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Relationship Between Attending STEM Extracurricular Programs and Aspiration Toward STEM Careers

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Abstract

Relationship Between Attending STEM Extracurricular Programs and Aspiration Toward STEM Careers

by

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MSc, University of Jordan, 2004

BS, University of Jordan, 2001

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Enhancing students' aspiration toward STEM-related careers is of a great importance for many communities that seeks the transformation to the knowledge-based economy. The problem this study explored was the literature gap in the relationship between Qatar students' attendance in STEM-related extracurricular programs and their aspiration to pursue STEM-related specializations and careers. The purpose of this quantitative, pre-experimental study was to investigate the relationship between attending STEM extracurricular programs and change in students' aspiration toward STEM careers. Additionally, the study aimed to investigate if the change in students' aspiration depends on students' gender and age group. Social cognitive career theory framed three research questions that examined 254 Qatari student aspirations toward STEM-related specializations and careers before and after attending STEM extracurricular programs in 36 schools. Students aspiration toward STEM careers was measured by the STEM Career Interest Survey (STEM-CIS). Repeated-measure ANOVAs were used to examine differences in students' overall aspirations, males and female aspirations, and middle versus high school aspirations. Findings indicated that attending a 4-week STEM-related extracurricular program elicited a significant increase in students' aspiration towards STEM-related careers and specializations. However, the change in students' aspiration was not dependent on gender or age group. Findings may drive positive social change in Qatar STEM education by informing educators and policymakers regarding the benefits of STEM-related extracurricular programs in encouraging students to enroll in STEM-related degrees and pursue STEM careers.

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Dedication

I would like to dedicate this dissertation to my beloved family and specially my late mother who believed in me and nursed me with all the love and support.

Acknowledgments

I would like to acknowledge all the school principals, teachers and students who helped me to collect the data and complete this dissertation. Additionally, I would like to thank my committee members, Dr. Debra C. Tyrrell and Dr. Tianyi Zhang Ulyshen who provided patient advice and guidance throughout the research process. And finally to my wife and my son for the immense support throughout the journey. Thank you all for your unwavering support.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction to the Study

Arabian students in the Arabian Peninsula consistently show low attitude toward science and mathematics as well as low performance in the Trends in International Mathematics and Science Study (TIMSS) and the Program for International Student Assessment (PISA) (Said, Summers, Abd-El-Khalick, & Wang, 2016; Sellami, El-Kassem, Al-Qassass, & Al-Rakeb, 2017). The low interest and the weak performance in STEM subjects may lead to lower interest in postsecondary education in these fields and to pursuing a STEM career. Arabian Gulf countries such as United Arab Emirates and Qatar ranked between 47 and 56 in mathematics and in science among globally competitive nations (Gurria, 2016). To gain a top-tier position in technology and compete in the global economy, there must be an increase in participation by boys and girls in STEM-related postsecondary majors and careers (Munce & Fraser, 2012).

The current study aimed to investigate the relationship between attending STEM-related extracurricular activities and students' aspirations toward joining STEM-related majors and careers. Additionally, the study aimed to find if aspirations toward STEM-related majors and careers is affected by gender (boys and girls), and age group (middle vs. high school). Findings from this study may serve as a catalyst for conversation among educators, educational policy makers leaders, and parents regarding the importance and the future of STEM extracurricular programs. This chapter includes the background, problem statement, purpose statement, research question and hypotheses, theoretical framework, nature of the study, definitions, assumptions, scope and delimitations, limitations, and significance of the study.

Background

To promote the global competitive abilities of graduates in the Arabian Gulf area, student interest in STEM careers at the secondary and postsecondary education levels must be increased (Dickson, Fidalgo, & Cairns, 2019; Sellami et al., 2017). Much concern surrounds the growth in STEM careers and the need for professionals in the industry (Atkinson & Mayo, 2010; Stout, Dasgupta, Hunsinger, & McManus, 2011; Tseng, Chang, Lou, & Wen-Ping Chen, 2013). Economic transformations in the Arabian Gulf countries pose a need for more specialists in the fields of STEM which in turn will require more and more graduates with STEM-related degrees especially in fields of engineering and technology (Almoli, 2018).

