</td>
</tr>
<tr>
<td>3</td>
<td>What are the differences in how STEM and non-STEM majors perceive the Internet?</td>
<td>MANOVA followed by DDA</td>
</tr>
<tr>
<td>4</td>
<td>What are the differences in Internet attitudes among undergraduate students enrolled in an Honors college and those not enrolled in an Honors college?</td>
<td>MANOVA followed by DDA</td>
</tr>
<tr>
<td>5</td>
<td>What are undergraduate students’ perceptions toward a career in STEM (science/mathematics self-efficacy, STEM career attitudes and science/mathematics outcome expectations)?</td>
<td>Descriptive analyses and conventional content analysis</td>
</tr>
<tr>
<td>6</td>
<td>How are male and female undergraduate students different in their STEM career-related perceptions?</td>
<td>MANOVA followed by DDA</td>
</tr>
<tr>
<td>7</td>
<td>What are the differences in how STEM and non-STEM majors perceive STEM career-related perceptions?</td>
<td>MANOVA followed by DDA</td>
</tr>
<tr>
<td>8</td>
<td>What are the differences in STEM career-related perceptions between Honors college and non-Honors college students?</td>
<td>MANOVA followed by DDA</td>
</tr>
<tr>
<td>9</td>
<td>What is the relation between undergraduate students’ Internet attitudes and their STEM career-related perceptions</td>
<td>Canonical correlation, and directed content analysis</td>
</tr>
</tbody>
</table>
A multivariate analysis of variance is commonly used to compare means between groups when there are two or more dependent variables (Fraenkel et al., 2011). A MANOVA is recommended instead of multiple ANOVAs for two main reasons. First, instead of studying or analyzing variables in isolation, a MANOVA helps to also consider the relationships between variables. A MANOVA uses the variance–covariance matrices thereby considering the inter-correlation between the dependent variables studied. Therefore, a more comprehensive understanding of the behavior is obtained (Meyers et al. 2012). Second, a multivariate analysis helps to protect against Type I errors. A type I error is made when the researcher concludes that there is a difference between groups when in reality there is no difference among the groups in the population (Fraenkel et al., 2011).

However, a MANOVA will only answer if there is a difference between two or more groups, and might not offer more information as to where the differences exist, and if the differences are large enough to be meaningful (Henson, 2000). It is recommended that post-hoc analyses following a MANOVA are performed using descriptive discriminant analyses (DDAs) instead of several follow-up ANOVAs (Henson, 2000). This will help in identifying the dependent variables that capture the group differences (Meyers et al. 2012). In addition, having groups with equal size of members in each group is ideal for performing MANOVA analyses. However, often in practical research situations using existing demographic groups, the group sizes are not equal. In contrast, a discriminant analysis allows the groups to be of different group sizes. Therefore, the MANOVA analyses in the study were followed by discriminant analyses.
For the research questions 2, 3, and 4 in Table 4.1, a group comparison of mean scores on Internet attitudes was performed for groups based on gender, major, and belonging to an Honors program. Similarly, for the research questions 6, 7, and 8 in Table 4.1, a group comparison of mean scores on the STEM perceptions was performed for groups based on gender, major, and belonging to the honors group.

In addition to the MANOVA and DDA analyses, a canonical correlation analysis (CCA) was employed to understand the relationship between the key constructs namely Internet attitudes and STEM career-related perceptions. A CCA is considered as the most general case of the General Linear model of analyses (Henson, 2000). This analysis helps to determine the correlation between different sets of variables or constructs. Henson, in his article, illustrated how all parametric analyses such as *t-tests* and *ANOVAs* can be considered as special cases of a CCA. In addition, by analyzing the correlation between multiple independent constructs and dependent constructs, an analysis such as a CCA reflects the reality of psychological research that, there are often multiple causes and multiple effects in nature (Sherry & Henson, 2005).

4.1.2 Qualitative Methods

Qualitative content analyses were used to analyze the responses to the open-ended questions in the survey. A content analysis method is used when the researcher wants to analyze the text content systematically using codes, and then identify the emerging themes about the variables of interest to the study. Hsieh and Shannon (2005) described three methods of qualitative content analyses namely conventional, directed, and summative analyses. In this study, the first two methods of content analyses were employed.
A conventional content analysis was used to analyze the qualitative data content of two open-ended survey questions that examined factors influencing students’ perceptions towards a STEM career. The questions were:

- Currently, what/who is influencing your career choice? Why do you like this career?
- Currently, what factors affect (positively or negatively) your perceptions towards a career in science, mathematics, engineering and/or technology?

The steps followed in the conventional qualitative data analysis for the above questions were:

i. In NVivo, glance through the responses for the open-ended questions to get familiar with the responses.

ii. Make notes and memos documenting the initial understanding of the data.

iii. Highlight exact texts that depicted the initial concepts or thoughts, and develop initial codes.

iv. Identify categories based on the relationship between the main thoughts to obtain an initial coding scheme.

v. Form themes or clusters based on the various categories.

The conventional content analysis helped to describe the STEM career-related perceptions of students, and allowed themes to emerge from the data rather than approaching the data analysis with preconceived themes based on previous research.
The second method of content analysis, namely, a directed content analysis was used to extend the quantitative findings for the research question,

- What is the relationship between undergraduate students’ attitudes towards the Internet and STEM career-related perceptions?

The open-ended question asked the students the role the Internet played in influencing their career choices and interests. A directed content analysis (Hsieh & Shannon, 2005) is used when the researcher approaches qualitative data analysis based on previous literature. A deductive approach was followed as responses were coded with pre-constructed categories and responses were assigned into one of the categories. The 5T model by Chou et al. (2009) guided the directed content analysis of the open-ended responses. The following steps outline the process of directed content analysis used in this study.

i. In NVivo, make note of the five categories of Internet attitudes namely tool, toy, treasure, telephone, and territory.

ii. Maintain memos when there are any content that can fit more than one of the five categories.

iii. Classify each response into one of the five categories of Internet attitudes.

iv. Create a new category if the response does not fit into one of the five categories.

v. Make note of exemplar responses that reflect the categories to include them in the description of the findings.

4.2 Preliminary Analyses

As described in Chapter 3, data was collected from 566 participants who were enrolled in undergraduate programs. Several preliminary analyses were performed on
the data before implementing the actual multivariate analyses. These include the data screening processes and the confirmatory factor analyses.

4.2.1 Data Screening

To ensure the validity of the results, the collected data was screened to verify if the data represented what was measured and if the assumptions underlying the quantitative analyses were met (Meyers et al., 2012). Data screening involved addressing the missing data, dealing with the outliers, and checking for assumptions. Following Meyers et al.’s (2012) suggestions, the data screening began with the process of value cleaning to make sure that all the variables had values that were not extreme values, and that the values were within reasonable and prescribed limits. Using the SPSS software, descriptives and frequency tables were obtained for the variables considered in this study, and it was noted that the values for the variables considered were reasonable.

4.2.1.1 Missing Data Analysis

The Missing Value Analysis and Missing Values Patterns modules in SPSS were used to examine the percentage of missing data, and patterns of missing data. The missing value data analysis chart (see Figure 4.1) indicated that less than 5% (1.587%) of the data values were missing. Such a small percentage of missing data can be ignored (Tabachnick & Fidell, 2007). Next, the patterns of missing data were analyzed to check if the data was missing at random, or because of some underlying reason.

The missing data is usually classified as missing completely at random (MCAR), missing at random (MAR) or not missing at random (NMAR) (Enders, 2003, Little & Rubin, 2002). The MCAR type of missing data is observed when, on average, the cases
with missing data are very similar to the cases without any missing data. This type of
missing data is very uncommon in practical research (Meyers et al., 2012).

![Pie chart indicating the missing data](image)

**Figure 4.1** Pie chart indicating the missing data

A statistical test called Little's MCAR test was used to test the type of missing
data. Meyers et al. suggested that if the Little’s test statistic was statistically significant
\((p<0.05)\), the data was not MCAR and it could be either MAR or NMAR. The result of
the Little’s MCAR test for the research data was statistically significant, and therefore
the data was not considered MCAR. The data was further screened to examine if it was
NMAR. Since the missing data of the values was not related to the variables in which
the data was missing, it was concluded that the data was not NMAR (Meyers et al,
2012). On further investigation, it was concluded that a majority of the missing variables
can be considered MAR because the missing data on one variable may or may not be
related to other variables studied (Little & Rubin, 2002). To impute the missing values, a
multiple imputation procedure based on Schafer’s (1997) recommendation was
performed using Lisrel 9.1. This process created multiple imputations of the original
data, which were finally pooled together to form one imputed dataset. This imputed dataset was used for further quantitative analyses.

4.2.1.2 Addressing Outliers

Using the *explore* option in SPSS, the statistics including the descriptives, M-estimators, outliers, and percentiles were requested. In addition, box plots, stem-and-leaf plots, and normality plots were also requested. After examining the box plot and the extreme-values table information for each variable as illustrated in Meyers et al. (2012, p. 106-109), two cases were deleted reducing the sample size to 564 as these cases had extreme values. Further, the standardized scores (z scores) were obtained for each variable. The variables whose minimum and maximum standardized values exceeded the critical value of 3.29 (i.e. three standard deviations from mean score for each variable) (Tabachnick & Fidell, 2007) were noted down for further scrutiny when performing the confirmatory factor analyses.

4.2.1.3 Checking for Univariate Assumptions

The univariate and multivariate assumptions were checked to ensure that the results were not biased or affected (Hair et al., 2010; Meyers et al., 2012; Tabachnick & Fidell, 2007). As suggested by Tabachnick & Fidell (2007), a combination of histograms, normal plots, Q-Q plots and descriptive statistics were consulted for each variable. The skewness and kurtosis values were also closer to the (+1,-1) range suggesting univariate normality. Bivariate normality was examined by using a scatterplot matrix, and a linear relationship was observed between the variables. The univariate and bivariate normality checks indicated that a few Internet variables had a slightly higher skewness and kurtosis values. They were not removed during initial data screening as
they were within the skewness < 2 and kurtosis < 7 range prescribed by West, Finch and Curran (1995). These values were marked as candidates for deletion if needed during the confirmatory factor analyses, which is described in a later section.

Next, the linearity assumption was checked to examine if the variables of interest were linearly related to each other (Meyers et al., 2012). One of the scatterplot matrices is shown in Figure 4.2. This matrix showed the linear relationship between the variables measuring Internet attitudes.

![A scatterplot matrix of Internet attitudes](image)

**Figure 4.2** A scatterplot matrix of Internet attitudes

The multivariate normality was assessed using Mardia’s multivariate kurtosis coefficient. The Mardia’s coefficient was found to be 1.12, which is well within the suggested |3| range (Bentler & Wu, 2002). Further, a graphical diagram was plotted using the Mahalanobis distances for each case and the $\chi^2$ values. The Mahalanobis distance is a measure of how far is a set of scores from the group means after accounting for the correlation between the variables, and can be thought of as the
multivariate Cohen’s d (Henson, 1999). If the plot forms a straight-line, data are considered multivariate normal. Three multivariate outlier cases were detected using this graph and were removed from further analyses. As the normality assumptions were met, no transformations were necessary for the variables of interest.

The next assumption that was checked was the homogeneity of variance assumption. This assumption checked if the dependent variables had equal variances across different levels of the independent variables (Meyers et al., 2012). The variance-covariance matrices were requested after splitting the data file in SPSS based on the groups considered for each multivariate analysis (see Table 4.2). A general rule of thumb suggests that none of the variance-covariance values in one group be more than three times than that of the values in the other group.

The Box’s M test was used to check the multivariate homoscedasticity assumption i.e. to examine if the covariance matrices were equal across the independent variable levels (Stevens, 2009). If the Box’s M value was statistically not significant, it added more support that the variance-covariance matrices are equal across the groups compared. The significance value of Box’s M was tested at \( p = 0.005 \) as the Box’ M is sensitive to departures from normality (Stevens, 2009). A Levene’s test of equality of univariate error variances was also not statistically significant suggesting that the assumptions for univariate homogeneity of variances were also met. The values on the variables included were also independent of values on other variables because sampling-related issues were considered during the research design. Further, no time or spatial-related variables were included in this study (Meyers et al., 2012).
Another assumption underlying a multivariate analysis of variance test is that the dependent variables are sufficiently related to each other. The Bartlett’s test of sphericity was found to be statistically significant ($p < 0.001$); therefore the dependent variables were considered correlated enough to be used in a MANOVA (Meyers et al. 2012). Additionally, to avoid multi-collinearity, it is suggested that the dependent variables used in the MANOVA not be very high related to each other (Meyers et al. 2012). The correlations between the five Internet variables were less than $r = 0.70$. Similarly, the correlations between the STEM career-related variables were also found to be less than $r = 0.70$. 

Table 4.2

*An Example of an Inter-Item Covariance Matrix*

<table>
<thead>
<tr>
<th>Gender</th>
<th>Tool</th>
<th>Toy</th>
<th>Treasure</th>
<th>Territory</th>
<th>Telephone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>Tool</td>
<td>.492</td>
<td>.372</td>
<td>.317</td>
<td>.266</td>
</tr>
<tr>
<td></td>
<td>Toy</td>
<td>.372</td>
<td>.573</td>
<td>.299</td>
<td>.348</td>
</tr>
<tr>
<td></td>
<td>Treasure</td>
<td>.317</td>
<td>.299</td>
<td>.452</td>
<td>.254</td>
</tr>
<tr>
<td></td>
<td>Territory</td>
<td>.266</td>
<td>.348</td>
<td>.254</td>
<td>.748</td>
</tr>
<tr>
<td></td>
<td>Telephone</td>
<td>.229</td>
<td>.302</td>
<td>.105</td>
<td>.396</td>
</tr>
<tr>
<td>Female</td>
<td>Tool</td>
<td>.427</td>
<td>.329</td>
<td>.259</td>
<td>.248</td>
</tr>
<tr>
<td></td>
<td>Toy</td>
<td>.329</td>
<td>.597</td>
<td>.283</td>
<td>.368</td>
</tr>
<tr>
<td></td>
<td>Treasure</td>
<td>.259</td>
<td>.283</td>
<td>.410</td>
<td>.270</td>
</tr>
<tr>
<td></td>
<td>Territory</td>
<td>.248</td>
<td>.368</td>
<td>.270</td>
<td>.765</td>
</tr>
<tr>
<td></td>
<td>Telephone</td>
<td>.279</td>
<td>.456</td>
<td>.250</td>
<td>.551</td>
</tr>
</tbody>
</table>
Overall, the underlying assumptions of the multivariate analyses performed in the study were met. The preliminary analysis resulted in 564 cases to be used for the subsequent analyses. The preliminary analysis was followed by a series of confirmatory factor analyses and reliability analyses for the four scales used in this study. The details are explained in the next sections.

4.2.2 Confirmatory Factor Analyses

Confirmatory factor analyses (CFA) were performed to validate the scales used in this study. The CFA analyses checked if the hypothesized factor models held true for the sample considered in this study. The data screening procedures described earlier ensured that there was no missing data. The multivariate normality assumption was also checked earlier, and was found to be met for the multivariate analyses. To confirm the factor structure for each scale, five steps of analyses were performed namely: model specification, model identification, model estimation, model evaluation and model re-specification (Meyers et al., 2012; Schreiber, Amaury, Stage, Barlow, & King, 2006; Schumacker & Lomax, 2010). Since the variables were ordinal in nature, polychoric correlation matrices and asymptotic covariance matrices were used as input to the CFAs. Lisrel version 9.1 was used to estimate the models. A Santora-Bentler estimation was employed to account for the ordinal nature of the data (Schumacker & Lomax, 2010). To test if the model fit the sample data, modification indices, $t$-statistics of the parameters, and variances accounted for ($R^2$ values) between the indicator-latent variables were evaluated. A visual inspection of error covariances, correlation between standard errors of parameters, and absence of negative variances was also performed (Everitt & Hothorn, 2011). The model fit indices that were consulted were the goodness
of fit index (GFI), the comparative fit index (CFI), the normative fit index (NFI), the squared errors of approximation (RMSEA and SRMR), and the Chi-square/degrees of freedom ratio (Schumacker & Lomax, 2010). Recommendations and guidelines for model indices were decided after consulting multiple articles on the topic. The model was considered acceptable if GFI ≥ 0.90, CFI ≥ 0.95, SRMR ≤ 0.08 (Schumacker & Lomax, 2010; Schreiber et al., 2006), and RMSEA closer to 0.06 (Hooper, Coughlan & Mullen, 2008; Steiger, 2007).

4.2.2.1 CFA for the Internet Attitude Scale

The 5T model developed by Chou et al. (2009) was used in this study to measure Internet attitudes. The five factors tested in the hypothesized model were tool, toy, treasure, territory and telephone. These factors referred to how students perceived the different dimensions of the Internet. The Internet Attitude scale comprised of 43 items from Chou et al. (2011) which were used as the observed variables in the confirmatory factor analysis. A model identification using the order condition indicated that the model was over-identified because the number of unique identifiers exceeded the number of parameters (factor variances, path coefficients, correlations, error variances) to be estimated (Meyers et al., 2012).

In the initial hypothesized model, the measurement error variances of the observed variables were not correlated. However, the five factors were correlated as it was hypothesized that the five factors were related to each other because they measured some dimension of Internet attitudes. The first item of each Internet factor was fixed to 1 to scale the latent variable. In the initial measurement model, the factor pattern coefficients were all positive. The CFA analysis indicated that none of the initial
model fit indices was acceptable when evaluated against the model fit criteria mentioned earlier. It was decided that modifications were necessary to obtain an acceptable model to fit the given data. Table 4.3 shows the model modification made to the initial model and the corresponding model fit indices.

Table 4.3

<table>
<thead>
<tr>
<th>Comparison of Model Fit Indices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor model</td>
</tr>
<tr>
<td>Original model</td>
</tr>
<tr>
<td>Final model</td>
</tr>
</tbody>
</table>

At each stage of the modification, considerations were made to check if paths from observed variables to latent variables should be changed, if errors should be covaried, or if variables should be omitted. The items for which the factors accounted for a very low variance (less than 30%) were removed. The items which cross loaded on more than a factor were also evaluated and removed if necessary. Some errors between items belonging to the same factor were correlated if the modification indices were very high, and if the relation could be justified. For instance, items 25 and 26 asked the students the extent to which information from the Internet enabled them to do creative things (item 25) and interesting things (item 26) respectively. Since how students perceived interesting and creative things can be related, the errors were allowed to covary.

When conditions for the different goodness of fit indices were met, the model was considered acceptable. In the final model, the fit indices were found to be: $X^2 = 262.65$, 

The variances accounted for by the Internet dimension latent factors for their corresponding observed variables were greater than 50% as seen in Figure 4.3. As a result, only 20 variables of the original 43 variables were included for the final model: four items for tool, toy, and territory dimension, five items for the treasure dimension, and three items for telephone dimension. Although many variables from the initial model were deleted, the final model indicated a good fit, and also ensured a parsimonious scale construction.

4.2.2.2 CFA for the Science/Mathematics Self-efficacy Scale

The science and mathematics self-efficacy perceptions of the undergraduate students were measured using the Science/Mathematics Self-efficacy scale developed by Ferry et al. (2000). For the confirmatory factor analysis, seven items of the scale were entered as the observed variables. The initial model was altered to correlate errors of a few indicator variables. The item that asked students about their self-efficacy in constructing a graph of rainfall amount by state was removed because of a low path coefficient ($R^2 < 0.30$).
Figure 4.3 CFA model for the Internet attitudes scale.
The final model as shown in the Figure 4.4 indicated that the remaining six items formed a single construct, named science/mathematics self-efficacy. The goodness of fit indices namely (GFI = 0.98, NFI = 0.99; CFI: 0.99; SRMR= 0.017; RMSEA= 0.062) also indicated an acceptable model fit.

Figure 4.4 CFA model for the science/mathematics self-efficacy scale.
4.2.2.3 CFA for the Science/Mathematics Outcome Expectations Scale

The next CFA analysis was performed to verify the model for the science and mathematics outcome expectations construct.

![CFA Model Diagram]

Figure 4.5 CFA model for the science/mathematics outcome expectations scale.

The outcome expectations measure developed by Ferry et al. (2000) measured how students perceived outcomes of doing well in science and mathematics areas. The initial model with eleven items did not fit the data well. After deleting five items that had lower variances accounted for by the outcome expectations construct, the final model with 6 items, as shown in Figure 4.5, fitted the data well.
The goodness of fit indices (GFI = 0.98; CFI = 1.0; NFI = 0.99; RMSEA = 0.047; SRMR = 0.02) indicated a good fit of the model to the given data.

**CFA for the STEM Career Attitudes Scale**

*Figure 4.6 Initial CFA model for attitudes towards a STEM career scale*

The final confirmatory factor analysis was performed to confirm the validity of the Attitudes towards a STEM Career subscale. The participants' attitudes towards a career in STEM were measured using the Attitudes towards a STEM Career subscale of the STEM semantics survey developed by Knezek & Christensen (2008). A newer version of this subscale included five more items in addition to the original five items. The initial
model (shown in Figure 4.6) tested was to see if all the ten items formed a single construct that can explain students’ attitudes towards a STEM career. As seen in Figure 4.6, the model did not fit well.

Figure 4.7 Final CFA model for attitudes towards a STEM career scale

After deleting items that did not follow a normal distribution (car 6, car7) and separating the variables car8, car9, car10 to a new factor called ease of a STEM career, the final model with two factors (see Figure 4.7) fit the data well. The goodness of fit
indices for the two factor model (GFI= 0.975; CFI= 0.99; NFI =0.98; RMSEA= 0.07; SRMR = 0.04) indicated an acceptable fit. Only the factor named *attitudes towards a STEM career* was used for the multivariate analyses. The descriptive analyses included both the factors namely *attitudes towards a STEM career* and *ease of a STEM career*.

4.2.3 Reliability Analyses

The reliability analyses were performed using SPSS (PASW) version 18 software. The items derived from the confirmatory factor analyses for the Internet-related and STEM career related constructs were subjected to reliability analyses. The Cronbach’s alpha coefficient was calculated for each factor as the reliability coefficient. The alpha values for the Internet factors are given in Table 4.4.

Table 4.4

<table>
<thead>
<tr>
<th>Factor/Construct</th>
<th>Number of Items</th>
<th>Cronbach’s alpha (reliability coefficient)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tool</td>
<td>4</td>
<td>0.78</td>
</tr>
<tr>
<td>Toy</td>
<td>4</td>
<td>0.82</td>
</tr>
<tr>
<td>Treasure</td>
<td>5</td>
<td>0.84</td>
</tr>
<tr>
<td>Territory</td>
<td>4</td>
<td>0.85</td>
</tr>
<tr>
<td>Telephone</td>
<td>3</td>
<td>0.81</td>
</tr>
</tbody>
</table>

These reliability estimates in Table 4.4 can be considered very good according to Devellis (1991). This suggests that the items in each scale were consistent with each other. Similarly, the reliability estimates for the scales measuring STEM career-related constructs were also found to be reliable (see Table 4.5).
Table 4.5

*Reliability Estimates for STEM-related Instruments*

<table>
<thead>
<tr>
<th>Factor/Construct</th>
<th>Number of Items</th>
<th>Cronbach’s alpha (reliability coefficient)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitudes towards a STEM career</td>
<td>5</td>
<td>0.92</td>
</tr>
<tr>
<td>Ease of a STEM career</td>
<td>3</td>
<td>0.87</td>
</tr>
<tr>
<td>Science/Mathematics self-efficacy</td>
<td>6</td>
<td>0.89</td>
</tr>
<tr>
<td>Science/Mathematics outcome expectations</td>
<td>6</td>
<td>0.86</td>
</tr>
</tbody>
</table>

4.3 Results and Findings

As described earlier in the research design, the quantitative and qualitative analyses were performed separately. The mixing of the two methods is described in Chapter 5, where the findings are interpreted and discussed in detail. Findings from the quantitative analyses are described below for each research question.

4.3.1 Quantitative Findings

**Findings on Internet Attitudes of Undergraduate Students**

Research Question 1. What are undergraduate students’ perceptions towards the different dimensions of the Internet?

A higher order factor analysis was performed to examine which of the Internet dimensions was predominantly perceived by the undergraduate students who participated in this research. As seen in Figure 4.8, the five factor model indicated an acceptable fit.
Figure 4.8 A higher order factor analysis for Internet attitudes

The undergraduate students in this study reported higher positive attitudes towards the toy dimension closely followed by the tool and treasure dimensions of Internet attitudes. The students reported lower attitudes towards the territory and telephone dimensions. Overall, the undergraduate students perceived the Internet more as a toy to entertain, avoid boredom, watch videos and to help them relax when compared to the other Internet dimensions. They also perceived Internet as a tool to help with their daily activities, and as a treasure of information to perform interesting tasks and broaden their knowledge. The lower perceptions on the telephone dimension suggested that the students did not rely much on the Internet for communication with other people or to meet new friends.
Research Question 2. How are male and female undergraduate students different in their Internet attitudes?

A multivariate analysis of variance (MANOVA) was performed with one independent variable (gender) and five dependent variables (tool, toy, treasure, territory, and telephone i.e. the five dimensions of Internet attitudes considered in this study). The group sizes for the male and female students were unequal. Both Wilk’s $\lambda$ and Pillai’s trace have been reported because the latter is more robust to unequal group sizes (Meyers et al., 2012). The Box’s M test ($\text{Box’s } M = 13.877; F (15, 276669.3) = 0.912, p = 0.550$) was not statistically significant suggesting that the variance-covariance matrices were equal across the two groups. A manual observation of the matrices also indicated that the homogeneity assumption was met. Further, the Bartlett’s test of sphericity was statistically significant ($\chi^2 (14) = 1330.8; p <0.001$) suggesting that the dependent variables were correlated enough to be analyzed together in a MANOVA.

The results of the MANOVA (see Table 4.6) was not found to be statistically significant (Wilk’s $\lambda = 0.986; F (5,555) = 1.623; p = 0.152$). The variance in Internet attitudes explained by gender was 0.014, which can be considered small according to Cohen (1992). Although, the multivariate analysis did not indicate a statistically significant difference between the gender groups, a descriptive discriminant analysis was performed primarily to understand which of the five dimensions contributed to the discrimination of Internet attitudes among male and female students.
Table 4.6

**MANOVA for Gender Differences in Internet Attitudes**

<table>
<thead>
<tr>
<th>Effect</th>
<th>Co-efficient</th>
<th>Value</th>
<th>F</th>
<th>Hypothesis df</th>
<th>Error df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Pillai's Trace</td>
<td>0.014</td>
<td>1.623</td>
<td>5</td>
<td>555</td>
<td>.152</td>
</tr>
<tr>
<td></td>
<td>Wilks' Lambda</td>
<td>0.986</td>
<td>1.623</td>
<td>5</td>
<td>555</td>
<td>.152</td>
</tr>
</tbody>
</table>

The canonical discriminant functions indicated that there was only a small canonical correlation ($R_c = 0.12$; $p > 0.05$) on Function 1 (as there were only two groups, only one function is calculated), and the effect size was $R_c^2 = 0.015\%$.

To understand which of the five Internet dimensions discriminate between the two genders, the standardized function coefficients and the structure coefficients were consulted (see Table 4.7).

Table 4.7

**Coefficients for Gender Differences in Internet Attitudes**

<table>
<thead>
<tr>
<th></th>
<th>Standardized coefficients</th>
<th>Structure coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treasure</td>
<td>1.130</td>
<td>.768</td>
</tr>
<tr>
<td>Toy</td>
<td>.423</td>
<td>.465</td>
</tr>
<tr>
<td>Telephone</td>
<td>.184</td>
<td>.310</td>
</tr>
<tr>
<td>Territory</td>
<td>-.175</td>
<td>.291</td>
</tr>
<tr>
<td>Tool</td>
<td>-.913</td>
<td>.077</td>
</tr>
</tbody>
</table>

The standardized discriminant function coefficients are similar to $\beta$ values in regression, as they denote which variables are weighted more heavily when compared
to the other variables in the model. The structure coefficients, denote the correlation between the observed and latent variables (Meyers et al., 2012). Table 4.8 shows the descriptive statistics for Internet attitudes for male and female students. Both the standardized discriminant function coefficients and the structure coefficients, as seen in Table 4.7, indicated that treasure and toy were the two dimensions contributing to the gender-based discrimination of Internet attitudes.

Table 4.8  

*Effect Sizes for Gender Differences in Internet Attitudes*

<table>
<thead>
<tr>
<th>Construct</th>
<th>Male Mean</th>
<th>Male SD</th>
<th>Female Mean</th>
<th>Female SD</th>
<th>Effect size (Cohen's d)</th>
<th>CI for effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treasure</td>
<td>4.11</td>
<td>0.67</td>
<td>3.97</td>
<td>0.64</td>
<td>0.22</td>
<td>(0.11,0.28)</td>
</tr>
<tr>
<td>Toy</td>
<td>3.79</td>
<td>0.76</td>
<td>3.69</td>
<td>0.77</td>
<td>0.13</td>
<td>(0.01,0.20)</td>
</tr>
<tr>
<td>Telephone</td>
<td>2.70</td>
<td>1.02</td>
<td>2.61</td>
<td>1.08</td>
<td>0.08</td>
<td>(-0.08,0.19)</td>
</tr>
<tr>
<td>Territory</td>
<td>3.59</td>
<td>0.87</td>
<td>3.52</td>
<td>0.87</td>
<td>0.08</td>
<td>(-0.06,0.16)</td>
</tr>
<tr>
<td>Tool</td>
<td>4.06</td>
<td>0.70</td>
<td>4.04</td>
<td>0.65</td>
<td>0.03</td>
<td>(-0.09,0.09)</td>
</tr>
</tbody>
</table>

*Note.* n (male) = 140 and n (female) = 421

As previously illustrated in the discriminant analysis, male and female students were found to differ in their attitudes towards treasure and toy dimensions of Internet more than the other dimensions. It should be noted that the male students scored higher than female students in all five dimensions of Internet attitudes. However, the effect size measures (see Table 4.8) indicated that the differences were very small to be educationally meaningful. This trend can also be seen in the diagrammatic representation of gender differences in Internet attitudes (see Figure 4.8).
Research Question 3. What are the differences in how STEM and non-STEM majors perceive the Internet?