The strongest influences in students' decisions to enter STEM-related careers occur before they enter college (Nugent et al., 2015; Regan & DeWitt, 2015). Researchers keen to investigate the contextual factors and training programs that influence students' aspiration to engage in a STEM-related profession and sustain it. (Uğraş, 2018; Van Tuijl & van der Molen, 2016). Researchers reported that students who attended STEM programs showed higher levels of self-efficacy in the different STEM disciplines, especially mathematics and science. These researchers also reported that students with high self-efficacy in mathematics and science tend to have significantly higher interest to enroll in STEM-related specialization at the university or choose a career in STEM fields (Sithole et al., 2017; Van Aalderen-Smeets, & Walma van der Molen, 2016). Similarly, Blotnicky, Franz-Odendaal, French, and Joy (2018), Christensen and Knezek (2016), and Van Aalderen-Smeets, Walma van der Molen, and

Xenidou-Dervou (2019) suggested that students' interest in science and mathematics at middle school and their participation in STEM out-of-school programs, play a key role in their university career interest in STEM. Educators and STEM professionals have created partnerships to address the need for increased interest by implementing STEM programs for high school students.

Engaging students prior to college will provide more long-term, positive performance in the field (Findley-Van Nostrand & Pollenz, 2017; Florence, Bajaj, & Chiu, 2018). One method of attracting students to STEM careers is the use of STEM extracurricular programs. STEM-related extracurricular programs have been an option to schoolchildren and their parents since the early 1900s (Charmaraman & Hall, 2011). Research has indicated that these programs keep students engaged in positive social behavior that increases their likelihood of academic completion (Guèvremont, Findlay, & Kohen, 2014; Qaiser, 2017).

STEM-related programs provide a platform that is uniquely constructed to deepen learning by applying learning concepts through enrichment activities (Marten, Hill, & Lawrence, 2014). Stringer, Mace, Clark, and Donahue (2019) argued that STEM extracurricular programs including afterschool clubs and science fair competitions increased postsecondary students' matriculation in STEM majors. STEM programs have ushered in a new era for the way young people are affected by STEM by providing hands-on experiences that link academia with STEM activities (Ekmekci, Sahin, & Waxman, 2019). Many programs have helped participants interpret and connect abstract mathematics and science concepts, providing a more holistic development of

participants (Ekmekci et al., 2019). The informal learning in STEM programs can be leveraged to promote learning in support of technology and engineering skills that allow graduates to take leading roles in the growing knowledge-based economy (Allen, & Peterman, 2019; Hakovirta, & Lucia, 2019).

Graduation statistics show that only half of students who enroll in STEM majors complete a degree in a STEM field (Wilson et al., 2012). Students are not graduating with STEM careers at a time when these professionals are in high demand. Students who enter postsecondary education to major in STEM fields are increasingly switching to majors in fields not related to STEM (Chen & Ho, 2012). Hardin and Longhurst (2015) found that undergraduate female students had less self-efficacy regarding their ability to succeed in STEM classes and lower interest in pursuing a STEM degree compared to their male classmates. Hardin and Longhurst reported that girls showed lower levels of self-efficacy compared to boys at the beginning of postsecondary STEM programs at universities and career fields. Therefore, Hardin and Longhurst suggested that schools should implement intervention programs during the middle and high schools to enhance girls' self-efficacy in STEM to reduce the gender gap.

In Qatar, little information is available about the impact of attending STEM schools or STEM programs on the development of interest in STEM careers and specializations (Almoli, 2018). In this study, I investigated if attending STEM-related extracurricular programs would affect students' aspiration toward STEM careers in Qatar, and if the change in aspiration is affected by students' gender (boys and girls) and/or grade level (middle and high school).

Problem Statement

STEM is the acronym for Science, Technology, Engineering, and Mathematics, and encompasses a vast array of subjects that fall under each of those terms (Williams, 2011). STEM education provides one of the best careers options for today's children and helps them to make wise decisions about emerging problems (Wang, 2013; Xie, Fang & Shauman, 2015). According to Basham and Marino (2013), researchers and educators commended STEM education for its role in fostering 21st-century skills such as critical thinking skills, problem-solving skills, and creativity among students. In the current and future world, there is a significant demand for STEM-literate workers, who can use problem-solving strategies to lead innovation, increase productivity, and compete effectively in a growing global economy (Langdon, McKittrick, Beede, Khan, & Doms, 2011).