A series of Pearson correlations were conducted between all the five Internet attitudes dimensions to examine the assumption that the dependent variables in a MANOVA are moderately correlated with each other (Meyers, Gampst, & Guarino, 2012). Further, the Bartlett’s test of sphericity was statistically significant ($\chi^2 (14) = 1335.9; p <0.001$) suggesting that the dependent variables are correlated enough to be analyzed together in a MANOVA. Box’s M value (Box’s $M = 9.365; F (15, 179780) = 0.614; p =0.866$) was found to be not statistically significant. A careful examination of the covariance matrices across the STEM and non-STEM majors also indicated that the equality of covariance assumption i.e. the homogeneity assumption was met. A one-way MANOVA was performed to check if there are one or more mean differences in the Internet attitude dimensions between STEM and non-STEM majors. The result of the
MANOVA, as seen in Table 4.9, was statistically significant (Wilk’s $\lambda = 0.966$; $F (5, 555) = 3.853; p=0.002$).

Table 4.9

**MANOVA for Major-based Differences in Internet Attitudes**

<table>
<thead>
<tr>
<th>Effect</th>
<th>Value</th>
<th>$F$</th>
<th>Hypothesis df</th>
<th>Error df</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pillai's Trace</td>
<td>.034</td>
<td>3.853</td>
<td>5</td>
<td>555</td>
<td>.002</td>
</tr>
<tr>
<td>major Wilks’ Lambda</td>
<td>.966</td>
<td>3.853</td>
<td>5</td>
<td>555</td>
<td>.002</td>
</tr>
</tbody>
</table>

The eta-squared value was found to be 0.034, which indicated that one’s major explained just over 3% of the variance in the canonically derived variate namely, Internet attitudes. This can be considered a small effect size (Cohen, 1988). To interpret the results from the MANOVA, the standardized discriminant function coefficients and structure coefficients were consulted using a descriptive discriminant analysis. The canonical correlation for Function 1 was found to be statistically significant (Wilk’s $\lambda = 0.966; p=0.002$). Because the discriminant function was significant, further analyses of the weighting of individual Internet dimensions were examined. The standardized discriminant function coefficients and structure coefficients are presented in Table 4.10.

The treasure, tool and toy dimensions were determined as the prominent dimensions that discriminated the STEM and non-STEM majors based on the structure coefficients. The group centroids indicated that STEM majors reported higher Internet attitudes than the non-STEM majors i.e. the STEM majors reported higher attitudes towards the treasure, tool and toy dimensions than the non-STEM majors. As suggested by Enders (2003), an ANOVA was performed on the overall Internet attitudes
score that was canonically derived from the discriminant analysis. The results also indicated a statistically significant difference between STEM and non-STEM majors on the canonically derived Internet attitudes variable.

Table 4.10

*Coefficients for Major-based Differences in Internet Attitudes*

<table>
<thead>
<tr>
<th></th>
<th>Standardized Coefficients</th>
<th>Structure Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treasure</td>
<td>1.136</td>
<td>.832</td>
</tr>
<tr>
<td>Tool</td>
<td>-0.081</td>
<td>.413</td>
</tr>
<tr>
<td>Toy</td>
<td>0.110</td>
<td>.340</td>
</tr>
<tr>
<td>Territory</td>
<td>-0.608</td>
<td>-0.080</td>
</tr>
<tr>
<td>Telephone</td>
<td>-0.075</td>
<td>-0.026</td>
</tr>
</tbody>
</table>

The mean scores and effect size (Cohen’s d) values are shown in Table 4.11. The effect size for the mean differences in attitudes towards treasure was moderate and can be considered educationally meaningful (Cohen, 1988). Small effect sizes were also noted for the mean differences in tool and toy dimensions. The STEM majors reported higher attitudes in all dimensions of Internet attitudes except the territory and telephone dimensions. In these two dimensions, both STEM and non-STEM majors reported similar perceptions.
Table 4.11

Effect Sizes for Major-based Differences in Internet Attitudes

<table>
<thead>
<tr>
<th>Construct</th>
<th>STEM majors</th>
<th>non-STEM majors</th>
<th>Effect size</th>
<th>Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Treasure</td>
<td>4.19</td>
<td>0.67</td>
<td>3.95</td>
<td>0.64</td>
</tr>
<tr>
<td>Tool</td>
<td>4.15</td>
<td>0.68</td>
<td>4.02</td>
<td>0.66</td>
</tr>
<tr>
<td>Toy</td>
<td>3.81</td>
<td>0.86</td>
<td>3.69</td>
<td>0.74</td>
</tr>
<tr>
<td>Territory</td>
<td>3.51</td>
<td>0.96</td>
<td>3.54</td>
<td>0.85</td>
</tr>
<tr>
<td>Telephone</td>
<td>2.62</td>
<td>1.08</td>
<td>2.63</td>
<td>1.06</td>
</tr>
</tbody>
</table>

Note. n (STEM) = 117; n (non-STEM) = 444

The major-based differences are graphically shown in Figure 4.9.

![Figure 4.10 Major-based differences in Internet attitudes](image)

*Figure 4.10 Major-based differences in Internet attitudes*
Research Question 4. What are the differences in Internet attitudes between undergraduate students enrolled in an Honors college and those not enrolled in an Honors college?

A one-way MANOVA was performed to check if there were one or more mean differences in the Internet attitude dimensions between Honors and non-Honors college students. Pearson correlations and Bartlett’s test of sphericity ($\chi^2 (14) = 1335.9; p < 0.001$) suggested that the dependent variables were correlated enough to be analyzed together in a MANOVA (Meyers, Gampst, & Guarino, 2012). Box’s M value (Box’s $M = 25.204; F (15, 179880) = 1.653; p = .053$) was not found to be statistically significant, and a careful examination of the covariance matrices across the Honors and non-Honors students also indicated that the equality of covariance between the two groups. The results of the MANOVA (see Table 4.12) was statistically significant (Wilk’s $\lambda = 0.969; F (5, 554) = 3.558; p = 0.004$). The eta-squared value was found to be 0.031, which indicated that over 3% of the variance in the canonically derived variate namely Internet attitudes was explained by the enrollment in an Honors program. This can be considered a small effect size (Cohen, 1992).

Table 4.12

<table>
<thead>
<tr>
<th>Effect</th>
<th>Value</th>
<th>F</th>
<th>Hypothesis df</th>
<th>Error df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Honors enrollment</td>
<td>.031</td>
<td>3.558</td>
<td>5.000</td>
<td>554.000</td>
<td>.004</td>
</tr>
<tr>
<td>Wilks' Lambda</td>
<td>.969</td>
<td>3.558</td>
<td>5.000</td>
<td>554.000</td>
<td>.004</td>
</tr>
</tbody>
</table>
To interpret the results from MANOVA, the standardized discriminant function coefficients and structure coefficients were consulted using a descriptive discriminant analysis. The canonical correlation for Function 1 was found to be statistically significant (Wilk’s \( \lambda = 0.969; p = 0.004 \)). Because the discriminant function was significant, further analyses of the weighting of individual Internet dimensions were examined. The standardized discriminant function coefficients and structure coefficients are presented in Table 4.13.

Table 4.13

*Coefficients for Honors-based Differences in Internet Attitudes*

<table>
<thead>
<tr>
<th>Internet dimension</th>
<th>Standardized coefficients</th>
<th>Structure coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treasure</td>
<td>.881</td>
<td>.850</td>
</tr>
<tr>
<td>Tool</td>
<td>.300</td>
<td>.639</td>
</tr>
<tr>
<td>Toy</td>
<td>.120</td>
<td>.449</td>
</tr>
<tr>
<td>Telephone</td>
<td>-.323</td>
<td>-.078</td>
</tr>
<tr>
<td>Territory</td>
<td>-.388</td>
<td>.050</td>
</tr>
</tbody>
</table>

The treasure, tool and toy dimensions were determined as the prominent dimensions that discriminated the Honors and non-Honors groups based on the structure coefficients. The group centroids indicated that Honors majors reported higher Internet attitudes than the non-Honors i.e. the Honors College students reported higher attitudes towards the treasure, tool and toy dimensions than the non-Honors majors. As suggested by Enders (2003), an ANOVA was performed on the overall Internet attitudes score that was canonically derived from the discriminant analysis. The results of the
ANOVA also indicated a statistically significant difference between Honors and non-Honors majors on the canonically derived Internet attitudes variable.

Table 4.14

<table>
<thead>
<tr>
<th>Construct</th>
<th>Honors Mean</th>
<th>Honors SD</th>
<th>non-Honors Mean</th>
<th>non-Honors SD</th>
<th>Effect Size (Cohen’s d)</th>
<th>CI for the Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treasure</td>
<td>4.19</td>
<td>.64</td>
<td>3.95</td>
<td>.65</td>
<td>0.372</td>
<td>(0.26,0.43)</td>
</tr>
<tr>
<td>Tool</td>
<td>4.19</td>
<td>.65</td>
<td>4.01</td>
<td>.67</td>
<td>0.273</td>
<td>(0.15,0.33)</td>
</tr>
<tr>
<td>Toy</td>
<td>3.83</td>
<td>.82</td>
<td>3.68</td>
<td>.76</td>
<td>0.189</td>
<td>(0.05,0.27)</td>
</tr>
<tr>
<td>Telephone</td>
<td>2.60</td>
<td>1.08</td>
<td>2.64</td>
<td>1.06</td>
<td>0.037</td>
<td>(-0.15,0.14)</td>
</tr>
<tr>
<td>Territory</td>
<td>3.55</td>
<td>.94</td>
<td>3.53</td>
<td>.85</td>
<td>0.023</td>
<td>(-0.15,0.10)</td>
</tr>
</tbody>
</table>

Note. N (honors) = 117; n (non-honors) = 443

These trends can also be seen in Figure 4.10.

Figure 4.11 Honors enrollment-based differences in Internet attitudes
The effect sizes (see Table 4.14) for the mean differences in attitudes towards the treasure and tool dimensions was approaching moderate and could be considered educationally meaningful (Cohen, 1992). A small effect size was also noted for the mean differences between Honors and non-Honors students for the toy dimension. However, the Honors and non-Honors students reported similar attitudes towards the telephone and territory dimensions.

4.3.1.2. Findings on STEM Career-Related Perceptions

Research Question 5. What are undergraduate students' attitudes toward STEM career-related perceptions (self-efficacy, attitudes and outcome expectations)?

Four STEM-related constructs were measured to examine how the undergraduate students perceived careers in STEM areas. The first construct was about students’ attitudes towards a STEM career, and the second construct was about how they perceived the ease of STEM careers. Both these constructs were measured on a semantic scale ranging from 1 to 7. As seen in the Table 4.15, the undergraduate students reported above average positive attitudes towards pursuing a career in STEM.

Table 4.15

Descriptives for Attitudes towards a STEM Career

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitudes towards a STEM career</td>
<td>4.41</td>
<td>1.67</td>
</tr>
<tr>
<td>Ease of a STEM career</td>
<td>2.52</td>
<td>1.25</td>
</tr>
<tr>
<td>Attitudes towards a non-STEM career</td>
<td>5.07</td>
<td>1.41</td>
</tr>
<tr>
<td>Ease of a non-STEM career</td>
<td>4.09</td>
<td>1.28</td>
</tr>
</tbody>
</table>
However, the undergraduate students in this study perceived the STEM careers to be more difficult and complex as indicated by their lower scores in the *Ease of a STEM career* scale. Two other constructs were also measured to understand student perceptions about non-STEM careers (see Table 4.15). This was done to compare students’ attitudes towards both STEM and non-STEM areas. Students reported higher attitudes towards a non-STEM career compared to a career in a STEM field. When asked about the complexity of non-STEM careers, the undergraduate students reported that non-STEM careers were neither complex nor easy.

In addition to attitudes towards STEM careers, participants were also measured on their self-efficacy and outcome expectations (see Table 4.16) related to science and mathematics content areas (on a scale ranging from 1 to 5).

<table>
<thead>
<tr>
<th>Table 4.16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Descriptives for Science/Math Self-Efficacy and Outcome Expectations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science/Mathematics self-efficacy</td>
<td>4.26</td>
<td>0.74</td>
</tr>
<tr>
<td>Science/Mathematics outcome expectancies</td>
<td>3.25</td>
<td>0.81</td>
</tr>
</tbody>
</table>

Overall, the students reported that with proper training, they felt confident to perform well in science and mathematics fields. However, the participants’ outcome expectations in science and mathematics were found to be average.
Research Question 6. How are male and female undergraduate students different in their STEM career-related perceptions (self-efficacy, attitudes and outcome expectations)?

A one-way MANOVA was performed to check if there were one or more mean differences in STEM-related perceptions between male and female undergraduate college students. Box’s M value \( (M = 2.23; F (6, 416128.93) = .368; p=.900) \) was found to be not statistically significant. An examination of the covariance matrices across the gender levels also indicated that the equality of covariance assumption i.e. homogeneity assumption was met. Pearson correlations and the Bartlett’s test of sphericity \( (\chi^2 (5) = 646.671; p <0.001) \) suggested that the dependent variables are correlated enough to be analyzed together in a MANOVA (Meyers, Gampst, & Guarino, 2012).

<table>
<thead>
<tr>
<th>Effect</th>
<th>Value</th>
<th>F</th>
<th>Hypothesis df</th>
<th>Error df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Pillai’s Trace</td>
<td>.024</td>
<td>4.543</td>
<td>3</td>
<td>557.0</td>
</tr>
<tr>
<td></td>
<td>Wilks’ Lambda</td>
<td>.976</td>
<td>4.543</td>
<td>3</td>
<td>557.0</td>
</tr>
</tbody>
</table>

The result of the MANOVA, as seen in Table 4.17, was statistically significant \( (\text{Wilk’s } \lambda = 0.976; F (3,557) = 4.543; p=0.004) \). The eta squared value was found to be 0.024, which indicated that about 2.5% of the variance in the canonically derived variate namely STEM perceptions could be explained by gender. This could be considered a small effect size (Cohen, 1992). To interpret the results from the MANOVA, the standardized discriminant function coefficients and structure coefficients were consulted.
using a descriptive discriminant analysis. The canonical correlation for Function 1 was found to be statistically significant (Wilk’s $\lambda = 0.976; p=0.004$). Because the discriminant function was significant, further analyses of the weighting of individual STEM variables were examined. The standardized discriminant function coefficients and structure coefficients are presented in Table 4.18.

Table 4.18

*Coefficients for Gender Differences in STEM Career Perceptions*

<table>
<thead>
<tr>
<th></th>
<th>Standardized Coefficients</th>
<th>Structure Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitudes towards a STEM career</td>
<td>.885</td>
<td>.984</td>
</tr>
<tr>
<td>Science/Mathematics outcome expectations</td>
<td>.153</td>
<td>.591</td>
</tr>
<tr>
<td>Science/Mathematics self-efficacy</td>
<td>.110</td>
<td>.350</td>
</tr>
</tbody>
</table>

Based on the standardized coefficients and structure coefficients, undergraduate students’ attitudes towards a STEM career followed by the outcomes they expect out doing well in science and mathematics had more influence on discriminating between the male and female students. The group centroids indicated that male students reported higher STEM perceptions than the female students especially in their attitudes towards a STEM career and their outcome expectations. As shown in Table 4.19, the effect size for the mean differences in attitudes towards pursuing a STEM career was found to be moderate (Cohen’s $d = 0.35$) and this could be considered educationally meaningful. The mean differences in outcome expectations and self-efficacies between male and female students were found to be small.
<table>
<thead>
<tr>
<th>Construct</th>
<th>Male Mean</th>
<th>Male SD</th>
<th>Female Mean</th>
<th>Female SD</th>
<th>Effect size (Cohen’s d)</th>
<th>CI for effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitudes towards a STEM career</td>
<td>4.85</td>
<td>1.65</td>
<td>4.27</td>
<td>1.66</td>
<td>0.35</td>
<td>(0.08, 0.51)</td>
</tr>
<tr>
<td>Science/Mathematics outcome expectations</td>
<td>3.38</td>
<td>0.80</td>
<td>3.20</td>
<td>0.81</td>
<td>0.22</td>
<td>(0.09, 0.30)</td>
</tr>
<tr>
<td>Science/Mathematics self-efficacy</td>
<td>4.33</td>
<td>0.77</td>
<td>4.24</td>
<td>0.73</td>
<td>0.12</td>
<td>(0.01, 0.19)</td>
</tr>
</tbody>
</table>

Although not included in the MANOVA analyses, three other STEM-related constructs were also examined to understand the gender-based differences in STEM perceptions (see Table 4.20). The mean scores and the effect sizes for students’ perceptions about a career in a non-STEM area are given in Table 4.20.

Table 4.20

<table>
<thead>
<tr>
<th>Construct</th>
<th>Male Mean</th>
<th>Male SD</th>
<th>Female Mean</th>
<th>Female SD</th>
<th>Effect Size (Cohen’s d)</th>
<th>CI for effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitudes towards a non-STEM career</td>
<td>4.77</td>
<td>1.40</td>
<td>5.17</td>
<td>1.40</td>
<td>0.286</td>
<td>(0.05, 0.42)</td>
</tr>
<tr>
<td>Ease of a non-STEM career</td>
<td>4.13</td>
<td>1.19</td>
<td>4.07</td>
<td>1.30</td>
<td>0.048</td>
<td>(-0.15, 0.17)</td>
</tr>
</tbody>
</table>

Note. n (male) = 140; n (female) = 421

The various STEM career related constructs including undergraduate students’ perceptions about a career in non-STEM fields are graphically illustrated in Figure 4.11.
Research Question 7. What are the differences in how STEM and non-STEM majors perceive STEM career-related perceptions?

A one-way MANOVA was performed to check if there was one or more mean differences in STEM-related perceptions between STEM and non-STEM undergraduate college students. Although the Box’s M value was found to be statistically significant, an examination of the covariance matrices across the gender levels indicated that the equality of covariance assumption, that the homogeneity assumption was met. Pillai’s trace was consulted as it is more robust to unequal variances and group sizes when compared to Wilk’s λ. Pearson correlations and the Bartlett’s test of sphericity ($\chi^2 (5) = 465.43; p <0.001$) suggested that the dependent variables are correlated enough to be
analyzed together in a MANOVA (Meyers et al., 2012). The result of the MANOVA (as seen in Table 4.21) was statistically significant (Pillai’s trace = 0.277; $F(3,557) = 70.98$; $p=0.000$). The eta squared value was found to be 0.277, which indicated that over 27.7% of the variance in the canonically derived variate namely STEM perceptions could be explained by the major classification. This could be considered a moderate to large effect size (Cohen, 1992).

Table 4.21

<table>
<thead>
<tr>
<th>Effect</th>
<th>Value</th>
<th>F</th>
<th>Hypothesis df</th>
<th>Error df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>major Pillai’s Trace</td>
<td>.277</td>
<td>70.98</td>
<td>3</td>
<td>557</td>
<td>.000</td>
</tr>
<tr>
<td>Wilks’ Lambda</td>
<td>.723</td>
<td>70.98</td>
<td>3</td>
<td>557</td>
<td>.000</td>
</tr>
</tbody>
</table>

To interpret the results from MANOVA, the standardized discriminant function coefficients and structure coefficients were consulted using a descriptive discriminant analysis. The discriminant function coefficient for Function 1 was found to be statistically significant (Wilk’s $\lambda = 0.723$; $p=0.000$). Therefore, further analyses of the weighting of individual STEM variables were examined.

The standardized discriminant function coefficients and structure coefficients are presented in Table 4.22. Based on the standardized coefficients and structure coefficients, undergraduate students’ attitudes towards pursuing a STEM career and the outcomes they expect out of a STEM career had more influence on discriminating between the STEM and non-STEM majors. The group centroids indicated that STEM students reported higher STEM perceptions than the non-STEM majors especially in
their attitudes and their outcome expectations. As seen in Table 4.23, large effect sizes were found for the mean differences in attitudes towards STEM career, and outcome expectations and these differences can be considered educationally meaningful.

Table 4.22

Coefficients for Major-based Differences in STEM Career Perceptions

<table>
<thead>
<tr>
<th>Construct</th>
<th>Standardized Coefficients</th>
<th>Structure Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitudes towards a STEM career</td>
<td>.829</td>
<td>.946</td>
</tr>
<tr>
<td>Science/Mathematics outcome expectations</td>
<td>.350</td>
<td>.642</td>
</tr>
<tr>
<td>Science/Mathematics self-efficacy</td>
<td>-.047</td>
<td>.189</td>
</tr>
</tbody>
</table>

Table 4.23

Effect Sizes for Major-based Differences in STEM Career Perceptions

<table>
<thead>
<tr>
<th>Construct</th>
<th>STEM Mean</th>
<th>STEM SD</th>
<th>non-STEM Mean</th>
<th>non-STEM SD</th>
<th>Effect Size (Cohen's d)</th>
<th>CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitudes towards a STEM career</td>
<td>6.06</td>
<td>1.13</td>
<td>3.98</td>
<td>1.54</td>
<td>1.42</td>
<td>(1.22,1.57)</td>
</tr>
<tr>
<td>Science/Mathematics outcome expectations</td>
<td>3.83</td>
<td>.69</td>
<td>3.09</td>
<td>.73</td>
<td>1.04</td>
<td>(0.90,1.09)</td>
</tr>
<tr>
<td>Science/Mathematics self-efficacy</td>
<td>4.43</td>
<td>.76</td>
<td>4.22</td>
<td>.77</td>
<td>0.27</td>
<td>(0.14,0.35)</td>
</tr>
</tbody>
</table>

Note. n(STEM) = 117; n (non-STEM) = 444

Although not included in the MANOVA analyses, three other STEM-related constructs (see Table 4.24) were also examined to understand the major-based differences in STEM perspectives.
Table 4.24

*Mean Differences in Additional STEM Constructs*

<table>
<thead>
<tr>
<th>Construct</th>
<th>STEM Mean</th>
<th>STEM SD</th>
<th>non-STEM Mean</th>
<th>non-STEM SD</th>
<th>Effect Size (Cohen's d)</th>
<th>CI for Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitudes towards a non-STEM career</td>
<td>4.15</td>
<td>1.37</td>
<td>5.37</td>
<td>1.29</td>
<td>0.92</td>
<td>(0.67, 1.03)</td>
</tr>
<tr>
<td>Ease of non-STEM career</td>
<td>4.61</td>
<td>1.25</td>
<td>3.95</td>
<td>1.25</td>
<td>0.53</td>
<td>(0.30, 0.65)</td>
</tr>
<tr>
<td>Ease of STEM career</td>
<td>2.70</td>
<td>1.07</td>
<td>2.47</td>
<td>1.29</td>
<td>0.19</td>
<td>(0.01, 0.30)</td>
</tr>
</tbody>
</table>

As seen in Table 4.24, there was a very large meaningful difference in how STEM and non-STEM majors perceived careers in non-STEM fields. While both STEM and non-STEM majors reported that STEM careers were very difficult, when asked about the easiness of non-STEM careers, STEM majors perceived that non-STEM careers were easier. Figure 4.12 shows a diagrammatic representation of major-based differences in STEM perceptions. As seen in this figure, the largest difference was noted for attitudes towards a STEM career.

*Figure 4.13* Major-based differences in STEM career perceptions
Research Question 8. What are the differences in STEM career-related perceptions (self-efficacy, attitudes and outcome expectations) between Honors and non-Honors college students?

A one-way MANOVA was performed to check if there were any differences in STEM-related perceptions between Honors and non-Honors undergraduate college students. Box’s M value (Box’s $M = 11.96$; $F (6, 266277) = 1.974; p = .066$) was found to be not statistically significant. An examination of the covariance matrices across the gender levels also indicated that the equality of covariance assumption i.e. homogeneity assumption was met. The Bartlett’s test of sphericity ($\chi^2 (5) = 664.96; p < 0.001$) and Pearson correlations suggested that the dependent variables are correlated enough to be analyzed together in a MANOVA (Meyers, Gampst, & Guarino, 2012).

The result of the MANOVA, as seen in Table 4.25, was statistically significant (Wilk’s $\lambda = 0.978$; $F (3, 556) = 2.191; p=0.006$). The eta squared value was found to be 0.022, which indicated that over 2% of the variance in the canonically derived variate namely STEM perceptions, and this can be considered a small effect size.

Table 4.25

MANOVA for Honors-based Differences in STEM Career Perceptions

<table>
<thead>
<tr>
<th>Effect</th>
<th>Value</th>
<th>F</th>
<th>Hypothesis df</th>
<th>Error df</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>major Pillai’s Trace</td>
<td>.023</td>
<td>4.354</td>
<td>3</td>
<td>556</td>
<td>.005</td>
</tr>
<tr>
<td>Wilks’ Lambda</td>
<td>.977</td>
<td>4.354</td>
<td>3</td>
<td>556</td>
<td>.005</td>
</tr>
</tbody>
</table>

To interpret the results from MANOVA, the standardized discriminant function coefficients and structure coefficients were consulted using a descriptive discriminant
analysis. The canonical correlation for Function 1 was found to be statistically significant (Wilks’ $\lambda = 0.977$; $p = 0.005$). Because the discriminant function was significant, further analyses of the weighting of individual STEM variables were examined. The standardized discriminant function coefficients and structure coefficients are presented in Table 4.26.

Table 4.26

<table>
<thead>
<tr>
<th>Coefficients for Honors-based Differences in STEM Career Perceptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standardized Coefficients</td>
</tr>
<tr>
<td>---------------------------</td>
</tr>
<tr>
<td>Science/Mathematics self-efficacy</td>
</tr>
<tr>
<td>Attitudes towards a STEM career</td>
</tr>
<tr>
<td>Science/Mathematics outcome expectations</td>
</tr>
</tbody>
</table>

Based on the standardized coefficients and structure coefficients, undergraduate students’ self-efficacies in science and mathematics, and their attitudes towards a STEM career had more influence on discriminating between the Honors and non-Honors students. The group centroids indicated that Honors students reported higher STEM perceptions than the non-honors students especially in their self-efficacy followed by their attitudes towards a STEM career and outcome expectations. As seen in Table 4.27, the effect size for the mean differences in self-efficacy towards pursuing a STEM career was found to be moderate (Cohen’s $d = 0.30$) and this can be considered educationally meaningful. The mean difference in attitudes towards a STEM career was found to be small (Cohen’s $d = 0.17$). In addition to the above mentioned STEM
variables, three other variables namely perceptions about the complexity of STEM and non-STEM careers and attitudes towards a non-STEM career were also examined.

Table 4.27

Effect Sizes for Honors-based Differences in STEM Career Perceptions

<table>
<thead>
<tr>
<th>Construct</th>
<th>Honors Mean</th>
<th>Honors SD</th>
<th>non-Honors Mean</th>
<th>non-Honors SD</th>
<th>Effect Size (Cohen’s d)</th>
<th>Confidence Interval for The Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science/Mathematics self-efficacy</td>
<td>4.47</td>
<td>.66</td>
<td>4.26</td>
<td>.75</td>
<td>0.30</td>
<td>(0.17, .036)</td>
</tr>
<tr>
<td>Attitudes towards a STEM career</td>
<td>4.63</td>
<td>1.71</td>
<td>4.35</td>
<td>1.67</td>
<td>0.17</td>
<td>(-0.14, 0.32)</td>
</tr>
<tr>
<td>Science/Mathematics outcome expectations</td>
<td>3.29</td>
<td>.85</td>
<td>3.25</td>
<td>.82</td>
<td>0.05</td>
<td>(-0.11, 0.12)</td>
</tr>
</tbody>
</table>

Note. n (Honors) = 117; n(non-Honors) = 443

A graphical representation (see Figure 4.13) of all the STEM variables is shown in the Figure below. There were no differences in how Honors and non-Honors students perceived the difficulty of STEM and non-STEM areas and their attitudes towards a career in a non-STEM area.
Figure 4.14 Honors enrollment-based differences in STEM perceptions

To further understand the effect of gender, major and their interaction, factorial MANOVAS were run separately for Internet related variables and STEM career related variables. Although some of the factorial MANOVAs were not statistically significant, the graphical output plots were examined to understand the interaction effects, if any.

To make further interpretation of the interaction effects between gender, major and being part of an Honors program, the students were classified into 8 groups: Male-STEM-Honors, Male-STEM-nonHonors, Male-nonSTEM-Honors, Male-nonSTEM-nonHonors, Female-STEM-Honors, Female-STEM-nonHonors, Female-nonSTEM-Honors, and Female-nonSTEM-nonHonors.
**Figure 4.15** Interaction trends in Internet attitudes for Gender*Major*Honors
As shown in Figure 4.14 and Figure 4.15, female STEM majors in an Honors program reported lower attitudes towards the telephone and territory dimensions when compared to their peers.

![Comparison of Internet Attitudes](image)

*Figure 4.16 Comparison of the Internet attitudes for different student groups*

Similarly, plots were examined to understand the interaction effects of gender, enrollment in an Honors program and major program of study on STEM career-related perceptions of undergraduate students. Some of the interaction effects were statistically significant and have been noted in Table 4.28. The main effect of major on STEM career-related perceptions was statistically significant such that male students reported higher perceptions in terms of attitudes towards a STEM career, self-efficacies and outcome expectations than non-STEM majors. When asked about their attitudes towards STEM careers, whereas the main effect of major program of study made a
statistically significant difference. In addition, the interaction effect of gender and major program also made a statistically significant difference.

Table 4.28

*Factorial MANOVA on STEM Career-related Perceptions*

<table>
<thead>
<tr>
<th>Effect</th>
<th>Wilk’s λ</th>
<th>F</th>
<th>Error df</th>
<th>Hypothesid df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>major</td>
<td>.834</td>
<td>27.39</td>
<td>4</td>
<td>549</td>
<td>.000</td>
</tr>
<tr>
<td>gender * major</td>
<td>.92</td>
<td>2.68</td>
<td>4</td>
<td>549</td>
<td>.031</td>
</tr>
<tr>
<td>gender*honors</td>
<td>.98</td>
<td>2.53</td>
<td>4</td>
<td>549</td>
<td>.039</td>
</tr>
<tr>
<td>gender<em>major</em>honors</td>
<td>.98</td>
<td>2.39</td>
<td>4</td>
<td>549</td>
<td>.050</td>
</tr>
</tbody>
</table>

The female students in STEM majors reported the highest outcome expectations of doing well in science and mathematics, while female students in non-STEM majors reported the lowest outcome expectations (see Figure 4.16).

![Outcome expectations in Science/Math](image)

*Figure 4.17 Interaction trends in science/mathematics outcome expectations*
When asked about their attitudes towards a career in STEM, as seen in Figure 4.17, female students in a STEM and an Honors program reported very high positive attitudes while students in non-STEM majors, except male students in Honors program reported average attitudes towards a STEM career.

Figure 4.18 Interaction trends in attitudes towards a career in STEM

Third, interaction effects on science and mathematics self-efficacy scores, as seen in Figure 4.18, indicated that female STEM majors in an Honors program reported higher self-efficacy scores than their peers. Male STEM majors in Honors program reported the lowest self-efficacy scores among the eight groups. Finally, the interaction trends on whether the students perceived the STEM careers as easy or complex indicated that overall, all the student groups considered that the STEM careers were complex (see Figure 4.19). Specifically, the male students in STEM and non-Honors program and female students in non-STEM programs (both Honors and non-Honors) considered STEM careers as more complex than their peers.
Figure 4.19 Interaction trends in science/mathematics self-efficacy

Figure 4.20 Interaction trends about ease of a career in STEM
Findings on the Relationship between Internet Attitudes and STEM Perceptions

Research Question 9: What is the relation between attitudes towards the Internet and STEM career-related perceptions?

The relationship between the two constructs namely Internet attitudes and STEM career-related perceptions was analyzed using a canonical correlation analysis (CCA).

Table 4.29

Correlations between Internet and STEM Career-related Perceptions

<table>
<thead>
<tr>
<th></th>
<th>Tool</th>
<th>Toy</th>
<th>Treas</th>
<th>Terri</th>
<th>Tele</th>
<th>Att</th>
<th>SE</th>
<th>OE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tool</td>
<td>1</td>
<td>.66**</td>
<td>.63**</td>
<td>.43**</td>
<td>.38**</td>
<td>.04</td>
<td>.08</td>
<td>.14**</td>
</tr>
<tr>
<td>Toy</td>
<td>.66**</td>
<td>1</td>
<td>.58**</td>
<td>.54**</td>
<td>.51**</td>
<td>.03</td>
<td>.05</td>
<td>.20**</td>
</tr>
<tr>
<td>Treasure(Treas)</td>
<td>.63**</td>
<td>.58**</td>
<td>1</td>
<td>.47**</td>
<td>.31**</td>
<td>.095</td>
<td>.16**</td>
<td>.21**</td>
</tr>
<tr>
<td>Territory(Terri)</td>
<td>.43**</td>
<td>.54**</td>
<td>.47**</td>
<td>1</td>
<td>.55**</td>
<td>-.02</td>
<td>.08</td>
<td>.14**</td>
</tr>
<tr>
<td>Telephone(Tele)</td>
<td>.38**</td>
<td>.51**</td>
<td>.31**</td>
<td>.55**</td>
<td>1</td>
<td>.02</td>
<td>-.10*</td>
<td>.19**</td>
</tr>
<tr>
<td>Attitudes(Att)</td>
<td>.04</td>
<td>.03</td>
<td>.095</td>
<td>-.02</td>
<td>.02</td>
<td>1</td>
<td>.24**</td>
<td>.48**</td>
</tr>
<tr>
<td>Self-efficacy(SE)</td>
<td>.08</td>
<td>.05</td>
<td>.16**</td>
<td>.08</td>
<td>-.10*</td>
<td>.24**</td>
<td>1</td>
<td>.196**</td>
</tr>
<tr>
<td>Outcome expectations(OE)</td>
<td>.14**</td>
<td>.20**</td>
<td>.21**</td>
<td>.14**</td>
<td>.19**</td>
<td>.48**</td>
<td>.196**</td>
<td>1</td>
</tr>
</tbody>
</table>

** p< 0.001 *p<0.01

The two variable sets used in the CCA were:

1. The first variable set consisted of five variables for five dimensions of Internet attitudes namely tool, toy, treasure, territory, and telephone.
2. The second variable set consisted of STEM career-related perceptions related variables namely STEM career attitudes, science/mathematics self-efficacy, and science/mathematics outcome expectations.
The correlations between all the variables are shown in Table 4.29. The canonical correlation analysis combined the variables in each set using a linear equation and created two synthetic variables: predictor (Internet attitudes) and criterion (STEM career-related perceptions) variables. Because there were five Internet variables, and three STEM career variables, the relationship between these two sets of variables was expressed as three functions denoting the smallest number of variables among the two sets (Meyers et al., 2012). Each function for these two sets of variables was denoted as

\[ w \cdot (\text{tool}) + w \cdot (\text{toy}) + w \cdot (\text{treasure}) + w \cdot (\text{territory}) + w \cdot (\text{telephone}) = z \cdot (\text{Sci-math\_self-efficacy}) + z \cdot (\text{STEMcareer\_attitudes}) + z \cdot (\text{Sci-math\_outcomeexpect}) \]

With 561 cases included for analysis, the relationship between the set of Internet attitudes variables and the set of STEM career-related perceptions variables was found to be statistically significant (Wilk's \( \lambda = 0.86, R_c^2 = 0.14, F(15,1526.99) = 5.611; p<0.0001 \).

Table 4.30

**Canonical Correlation between Internet and STEM Perceptions**

<table>
<thead>
<tr>
<th>Function</th>
<th>Eigen value</th>
<th>Variance Explained (Percent)</th>
<th>Canonical correlation</th>
<th>Squared canonical correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.08</td>
<td>49.96</td>
<td>0.26</td>
<td>0.07</td>
</tr>
<tr>
<td>2</td>
<td>0.06</td>
<td>40.85</td>
<td>0.24</td>
<td>0.06</td>
</tr>
<tr>
<td>3</td>
<td>0.01</td>
<td>9.18</td>
<td>0.11</td>
<td>0.01</td>
</tr>
</tbody>
</table>

All three functions of the canonical correlation analysis were extracted. The eigen values, variances explained and canonical correlations are shown in Table 4.30. The first function accounted for approximately 50% of the explained variance, while the second function explained approximately 41% of the remaining variance. The dimension
reduction analysis indicated that the first two functions were statistically significant. The third function was marginally statistically at \( p = 0.052 \). However, because the third function only explained 9% of the variance left unexplained by the first two functions, only the functions 1 and 2 were considered for interpreting the canonical correlation.

As Meyers et al. (2012) suggested the Cramer-Nicewander index was calculated as 0.05. In other words, the variance explained in STEM variables by Internet related variables was 5%. On average, the canonical correlation between Internet variables and STEM career variables was found to be small \( (R_c = 0.21) \). The structure coefficients for the functions 1 and 2 are given for Internet related variables and STEM career related variables in Tables 4.31 and 4.32 respectively.

Table 4.31

Structure Coefficients for Internet Attitudes

<table>
<thead>
<tr>
<th>Variable</th>
<th>Function 1</th>
<th>Function 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tool</td>
<td>.57</td>
<td>-0.18</td>
</tr>
<tr>
<td>Toy</td>
<td>.81</td>
<td>-0.03</td>
</tr>
<tr>
<td>Treasure</td>
<td>.82</td>
<td>-0.47</td>
</tr>
<tr>
<td>Territory</td>
<td>.64</td>
<td>-0.21</td>
</tr>
<tr>
<td>Telephone</td>
<td>.73</td>
<td>-0.59</td>
</tr>
</tbody>
</table>

As shown in Tables 4.31 and 4.32, for the first function, Internet attitudes variate was positively associated primarily with the attitudes towards the treasure and toy dimensions. In addition, the STEM career-related variate was positively associated with attitudes towards outcome expectations. Taken together, the first function indicated that students who perceived Internet more as a treasure and a toy reported higher outcome expectations from doing well in science and mathematics.
Table 4.32

*Structure Coefficients for STEM Career-related Constructs*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Function 1</th>
<th>Function 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEM career attitudes</td>
<td>.19</td>
<td>-0.09</td>
</tr>
<tr>
<td>Science/Mathematics self-efficacy</td>
<td>.22</td>
<td>-0.97</td>
</tr>
<tr>
<td>Science/Mathematics outcome expectations</td>
<td>.96</td>
<td>0.04</td>
</tr>
</tbody>
</table>

Similarly for the second function, the Internet attitudes variate was negatively associated with attitudes towards the telephone and treasure dimensions. The STEM career related variate was found to be negatively associated with science and mathematics self-efficacy. Taken together, the second function indicated that students who reported lower perceptions about the telephone and treasure dimensions also reported lower self-efficacies about doing well in science and mathematics.

The canonical correlation model for the first function can be denoted as in Figure 4.20.
The canonical correlation model for the second function is given in Figure 4.21.

Figure 4.22 Canonical correlation model for the second function
4.3.2 Qualitative Findings

In order to understand the results from the quantitative analyses, qualitative content analyses were performed. Hsieh and Shannon (2005) suggested three different methods of qualitative content analyses. In this study, directed and conventional methods of analyses have been employed. For the qualitative data analyses to be valid, the data coding process should also be reliable. Issues with reliability can be attributed to how the text content is interpreted, and how the categories and themes are coded (Tashakkori & Teddlie, 2003). The data coding methods are elaborated in this section to allow external coders to repeat the process.

The responses to the three open-ended questions included in the survey were analyzed. The first question asked the participants on what or who influenced their career choices and interests. The second question was more specific about factors influencing their choices and interests in STEM careers. Finally, the third question asked the participants how they perceived the role of the Internet in their career-related perceptions. In the NVivo software, various data objects of analyses were created to allow a deeper understanding of the responses.

Table 4.33 lists the objects that were created in NVivo and describes how each object was used in the current analysis.

Open-ended Question 1
What/Who influenced your career choices and interests? Why do you like this career?

Of the 566 undergraduate students who responded to the survey, 244 students responded to the question on factors influencing their career-related perceptions.
Table 4.33

*Objects Used for Content Analysis in NVIVO*

<table>
<thead>
<tr>
<th>Object</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nodes</td>
<td>Three nodes were created for the three questions. Similarly, nodes were also created for respondents.</td>
</tr>
<tr>
<td>Classifications</td>
<td>Node classifications were created to enable assigning attributes to each respondent. This allowed inclusion of valuable demographic information about each respondent, and examination of differences due to gender, major, and enrollment in an Honors program.</td>
</tr>
<tr>
<td>Sets</td>
<td>Eight sets were created to group the respondents into eight clusters based on gender, major and Honors enrollment.</td>
</tr>
<tr>
<td>Matrix coding</td>
<td>Queries were executed to develop a cross tabulation of categories and sets. For instance, the categories and themes were entered as rows, and the eight sets (based on gender, honors, major) were entered as columns. The number of codes in each cell of the cross tabulation was interpreted to analyze the weightage for the themes and categories.</td>
</tr>
</tbody>
</table>

Table 4.34 lists the categories and themes emerging from the responses for this question. The themes and categories were derived to examine if the undergraduate students perceived the Internet as an integral factor related to their general career-related perceptions. Some respondent comments contained more than one code, so the number of codes was higher than the number of student comments. Responses to the
questions were read twice to understand the comments and the context, and to prepare for the coding process.

As seen in Table 4.34, the categories were grouped into thematic groupings for further interpretation.

Table 4.34

*Factors Influencing Students’ General Career Perceptions*

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Categories</th>
<th>Code counts</th>
<th>Percentage</th>
<th>Theme groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Me/Myself</td>
<td>102</td>
<td>33.8</td>
<td>Personal</td>
</tr>
<tr>
<td>2</td>
<td>Family</td>
<td>44</td>
<td>14.6</td>
<td>Family and Faith</td>
</tr>
<tr>
<td>3</td>
<td>Professors and/or teachers</td>
<td>34</td>
<td>11.3</td>
<td>School</td>
</tr>
<tr>
<td>4</td>
<td>School and Courses</td>
<td>33</td>
<td>10.9</td>
<td>School</td>
</tr>
<tr>
<td>5</td>
<td>Members in the society</td>
<td>27</td>
<td>8.9</td>
<td>Society</td>
</tr>
<tr>
<td>6</td>
<td>Friends and/or peers</td>
<td>15</td>
<td>5.0</td>
<td>Friends</td>
</tr>
<tr>
<td>7</td>
<td>Economy</td>
<td>12</td>
<td>4.0</td>
<td>Society</td>
</tr>
<tr>
<td>8</td>
<td>Mentoring and internships</td>
<td>11</td>
<td>3.6</td>
<td>Society</td>
</tr>
<tr>
<td>9</td>
<td>Other reasons</td>
<td>11</td>
<td>3.6</td>
<td>Other reasons</td>
</tr>
<tr>
<td>10</td>
<td>None</td>
<td>7</td>
<td>2.3</td>
<td>No influences</td>
</tr>
<tr>
<td>11</td>
<td>Faith</td>
<td>4</td>
<td>1.3</td>
<td>Family and Faith</td>
</tr>
<tr>
<td>12</td>
<td>Technology</td>
<td>2</td>
<td>0.7</td>
<td>Technology</td>
</tr>
</tbody>
</table>

The major themes that emerged include personal factors, school, society and family. The role of technology was mentioned only in two responses as related to
general career choices and interests. Overall, the students still perceived the traditional factors such as their personal factors and their immediate surrounding physical environment as related to their career choices and interests. Of the external factors, school-related influences including their teachers, professors, courses they take, and experiences in the school had more impact on their career-related perceptions.

Figure 4.23 Factors affecting students’ general career-related perceptions

Figure 4.22 shows how students in different groups (based on students’ major, enrollment in Honors and gender) perceived factors affecting their career interests and choices. As seen in Figure 4.22, overall, personal factors, school and society were the top three factors influencing undergraduate students’ career-related perceptions. In particular, male students in a non-STEM and non-Honors program, and female students in a STEM and an Honors program attributed their career-related perceptions to themselves. Compared to their peers, male students who were in both STEM and
Honors programs reported that their families and faith played a more important role in influencing their career-related perceptions. On the contrary, male students in an Honors and a non-STEM program reported that the society played an important role in their career-related perceptions. The top three factors that influence students' general career interests and choices are explained below to understand why students perceived these factors important.

First, to describe what students meant by the responses “Me/Myself”, the add-on question, “Why do you like this career?”, was analyzed qualitatively using a conventional content analysis. The responses grouped into three thematic groupings: attitudes/liking of things related to their careers; outcomes they expected out of their careers, and their perceptions of being good at tasks related to that career. These themes align with the three attributes, namely interests, outcome expectations and self-efficacy, suggested by the literature on career-related perceptions (Lent et al. 1994). Within the theme about outcome expectations, it was noted that having a stable career was the top outcome expected by male students, while being able to serve others was the major outcome expectation that female students reported. Similarly, students in STEM majors reported career stability as the major outcome while students in non-STEM areas considered the opportunity to serve others as a main reason for choosing careers in a non-STEM area. No such differences were noted between students who were enrolled in Honors program and those who were enrolled in a non-Honors program.

Second, of the school related factors, many respondents indicated that their experiences in school such as undergraduate research, interactions with advisors,
experiences in their first year, and extracurricular activities influenced their career-related perceptions. The students also mentioned the courses they enrolled in the university, and the guidance from their professors and high school teachers as being important to their career decisions.

Third, society-related factors included the people the students met or heard about every day in the society, the economy, mentoring opportunities and having part-time jobs outside the university.

Open-ended Question 2

What factors (positive and/or negative) affect students’ perceptions about STEM careers?

The second open-ended question was more specific, in that, it asked the students about factors influencing their perceptions about pursuing careers in STEM. There were 240 responses recorded for this question. Similar to the analysis of the first open-ended question, a conventional content analysis was employed, thereby letting the categories and themes emerge from the students’ responses. Since, the question asked for both positive and negative factors that influenced students’ perceptions about a STEM career, two themes emerged namely the positive factors and the negative factors.

Table 4.35 summarizes the number of codes and categories for the positive factors theme. Similarly, the responses for the negative factors were coded into sub-categories and categories as shown in Table 4.36. As seen in Table 4.35, the positive factor that mainly affected students’ perceptions about STEM careers was their
expectations about the outcomes of pursuing a STEM career. Respondents felt that a career in STEM would help them have job security and stability.

Table 4.35

*Positive Factors Influencing STEM Perceptions*

<table>
<thead>
<tr>
<th>Categories</th>
<th>No. of Codes</th>
<th>Sub-categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outcome expectations</td>
<td>64</td>
<td>Job stability; contribute to society; salary; recognition.</td>
</tr>
<tr>
<td>External Factors</td>
<td>31</td>
<td>School; parents; media; society; technology; friends</td>
</tr>
<tr>
<td>Attitudes</td>
<td>23</td>
<td>Fun; challenging</td>
</tr>
<tr>
<td>Self-concept</td>
<td>7</td>
<td>Being good at science/mathematics</td>
</tr>
</tbody>
</table>

Some of the respondents also indicated the need for engineers and other STEM professionals. One student responded that,

“…I see the world changing rapidly and I think those that learn about mathematics and science will always have a good, high paying job”.

The respondents also mentioned that the STEM careers would provide them with stable jobs and financial security. Other outcome expectations that were mentioned were being able to contribute to the society and make a change in others' lives. The responses reiterated how some students believed that mathematics and science were integral to a society’s progression. High salaries in the STEM areas and the recognition from the STEM careers were also considered as positive influences.

The second main positive theme mentioned by the students was the influence of external factors such as their professors, teachers, courses and parents. A few students mentioned the influence of friends and technology. For instance, one student mentioned how online information has been helpful in his/her studies,
“… I’ve started to enjoy science again mostly due to online information that I read and watch.”

However, the influence of technology or the Internet was not mentioned very frequently.

Of the negative factors influencing students’ perceptions about STEM careers, attitudes towards these careers were the largest negative factor (see Table 4.36).

Table 4.36

Negative Factors Influencing STEM Perceptions

<table>
<thead>
<tr>
<th>Categories</th>
<th>No of Codes</th>
<th>Sub-Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitudes</td>
<td>121</td>
<td>Difficulty of STEM subjects; lack of interest; lack of fun, too much hard work needed.</td>
</tr>
<tr>
<td>Self-concept and self-efficacy</td>
<td>35</td>
<td>Not good at STEM subjects or tasks in these areas.</td>
</tr>
<tr>
<td>External factors</td>
<td>31</td>
<td>School; society; cost of a degree in STEM; competitive fields.</td>
</tr>
<tr>
<td>Outcome expectations</td>
<td>25</td>
<td>Not meaningful; lack of happiness</td>
</tr>
</tbody>
</table>

As seen in Table 4.36, students’ self-efficacies in science and mathematics areas and what they experience and observe in school and society were equally important in influencing their perceptions about pursuing STEM careers.

Figure 4.23 shows the major categories that described students’ negative attitudes towards STEM. The students who mentioned that the STEM subjects were difficult used words such as “dreadful”, “awful”, “stress”, “mind numbing” to explain how they felt about the STEM content areas.
Not being interested in science and mathematics areas and/or being interested in some other areas also influenced their negative attitudes about pursuing careers in STEM. Lack of fun and having to work so hard were also mentioned as factors negatively associated with being interested in STEM factors.

Figure 4.24 Word cloud on negative attitudes towards STEM careers

On further analysis of the students’ responses, certain gender-based differences were noted in how the students perceived the factors influencing their STEM career-related perceptions. Male students reported that being able to contribute to the society, and having a stable career were factors that mainly influenced their perceptions about a STEM career (see Figure 4.24). For female students, in addition to job stability and serving others, having a fun and exciting career was also important (see Figure 4.25).
Figure 4.25 Factors influencing students' STEM career-related perceptions
Open-ended Question 3
What role does the Internet play in affecting students’ career choices and interests?

This open-ended question was included in the survey to extend the findings from the canonical correlation analysis on the role of the Internet on career-related perceptions. A directed content analysis was employed to code the responses for the above question. Individual responses were read twice to understand the context. The coding began with five predetermined themes which corresponded to the five dimensions of Internet attitudes considered in this study i.e. tool, toy, treasure, territory and telephone. Each response was assigned to one of these themes based on the 5T model of Internet attitudes by Chou et al. (2009), described in Chapter 2. If the responses conveyed additional concepts or ideas, they were coded as separate categories. At every stage, a coding comparison was made with each of the themes and the more appropriate theme was chosen. Some responses could fit in more than one category. For instance, one respondent mentioned, “the Internet is just a tool to get information”. Although the information dimension was mentioned, the response indicated more preference for the tool dimension, and so was coded under the tool theme.

The coding process indicated that many responses also indicated the intensity of the role of the Internet which formed into a separate theme. As shown in the table 4.37, many responses mentioned whether the Internet played a huge role, a small role, no role and some responses even mentioned a negative role of the Internet. Of the respondents who specified the extent to which the Internet played a role in their career
choices and interests, a majority of them either specified that the Internet played a huge role or no role at all.

Table 4.37

*Intensity of the Internet's Role on Career-related Perceptions*

<table>
<thead>
<tr>
<th>Categories</th>
<th>Number of Codes</th>
<th>Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large role</td>
<td>89</td>
<td></td>
</tr>
<tr>
<td>Small role</td>
<td>48</td>
<td>Intensity of the Internet’s Role</td>
</tr>
<tr>
<td>Negative role</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>No role</td>
<td>81</td>
<td></td>
</tr>
</tbody>
</table>

Some of the respondents described why they perceived the Internet to have a huge role in their careers. Their responses indicated the prevalence of the Internet and its influence on everyday lives of today's students. These reasons included:

“Everything is digital now”.

“…because I see how much time others spend on it and how much money I can make by using this knowledge”.

“I think most people will choose a career based on the Internet because it seems easier.”

“I feel that the Internet influences everything we do”

A few respondents also considered Internet as playing a negative role in their career choices and interests. Their responses indicated that they felt the Internet was more a distraction, and that the information in the Internet might not be authentic or very helpful to the real world. Some sample responses are highlighted below:
“... I am somewhat jaded by using the Internet so much because there is a lack of real-life communication”.

“... It dumbs us down”.

“... think the Internet actually inhibits the ability to search for careers because students will not explore themselves!”

“... there are so many unnecessary and distracting content online”.

“... it sugar coats a lot of things on trying to get to a successful point in that field”.

The responses on the perceptions of students about the five dimensions of Internet use was coded as one of the five Internet dimensions i.e. tool, toy, treasure, territory and telephone. The number of codes for the five themes is shown in the Table 4.38.

Table 4.38

Role of the Internet on General Career-related Perceptions

<table>
<thead>
<tr>
<th>Themes</th>
<th>Number of Codes</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tool</td>
<td>163</td>
<td>Research; search/explore, decision making, a general tool kit for job applications, career assessments, and resources</td>
</tr>
<tr>
<td>Treasure</td>
<td>151</td>
<td>Information resources; a database of information</td>
</tr>
<tr>
<td>Toy</td>
<td>18</td>
<td>Videos, advertisements and online hobbies</td>
</tr>
<tr>
<td>Territory</td>
<td>72</td>
<td>Online experiences, online professional networking, online marketing</td>
</tr>
<tr>
<td>Telephone</td>
<td>13</td>
<td>Communicate both personally and professionally</td>
</tr>
<tr>
<td>Teacher</td>
<td>11</td>
<td>Helps to learn</td>
</tr>
</tbody>
</table>

As seen in Table 4.38, a majority of responses indicated that the students mainly perceived the Internet as a tool or a treasure in their career choices and interests. Only a few students responded that the toy and telephone dimensions of Internet as being
related to their career choices and interests. The responses of the students for each of the themes are discussed in the following sections.

Theme 1. Internet is a Tool to help with my Career Choices and Interests.

A vast majority of responses included the word “research”. Examples of such responses include: “It allows for research.”, “I can research jobs online”. The word “research” can be defined as a systematic and careful investigation, explore or search for something and inquiry (http://dictionary.reference.com/browse/research).

A majority of students who indicated that they used Internet as a tool mentioned that they used the Internet for (a) exploring about different careers, (b) searching for specific topics/people and other materials related to their careers, (c) examining/investigating careers that might pay well or suit their interests, (d) making decisions about careers, (e) having a general tool kit to buy resources, take career assessments, apply for jobs or make any career-related tasks much easier. Some example responses are included below.

“… can get on the Internet and google questions about careers or look up careers to do research on them”.

“I have taken some career aptitude tests online, and they have helped me by confirming that I had chosen a good career path for my personality.”

“The Internet allows me to keep my options open by looking at a bigger picture of things, and narrowing down what I want to do”

“… because I can, with the click of a button, research different careers I maybe otherwise would have never heard of.”
Theme 2. Internet is a Treasure of Information for Career-Related Information

The second major theme was that the students perceived the Internet as a treasure of information. The responses were largely about how the Internet helped them to access information about careers and subject matters, and how the Internet was a database or repository of information, articles, and learning materials. Students reported that they can not only access endless career-related information, but also keep up-to-date on careers of their interests as new information is immediately available. Students used phrases such as “information highway”, “doorway to an unlimited amount of information”, “full of ideas and information”, “pretty good database of information”, and a “wealth of information”. One student answered,

“… The Internet can lead you to many different places. You start off in one area and it leads you to another. It gives you a wide variety of information to look at and remember.”

Some other students indicated how he/she used information from the Internet

“… it gives me information on picking the career I choose by looking at salaries and what the profession actually does.

“… information on the lifestyle that comes along with this career”.

Other responses also suggested that students used the information to stay updated with latest information related to their careers, gather statistics on different careers, information on economy and government, and read articles about topics of interests. Some students not only indicated that they used the information to decide about prospective careers, but also reported being affected by information that they read on Internet. For instance, one student responded,

“It decides whether we feel good about our career based on the information about different careers that is posted on the Internet...”
While some others responded:

“…love reading articles about the upcoming great paying future careers which makes me want to reconsider my field and al”..
“The Internet made me less willing to do Journalism because of the declining hiring rate”.

Overall, the responses indicated that many students recognized the Internet as a treasure of information for their careers when compared to the other dimensions.

Theme 3. Internet is an Online Territory for Developing Career Interests

The third dimension that was considered much related to their career interests and choices was the territory dimension. Students’ responses indicated how they considered Internet as their online space for discovering new interests and ideas. This can be understood by a students’ comment that,

“.. most of the career ideas I have are either based on the Internet or introduced to me by the Internet”.

While another student mentioned that,

“The influences the Internet has on our generation does influence the decisions we make and changes our outlook on society”.

The respondents suggested that they have considered doing working online, attract customers online for their future businesses, and even plans to make their efforts go “viral” ( a term used to spread messages rapidly on the Internet) to boost their careers and get noticed. Another set of responses indicated that students were noticing how many companies have created their online presence, and how students can learn about the companies from their websites and even connect with the company personnel. Students also mentioned the Web 2.0 aspect of the Internet where they can get inspired and receive feedback from other people. One student responded that
he/she is able to get a true picture of what a career involves. The student pointed out that

“...seeing realistic examples of real world application, that aren’t just propaganda from corporations, can put both sides of a career in perspective and give you a better picture of what you are getting yourself into…”

Connecting with other people with similar career interests was also mentioned by many students. Being able to see what others in similar career feel about the career, watch and read about their experiences, and even connect with them were cited as very helpful for building their career aspirations. In addition, some students also believed that the social media has paved a way for professional networking, joining similar interest groups such as Pinterest, collaboratively learn from online tutorials, read blogs or even write blogs on topics of interest.

One student also pointed the importance of maintaining a clean online presence when the student responded,

“Watch what you put on social media sites, it could affect future opportunities with employers”.

As seen in Table 4.38, the participants did not perceive the toy, telephone and teacher themes as influential on their career-related perceptions. These themes are discussed in the following sections to capture how some students perceived these dimensions of the Internet.

Theme 4. The Internet is a Toy I use to Support my Career Interests and Choices.

Of the 18 respondents who referred to using the Internet as a toy for their career goals, most of them mentioned the videos on the Internet. These students reported that interesting videos triggered their interests in a career.

One student answered,
When I was about 15, I was really into YouTube tutorials about makeup … those tutorials strongly influenced me to pursue a career in the beauty industry”.

The students also mentioned how their career interests were influenced by advertisements on the Internet which made them learn more about a career. One student described how the online advertisements targeted his/her career interests, “..because you always have ads popping up and they are for whatever you are interested in because of cookies ..”

One student wrote about how playing online games motivated his/her interest in the video game industry, and some others pointed how most of their hobbies in the Internet motivated them to pursue careers in web design. Overall, the students’ perceptions about the Internet as a toy indicated that the Internet made career-related ideas more interesting and fun. However, there were only a few responses that highlighted the role of the Internet as a toy in students’ general career perceptions.

Theme 5. Internet is a Telephone for Career-Related Communication.

Students did not perceive the communication aspect of the Internet as integral to their career-related perceptions. The students who mentioned using the Internet as a telephone indicated that they communicated online with people who had similar interests or were already working in careers that the students were interested in. This theme was also mentioned by only a few respondents.

Theme 6. Internet is a Teacher Who Helps Me Learn and Explore.

When referring to the Internet’s role in their career-related perceptions, some students used phrases such as “helps me learn”, “makes learning easier”. They also indicated that Internet helped them explore topics in detail outside class. In addition, they believed that Internet helped them to be more involved in learning.
Figure 4.26 Role of the Internet on general career-related perceptions.
After examining the overall themes of the role of the Internet in influencing students’ career-related perceptions, matrix queries were performed to understand how different groups of students perceived these themes. The figure 4.26 shows the differences based on gender, major, and enrollment in the Honors College. As seen in figure 4.26, overall, the male students perceived the Internet more as a treasure of information for influencing their career choices and interests, while female students considered Internet as both a treasure of information and a tool to help with various career-related tasks.

When the responses of students in an Honors program were compared with those in a non-Honors program, it was found that students in an Honors program valued the Internet as a territory indicating the acknowledgement of the social media and the ability to create an online presence for themselves. The students in the Honors program considered the Internet mainly as a treasure of information and a territory. Whereas, the students in the non-Honors program perceived the tool and treasure dimensions more related to their career-related perceptions. Further, a comparison of STEM and non-STEM majors’ responses indicated that STEM majors indicated using Internet more as a treasure and a tool. The non-STEM majors valued the territory dimension of the Internet slightly higher when compared to their STEM counterparts.
Figure 4.27. Differences among student groups on the role of the Internet on career-related perceptions.
Figure 4.27 shows a more detailed view comparing eight different clusters of students based on their gender, major and enrollment in an Honors program. As described earlier, the figure indicates how in general, male students preferred the treasure dimension of Internet more and how female students preferred the tool dimension of the Internet more related to their career-related perceptions. Specifically, male students in non-Honors programs preferred the treasure dimension more than the other student groups, and female students in STEM programs preferred the tool dimension more than the other student groups.

4.4 Summary

This chapter explained in detail the different statistical data analysis methods (both quantitative and qualitative) that were used in analyzing the data collected from the undergraduate students. The quantitative analyses and qualitative analyses were carried out separately. The quantitative analyses described the overall Internet attitudes and STEM career-related perceptions and also provided several findings on the differences in these perceptions based on gender, major and enrollment in an Honors program. A canonical correlation analysis helped in examining the relationship between different functions of the Internet and three STEM career-related perceptions. The qualitative analyses were used mainly to extend and understand the bigger picture of the role of the Internet among several factors that influenced the students’ career-related perceptions including their perceptions about STEM careers. These results from the quantitative and qualitative analyses will be synthesized in the discussion section (see Chapter 5) for triangulation of the research findings.
CHAPTER 5
DISCUSSION

The findings from the current study have several multi-disciplinary implications, primarily in the fields of Cyber-psychology, STEM education and career development. The following discussion is a synthesis of the findings from the quantitative and qualitative analyses to answer the three main objectives of this study. This discussion will also note the limitations of the current study and suggest future areas for research.

5.1 Major Findings

5.1.1 Major Findings on Undergraduates’ Internet Attitudes

What have we learned about Internet attitudes of undergraduate students?

Overall, the undergraduate students perceived the Internet more as a fun and an interesting medium, a toy with which to play, to be entertained and to avoid boredom (see Table 5.1). The next predominant perception was that the Internet was a helpful tool in their daily personal and academic activities. They also recognized the importance of the information from the Internet that enabled them to perform creative and interesting tasks. The students believed that the information from the Internet contributed to the growth of the society. Their perceptions of the Internet as a communication medium (telephone), or a space for their online presence and social interaction (territory) were lower than the other functions of the Internet.

A recent PEW study (2012) indicated that most teens used the Internet mainly for social networking and information seeking, whereas most adults used the Internet for communication and information seeking.
Table 5.1

Summary of Findings on Internet Attitudes

<table>
<thead>
<tr>
<th>Internet Perceptions</th>
<th>Statistical Significance</th>
<th>Tool</th>
<th>Toy</th>
<th>Treasure</th>
<th>Territory</th>
<th>Telephone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall perceptions</td>
<td></td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Gender differences (Male/Female)</td>
<td>no</td>
<td>no</td>
<td>very small (male)</td>
<td>small (male)</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Major-based differences (STEM/non-STEM)</td>
<td>yes</td>
<td>small (STEM)</td>
<td>small (STEM)</td>
<td>approaching (STEM)</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Honors enrollment-based differences (Honors/non-Honors)</td>
<td>yes</td>
<td>small (Honors)</td>
<td>small (Honors)</td>
<td>approaching (Honors)</td>
<td>no</td>
<td>no</td>
</tr>
</tbody>
</table>

*Note.* The group that reported higher Internet perceptions is mentioned within the parenthesis.
The college students in the current research study had different preferences towards the Internet functions when compared to the adults and teens in the PEW study. The college students in the current research valued the collaboration and communication functions of the Internet lower than the other functions.

The findings are in agreement with Jones et al. (2009) who found that the undergraduate students used the Internet mainly for entertainment and academic purposes. However, Jones et al. also pointed out a preference for socializing among college students. Such a trend was not observed in this study. There were similarities between the U.S. college students in the current study and the Asian college students in Chou et al.’s (2011) study because both groups of students perceived the Internet more as a tool and a toy. One difference was that the U.S. college students perceived the Internet primarily as a toy, whereas the Asian students considered the Internet mainly as a tool. The Asian and U.S. college students in these studies did not perceive the Internet as a telephone or a territory. One reason that Chou et al. (2011) pointed out was maybe the college students relied more on the mobile devices for communication. For instance, Bayer, Klein, and Rubenstein (2009) surveyed 472 college students about their use, frequency and effects of text messaging. The findings indicated that text messaging was perceived as an important form of communication. The students reported receiving and sending 10-25 text messages in the preceding day. The students also reported texting in the classrooms even though they recognized it as an inappropriate behavior. Similar findings were also found by Tindell and Bohlander (2012). In Tindell and Bohlander’s study, the college students kept time diaries on the time they spent on various activities. The students reported spending most of the time in
some form of communication. They reported spending almost 14 hours per week in text messaging and 6.5 hours talking over phone. Overall, the findings from the previous studies supported the current finding that the college students did not perceive the Internet as a communication medium because they relied more on text messaging, talking over phone or even face to face communication. Another explanation could be drawn from the field of Cyber-psychology. For example, the students in this study might have been very pleased with their social life and their face-face interactions with other people that they would rather use the Internet for instrumental or information seeking purposes (Amiel & Sargent, 2004).

No major differences were found in how the male and female undergraduate students perceived the different functions of the Internet. The male students perceived the Internet slightly higher for information-seeking and entertainment than the female students. Previous research had shown contrasting findings on gender differences in how students use the Internet (Chou et al., 2009; Jones et al., 2009; Tsai & Tsai, 2010). However, based on earlier research findings with college students (Chou et al., 2011; Hargittai & Hsieh, 2010; Jones et al., 2009), it was hypothesized that there might be some differences between male and female students such that male students might prefer the information or entertainment dimensions of the Internet more, and female students might prefer communication and social networking aspects of the Internet more. A recent study by Chou et al. (2009) also found gender differences among younger aged students such that boys viewed the Internet more as a tool, toy and a treasure when compared to the girls. The findings of the current research study suggested that the increasing access to the Internet at the university level might have
decreased the gender-based differences in use and perceptions about the Internet.

Another perspective on these findings was that maybe there were more intricate differences in how male and female students used the Internet in each of the dimensions. One explanation derived from Jones et al. (2009) was that even if male and female students viewed the Internet as an information source, females used the mainstream information seeking resources such as search engines, whereas the male college students used a variety of websites to search for information. Such intricate differences need further investigation.

As a group, the STEM majors reported higher attitudes towards the treasure, tool and toy dimensions when compared to the students in non-STEM majors. This difference could be considered educationally meaningful particularly in how the STEM majors perceived the Internet more as a treasure of information when compared to the non-STEM majors. This finding could be explained based on Wu and Tsai’s study where the participants were STEM majors. These students reported using the Internet frequently, and were also very confident in using the Internet. They also perceived the Internet as very useful. However, Wu and Tsai did not compare the Internet perceptions of STEM majors with that of non-STEM majors. It is unclear if the preference of STEM majors towards the treasure dimension is mainly because of requirements of intensive research and information seeking in STEM subjects than the non-STEM subjects. Nevertheless, the findings were in agreement with Horrigan (2006) ‘s findings that people who used the Internet for science-related purposes mainly used it as an information source to check scientific claims and look for meaning of scientific terms. One plausible explanation was that the STEM content areas typically involved more
abstract concepts for which the Internet offered a readily available and convenient source of information. In addition to the treasure dimension, the STEM majors also reported higher perceptions of the toy and tool dimensions. The use of the Internet as a tool can be thought of as the Internet being the extended calculator for the STEM students. There are several online websites that offer calculation applets and resources to help the STEM majors with their science and mathematics assignments. In contrast, the STEM and non-STEM majors were very similar in how they perceived the communication and collaboration functions of the Internet. This finding is in contrast with Hargittai and Litt (2011) who found the STEM majors were less likely to use Twitter to socialize with others. Suggestions for future research on STEM perceptions are mentioned in a later section.

The Honors students reported higher attitudes towards the treasure and tool dimensions when compared to the students who were not enrolled in an Honors program. Previous research on technology use for gifted students has shown it to be an effective medium for enrichment opportunities and for individualizing instruction (Gadanidis et al., 2011; Gentry et al., 2007; Gentry, 2008, Liu, 2004). The gifted students surveyed by different studies were found to be very proficient in using technology, and also have reported liking online environments for their learning (Chan et al., 2010; Kahveci, 2010; Wallace, 2009). However, prior research has not revealed specific findings on their attitudes towards the different functions of Internet use, and how their Internet attitudes compared with other college students. In the current study, it was hypothesized that the gifted college students might perceive the Internet differently because they have unique strengths and needs (Rinn, 2005). The findings of the current
research showed that the gifted college students perceived the Internet more as a
treasure of information, and reported using the information for creative and interesting
activities. They also believed that the information from the Internet made a great
contribution to the society. One explanation could be that the gifted college students
were more skilled in using the Internet for information seeking than the other functions
of the Internet. As these students are considered to be more curious about acquiring
advanced knowledge and solving challenging problems (Olszewski-Kubilius, & Lee,
2004), they might have preferred to use the Internet more for information seeking.
Previous research has suggested that it would be incorrect to assume that the the social
and emotional development of gifted students might match the students’ intellectual
needs (Cross, 2004; Cross, 2005). This explained the current findings that no
differences were observed between the Honors students and other college students in
how they used the Internet for communication, fun, and collaboration. This reiterated
that the Honors students also need additional guidance and scaffolding in learning
effective use of the Internet.

The current research has also contributed to some detailed descriptive findings
about the students’ Internet attitudes. For example, the male students who were in a
STEM major and a non-Honors program reported the highest perceptions about using
the Internet for information purposes. Although this could be explained by the complex
nature of STEM content areas, it is unclear as to how enrollment in Honors or non-
Honors programs contributed to such differences in Internet attitudes. In contrast,
female students who were in a STEM and an Honors program reported the lowest
attitudes towards the telephone dimension. One explanation might be that the
challenging atmosphere in an Honors program, and the complex academic demands of STEM areas might leave them less time for online communication. Suggestions for future research are noted in a later section.

5.1.2 Major Findings on Undergraduates’ STEM Perceptions

What have we learned about the STEM perceptions of the undergraduate students?

Overall, the undergraduate students in the research study reported average attitudes towards STEM careers, and average expectations from doing well in science and mathematics. However, they reported high self-efficacy in science and mathematics areas. This was an important finding because prior research had often attributed one’s choice and interest in science and mathematics careers to his/her self-efficacy in these areas (Betz & Hackett, 1986; Lent et al., 2008a; Lent et al., 2008b; Ferry et al., 2000). The college students in this research reported more positive attitudes towards a non-STEM career than towards a STEM career. The students also felt that the non-STEM careers were neither easy nor difficult, whereas they perceived the STEM careers were very difficult and hard. Overall, the attitude levels reported by the undergraduates towards the STEM careers in this study were more similar to the attitudes of pre-service teachers and middle school students who were surveyed in Tyler-Wood et al.’s (2010) study.

Because people’s attitudes have a positive and moderate relationship to their behaviors (Kraus, 1995; Emmioglu, & Capa-Aydin, 2012; Weinberg, 1995), the findings of the current study suggested that as a group, the undergraduates students might tend to choose non-STEM careers more than STEM careers. The findings are also in agreement to previous studies (Kitts, 2009; Weisgram & Bigler, 2006) which argued that
even when students felt that can “do” science and mathematics, such perceptions did not necessarily translate into students pursuing STEM careers. Previous studies with undergraduate students have also indicated that the students reported high self-efficacy in science and mathematics areas (Byars-Winston & Fouad, 2008; Lent et al., 2008a; Lent et al., 2008b); therefore the findings on self-efficacy for the whole group of undergraduate students are consistent with earlier findings. Previous research had also shown that the college students’ outcome expectations in science and mathematics areas ranged from below average to high (Blanco, 2011; Byars-Winston & Fouad, 2008; Lent et al., 2008a; Lent et al., 2008b). The reason for such contrasting findings was that these studies surveyed either participants enrolled in a STEM or a non-STEM program. However, the current study included both the STEM and non-STEM majors in a single study, and the findings indicated that, overall, the students reported above average outcome expectations in science/mathematics areas.

Based on previous research about gender differences in STEM education and careers (Foaud et al., 2010; Kan & Akbas, 2006; Su et al., 2009), it was hypothesized that the male college students would report more positive attitudes towards STEM careers than female college students. The findings from the current research supported the research hypothesis that the male college students had more inclination towards STEM careers when compared to their female peers. Although such a difference was small, it could be considered educationally meaningful. In contrast, the female students reported more inclination towards non-STEM careers when compared to male students.
Table 5.2

Summary of Findings on STEM Career-related Perceptions

<table>
<thead>
<tr>
<th>STEM Career-related perceptions</th>
<th>Statistical Significance</th>
<th>Practical Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Science/Math Self-Efficacy</td>
<td>Science/Math Outcome Expectations</td>
</tr>
<tr>
<td>Overall perceptions</td>
<td>high</td>
<td>average</td>
</tr>
<tr>
<td>Gender differences (Male/Female)</td>
<td>yes</td>
<td>small (male)</td>
</tr>
<tr>
<td>Major-based differences (STEM/non-STEM)</td>
<td>yes</td>
<td>small (STEM)</td>
</tr>
<tr>
<td>Honors enrollment-based differences (Honors/non-Honors)</td>
<td>yes</td>
<td>small but educationally meaningful (Honors)</td>
</tr>
</tbody>
</table>

Note. The group that reported higher STEM-related perceptions is mentioned within the parenthesis.
These findings might be due to various personal and social factors. One explanation that is often cited in the literature is gender typing or that females perceived certain careers such as STEM careers to be male-stereotyped and non-STEM careers as female-stereotyped (Diekman et al., 2011; Malin et al., 2012; Miller et al., 2006; Park et al., 2011).

Only a small difference was observed in the science and mathematics self-efficacy between male and female college students. This finding contrasted earlier findings (Bonitz et al., 2010; Byars-Winston & Fouad, 2008), which have found gender to have a significant effect on one’s science/mathematics self-efficacy. One reason for the lack of gender differences in the current research could be that all the students in this research reported high science/mathematics self-efficacy irrespective of their gender or major. However, there might have been some intricate gender differences in the sources that influenced self-efficacy, such as experiencing success in science/mathematics, social persuasion, or vicarious experiences (Sawtelle et al., 2012; Brittner & Pajares, 2001). The third STEM perception examined in this study was one’s outcome expectations in science and mathematics areas. Although the male students expected more positive outcomes from science and mathematics areas, such differences were small. This finding is in agreement with Byars-Winston & Fouad’s (2008) study with undergraduate students. Overall the current study indicated that gender seemed to have an impact on students’ self-efficacy and outcome expectations in science and mathematics areas.

The STEM majors, as a group, reported higher attitudes and higher outcome expectations when compared to non-STEM majors. These findings on STEM
perceptions were consistent with earlier findings (Blanco, 2011; Byars-Winston, & Fouad, 2008; Gogolin & Schwartz, 1992; Lent et al., 2008a; Lent et al., 2008b). Although one would expect the STEM majors to have more positive attitudes and expectations, the differences noted in this study were very high, and reiterated the importance of paying attention to student’s attitudes towards prospective careers. Another finding worth noting is that there was only a small difference between STEM and non-STEM majors in their confidence in science and mathematics areas. As indicated by the high self-efficacy scores of all the undergraduate students in this study, all the students felt they could do well in science and mathematics with proper training. The same could not be suggested about their attitudes towards STEM careers.

Although, there was not much difference in how students in an Honors or a non-Honors program felt about STEM careers, the Honors students reported higher self-efficacy in science and mathematics areas. Such high self-efficacy of Honors students can be attributed to their high academic proficiency. It is interesting to note that even though the Honors students reported being more confident in their abilities to do well in science and mathematics, their attitudes towards STEM careers and the outcomes they expected out of STEM careers were similar to the non-Honors students. Self-efficacy was also reported as an important factor for influencing high achieving individuals’ choice of STEM careers in Heilbronner’s (2013) study. Future studies can compare the self-efficacy in both STEM and non-STEM areas to clarify if these students also reported higher self-efficacy in non-STEM areas as found in earlier studies at the K-12 level (Olszewski-Kubilius & Turner, 2002).
Previous research findings on outcome expectations have shown mixed results. One argument was that gifted students might have more outcome expectations as they might expect a perfect career matching their abilities and interests (Rysiew, et al., 1999). Another argument was that because they strive for perfection, they might not perceive STEM careers ideal to help them balance both work and personal responsibilities (Reis, 1998). The findings from the current study agree with the latter argument as seen in the lack of difference in science and mathematics career attitudes and outcome expectations between Honors and non-Honors college students. Multi-potentiality, or having talents in both STEM and non-STEM areas could also have contributed to this lack of difference in outcome expectations and attitudes towards STEM careers.

When the students were classified into different clusters based on their gender, major and enrollment in an Honors program, several interesting findings emerged. Did male and female students in STEM majors differ in their STEM perceptions from the male and female students in a non-STEM major? The answer to this question from the study was that, both male and female students in STEM majors reported higher attitudes than their peers in non-STEM majors. However, when asked about the outcomes they expected from doing well in science and mathematics, the female STEM majors reported the highest outcome expectations while female non-STEM majors reported the lowest outcome expectations. The female non-STEM majors also perceived the STEM areas more complex than the other undergraduate students. Being enrolled in an Honors program seemed to have an influence on the female students' STEM perceptions. The female students who were both in a STEM major and
an Honors program reported the highest attitudes, outcome expectations and self-efficacy in science and mathematics. These female students reported more positive STEM perceptions than even the males in STEM and/or Honors programs.

5.1.3 Major Findings on Role of the Internet in STEM Perceptions

Is there a relationship between students’ Internet and STEM career-related perceptions?

The third objective of the research tried to understand the relationship between undergraduate students’ Internet attitudes and their STEM career-related perceptions. The findings from this research indicated that there was a small relationship between undergraduate students’ Internet attitudes and their STEM career-related perceptions. Although not a large relationship, this magnitude of relationship is still important among numerous factors including personal, background, and contextual factors that influence one’s career-related perceptions including perceptions related to a STEM career.

Further, students who perceived the Internet more as a treasure of information and as a toy also reported higher expectations about outcomes from doing well in science and mathematics. To understand these findings, the open-ended responses were consulted. When asked about factors influencing their general career interests and choices, the students attributed their career choices primarily to their own interests, attitudes, self-efficacy, and outcomes they expected from their careers. The students perceived the school-related factors as the second most influential factor. These school-related factors included their experiences in college such as being involved in research, and extracurricular activities, the courses they enrolled in, their professors, and their high school teachers. The third factor that the students attributed their general career
interests to was the society – the people they met every day, the economy, mentors and part time jobs outside the university. And the fourth influencing factor was their parents.

These findings suggested two explanations. In the overall scheme of career choices, the traditional factors such as personal, school, society and family were still perceived as the most important direct influences. Therefore, technology or specifically the Internet did not seem to directly influence undergraduate students’ general career choices and interests. The open-ended responses also showed that many students felt that the Internet played a huge role in their general career choices and interests. Students perceived that everything is digital now and the Internet had a widespread impact on several aspects of their lives. There were many students who also felt that the Internet did not play any role in their career choices and interests. A few responses even indicated that the Internet played a negative role as it caused distraction, made them dumb, and sometimes hyped the prospects of a future career. Such mixed responses explained that although the students recognized that the Internet had some role in their career-related perceptions, they still perceived the traditional factors as having more direct impact on their career choices. When asked about the role of the Internet on students’ general career interests, the undergraduate students perceived the Internet more as a tool to help them with researching careers, and making decisions on future careers. They also perceived the Internet as a tool kit to search and apply for jobs, and take career assessments. The Internet was also perceived by many students as a database of enormous information. Many students in this study also pointed how many companies and people have created an online presence enabling the students to connect with prospective employers and collaborate online. The male students
perceived the Internet mainly as a treasure of information, whereas the female students perceived it mainly as a tool to search, apply for jobs and take career assessments.

The next clarification sought was to examine how much of an influence the Internet had on students’ career choices and interests in STEM careers. An interesting finding was that influence of personal factors on STEM career choices and interests were four times higher than that of external factors. This aligned with the social and cognitive career theory model where the external and contextual factors influence one’s self-efficacy, and outcome expectations which in-turn influenced one’s career interest and subsequent choice (Lent et al., 1994; Lent et al., 2008a). Based on the current research and previous studies, a difference could be identified between the factors influencing the STEM perceptions of younger students and college-aged students. Younger students perceived parents, teachers or peers as the most influential factors (Byars-Winston & Fouad, 2008; Fouad et al., 2010; Robnett & Leaper, 2012) whereas the college students perceived themselves as more influential on their career choices and interests.

The specific findings about the role of the Internet on undergraduate students’ general and STEM career-related perceptions are summarized as follows.

1. Overall, the undergraduate students perceived the Internet as a tool and a treasure of information to help with their career choices and interests.

2. Further, the Internet seemed to have an indirect influence on the students’ STEM career-related perceptions through their personal factors (attitudes, self-efficacy, and outcome expectations).
3. Students who perceived the Internet more as a fun and interesting medium, and as an information source reported higher expectations about the outcomes of doing well in science and mathematics careers.

4. Many students indicated that the Internet helped them access information about careers and subject-related matters. The students perceived the Internet as a treasure of extensive information, and also as an information source that helped them be updated about new information. The convenience and being readily available when they needed information about their subject made the Internet an effective medium for information seeking. As indicated by the findings, the information in the Internet was more related to outcome expectations of a STEM career. When students learned about the salaries, demand for such careers, skills needed for a science or mathematics career, the lifestyle that comes with a STEM career, such information could have influenced their outcome expectations.

5. The other prominent dimension that had an influence on undergraduate students’ science/mathematics outcome expectations is their perception of the Internet as a fun and interesting medium. The students’ responses indicated that the online videos sparked their interests in a career. Students also recognized how the advertisements that show up on the Internet targeted their career interests. One explanation was that when students played online games, or viewed simulations of abstract concepts in science and mathematics, the Internet made their career-related ideas more interesting and fun. For some students, their hobbies on the Internet also motivated them to pursue careers in science and mathematics.
6. Although the tool and treasure were the predominant dimension having a role in
general career-related perceptions, only the treasure dimension was considered
to have an influence on STEM career-related perceptions mainly on outcome
expectations. The tool dimension was not reported as having an impact or
relation to STEM career-related perceptions. In addition, perceptions of the
Internet as a fun and interesting medium seemed to have an impact on how
students perceive science and mathematics areas.

7. Although there were no significant gender differences in how students perceived
the Internet for their personal activities, the female students reported using the
Internet more as a tool for their career choices and interests (both STEM and
non-STEM careers), whereas the male students used the Internet more as a
treasure for their careers. Differences were also noted for STEM and non-STEM
majors because STEM majors used the Internet more as treasure for their
personal uses as well as career-related uses. Whereas, the non-STEM majors
reported using the Internet more as a territory when compared to STEM majors
for their personal uses. These findings raise several questions. Suggestions for
future research in noted in a later section.

5.2 Directions for Future Research

5.2.1 Future Studies on Internet Use and Attitudes

The study has tested the 5-T model of Internet use with a U.S. college student
population, and discussed the findings in comparison with the previous research
findings with Asian students. Chen et al. (2011) recently suggested a 6-T model
including a new dimension called Trade signifying the increasing ecommerce on the
Internet. In the current study, the open-ended responses on the role of the Internet in career choices and interests indicated another dimension called teacher. It will be interesting to see if these two additional dimensions are perceived differently by students for their personal, social, and academic activities. The findings from the current study were not conclusive about the causal nature of the relation between a student’s major and his/her Internet perceptions. Nevertheless, the findings warrant future replication studies to identify if the major program influenced the motives of Internet use or if a user’s Internet psychology could provide motivation for one’s career inclination. Gender differences are always a topic of great interest in empirical research. This study indicated no gender differences among college students in their Internet attitudes across different dimensions.

Future studies can extend the current findings on Internet attitudes by taking into account the frequency, intensity and proficiency of Internet use. Further examination is needed on how personality and social-cognitive factors influence the students’ attitudes towards the different functions of the Internet. Such examination can help in understanding the Internet behaviors of today’s youngsters better. For instance, one area of study would be to examine how different typology of users either based on their nature of use (producers, consumers, pro-sumers) as suggested by Shao (2009) or based on their intensity of use (omnivores, dabblers, samplers and devotees) as suggested by Hargittai and Hsieh (2010) perceive these five dimensions of Internet use. Future studies can also combine the Uses and Gratification theory and the T-frameworks to examine the motives and gratifications for these Internet functions. Understanding how special populations of college students perceive the Internet will be
another area to extend the current findings. Future studies can also employ social network analysis to emulate how students use the various functions of the Internet and even predict their behaviors (Uddin & Jacobson, 2013).

5.2.2 Future Studies on STEM Career-related perceptions

By examining the three STEM related constructs namely science and mathematics self-efficacy, science and mathematics outcome expectations and attitudes towards a STEM career, the current study had revealed several interesting findings. The choice of a STEM career was not just dependent on achievement or confidence, because students’ attitudes and outcome expectations about careers in science and mathematics seemed to have an important influence on their career-related perceptions. A regression study with students’ STEM perceptions as predictors and the students’ career choice as a dependent variable can extend the current findings. Such a regression can also explain a causal relationship between students’ perceptions and the students’ actual behaviors of choosing a STEM career. The construct of science/mathematics self-efficacy was not significantly different between male vs. female students or between STEM vs. non-STEM majors. However, this study found a very large difference in attitudes towards a STEM career between STEM majors and non-STEM majors. Kitts (2009) noted that the attitudes towards science and mathematics might not necessarily translate into attitudes towards a STEM career. Therefore, further research can test the relationship between students’ attitudes towards the science/mathematics content areas and the attitudes towards a career in STEM.

5.2.3 Future Studies on the Role of External Factors on STEM Perceptions
In trying to explain the role of the Internet in undergraduate students’ STEM education and careers, this research has raised several questions for future studies to answer. The STEM majors in this study have reported using the Internet more as a treasure than the students in non-STEM majors for both general as well as career-related perceptions. Further, the study has also shown a small correlation between students’ perceptions of Internet as a treasure and student’s science and mathematics outcome expectations. The current study stops at establishing a relationship between these two areas. Future studies can extend these findings by testing a structural model to examine if being in a STEM major influences one to use the Internet as a treasure or if students who use the Internet mainly as a treasure tend to prefer STEM careers.

Using a quantitative structural modeling approach, future studies can examine how the Internet compares with the other external factors, and cross-validate the qualitative findings from this study. One suggestion would be to include an additional factor for the influence of the Internet in the career influence inventory. This instrument measures perceived social support from parents, peers, friends, teachers and the social environment (Rogers et al., 2008). By adding an additional factor for examining the role of the Internet, the comparative influence of the Internet as a contextual support can be determined. Future research can also adapt Fouad et al. (2010)’s measure of environmental supports and barriers to include the role of the Internet as a contextual support or barrier.

5.2.4 Future Studies on Honors College Students.

Empirical research on gifted college students including Honors college students is still emerging. There are very few research articles on technology use by gifted
college students. This research will be a good contribution to research in this area. Replication studies to confirm the findings of the current study with the gifted student population will be helpful in examining the role of the Internet in their overall development. Although research during the 1980s indicated that the gifted college students form a homogenous group, researchers have pointed out how later research findings showed that all the gifted students cannot be treated as a single group (Reis & Sullivan, 2008; Rinn, 2005). Future studies can extend the current findings and explore about Internet attitudes of special populations of gifted college students such as gifted rural students and twice exceptional students. There were several descriptive findings regarding the gifted college students that, although not conclusive, warrant future research to examine individual motives to use the Internet. The students in an Honors program also reported higher self-efficacy in science and mathematics. Future studies can examine if there are intricate differences in the sources of self-efficacy and outcome expectations such as mastery experiences, social persuasion and physiological arousal as suggested by Bandura (1994) as a result of participating in an Honors program.

5.3 Recommendations for Practice

The crux of this research started with a simple idea. Are our students just consumers of technology or do their interests in technology translate into positive perceptions about STEM majors and careers? Based on the findings from this research, two practical implications are noted. First, just because a student is capable, or confident in performing well in STEM areas, a student would not necessarily pursue a career in STEM. Educational institutions and educators should also pay attention to their students’ attitudes towards STEM careers and the outcomes or values that the
students expect from STEM careers. Such efforts should not stop at the K-12 education. Even at the college level, students might reconsider their decisions to remain in a STEM major and might get dropped out of the STEM workforce pipeline. Designing a curriculum that enables students to relate the abstract concepts to real-world problems has been strongly advocated for many decades now. Such a curriculum development in higher education should not solely focus on improving GPAs or learning of scientific concepts, but also consider improving students' perceptions about the science and mathematics content areas and careers.

The Internet offers numerous opportunities to create rich learning experiences for our students. However, merely providing access to the Internet and teaching courses or tutorials on technical skills limits our students' abilities to use the Internet effectively for their academic, personal, social and career development. Kenny and Gunter (2011) noted that without proper instructional design and scaffolding, students might end up just having fun and entertainment, and might not translate the experiences to their academic and career development. This research placed importance on the functional Internet literacy where students learn how to effectively communicate, collaborate, seek information and create new ideas. One finding from this research showed that when students recognize the importance of the information on the Internet, they expected more positive outcomes from science and math areas. Therefore, career counselors can model effective use of the Internet for searching and evaluating information to improve awareness about future careers. Educators should recognize that without proper guidance and scaffolding, students might end up viewing the Internet just as an entertainment medium or a helper for their daily activities.
5.4 Conclusion

Today's college students are generally considered adept in using the Internet. Such opinions are often reinforced by terms such as “digital natives” (Prensky, 2001), “the Millennial”, “the Net Generation” (Tapscott, 1998), “the Generation Y” used to refer these students. However, researchers have cautioned against such hype (Hargittai & Litt, 2011) and reiterated that it is incorrect to assume that all students have the necessary digital skills in various facets of their development. As seen in the current research, students belonged to two camps: those who perceived that the Internet played a huge role in their career choices and interests, and those who thought that the Internet did not play any role in their career choices. Does this indicate a digital divide in attitudes towards the Internet even among young students who are generally considered tech-savvy and proficient in using the new and emerging technologies? This study investigated how these students who have grown up with technology perceived the Internet for their (a) personal purposes, and (b) career choices and interests including STEM careers. The findings indicated that certain functions of the Internet were perceived more for different purposes. In their daily lives, the students perceived the Internet as a toy and a tool. For general career related activities, they perceived the Internet as a treasure and a tool. For STEM careers in particular, they perceived the treasure and toy dimensions more. The findings from the current study did not find support for “effective” use of the creation, collaboration and networking features of the Internet. This is an indication of the need for Internet literacy at the higher education level to emphasize on best practices geared towards students’ academic, and career development.
As more excitement develops around the “The Next big thing: the Internet of things”, where devices around us become smart and are all connected to each other (Feki, Kawsar & Boussard, 2013), it is equally important to consider how we prepare our students to effectively use the technology around us. With positive attitudes and better understanding of science, math and technology, our students will be better prepared for the 21st century.
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