According to the Secretariat for Development Planning GSDP (2016), Qatar has experienced a downward trend in the numbers of Qatari students enrolling in tertiary education in general and more specifically, in STEM-related careers such as science and engineering. Additionally, Said, Summers, Abd-El-Khalick, and Wang (2016) studied students' attitude toward science in the public schools in Qatar and found that Qatari students showed negative attitudes toward science subjects compared to non-Qatari students in the public schools in Qatar. Moreover, the effectiveness of STEM-related projects on students' learning, achievement, and motivation and career paths was investigated only once in Qatar by Abdulwahed, Ghani, Hasna, and Hamouda (2013). Also, Abdulwahed and colleagues' study included only 48 male Qatari students from

high schools, who participated in a customized engineering-based project. Their study did not include the students' aspiration toward STEM-related specializations and careers. However, Abdulwahed et al. (2013) emphasized that studying student' aspiration toward STEM-related specializations and careers is important to evaluate the feasibility of increasing STEM-related outreach programs for K-12 students in Qatar. Therefore, there is a research gap to explore the relationship between Qatar students' attendance in STEM-related extracurricular programs and their aspiration to pursue STEM-related specializations and careers in the fields of engineering, mathematics, science, and technologies.

On the other hand, the Management Association (2015), Christensen and Knezek, (2016) and Blickenstaff (2005) stated that girls are notably underrepresented in STEM-related careers. These studies reveal that girl and boy students, when having the opportunity to participate in the STEM-related extracurricular programs, may react differently to the program. Therefore, this study tested gender the difference in Qatar students' aspiration scores measured before and after participating STEM-related extracurricular programs.

Said et al. (2016) carried a cross-sectional study about the attitudes toward science among grades 3 through 12 Arab students in Qatar and found that students' attitudes toward science decrease with age. These results are consistent with the findings of Doerschuk et al. (2016) and Bergeron and Gordon (2015) who stated that learners' interest in STEM-related careers declines over time. Therefore, this study explored if students from two different age groups (middle school vs. high school) reacted differently

to the STEM-related extracurricular programs when measuring their pre- and post-aspiration scores.

Purpose of the Study

This Quantitative study aimed to investigate the change in students' aspiration toward STEM-related specializations and careers before and after attending STEM-related extracurricular programs. The study also aimed to investigate if changes in students' aspiration could depend on (a) students' gender (males or females) or (b) students' age group (middle school or high school).

Research Question and Hypotheses

This study addressed the relationship between attending STEM-related extracurricular programs and development of aspirations toward STEM careers among boys and girls enrolled in governmental middle and high schools in Qatar. The following research question (RQ) and hypotheses are used to guide the study:

Research Question 1: Is there any significant difference in students' aspiration toward STEM-related specializations and careers among Qatari students before and after attending STEM-related extracurricular programs?

$H_0$1: There is no significant difference in students' aspiration toward STEM-related specializations and careers among Qatari students before and after attending STEM-related extracurricular programs.

$H_1$1: There is a significant difference in aspiration toward STEM-related specializations and careers among Qatari students before and after attending STEM-related extracurricular programs.

Research Question 2: Is there any significant difference between boy and girl students regarding the changes of their aspiration toward STEM-related specializations and careers measured before and after they attend STEM-related extracurricular programs?

$H_0$2: There is no significant difference between boy and girl students regarding the change of their aspiration toward STEM-related specializations and careers measured before and after they attend STEM-related extracurricular programs.

$H_1$2: There is a significant difference between boy and girl students regarding the change of their aspiration toward STEM-related specializations and careers measured before and after they attend STEM-related extracurricular programs.

Research Question 3: Is there any significant difference between middle school students and high school students regarding the changes of their aspiration toward STEM-related specializations and careers measured before and after they attend STEM-related extracurricular programs?

$H_0$3: There is no significant difference between middle school students and high school students regarding the change of their aspiration toward STEM-related specializations and careers measured before and after they attend STEM-related extracurricular programs.

$H_0$3: There is a significant difference between middle school students and high school students regarding the change of their aspiration toward STEM-related specializations and careers measured before and after they attend STEM-related extracurricular programs.

Theoretical Framework

The current quantitative study used the social cognitive career theory (SCCT) as a theoretical framework. SCCT's interest and choice models comprise a variety of constructs such as vocational self-efficacy, outcome expectations, career interests, and goals, as well as contextual factors that influence an individual's career choices. More specifically, SCCT proposes that individual and contextual factors influence that person's self-efficacy belief and outcome expectations, which in turn influence his or her career interests, goals, and decision-making (Lent, Brown, & Hackett 1994). Empirical studies have shown that STEM-related activities and school experience are predictive of STEM career choices among different age groups and genders (Miller, Sonnert, & Sadler, 2017; Nugent et al., 2015). Additionally, an empirical study carried out by Mau, Chen, and Lin (2019) found that the development of STEM career interest significantly depends on contextual factors, outcomes expectations, personal inputs, and self-efficacy which are parallel to SCCT constructs. Li et al. explained that personal factors (e.g., gender & age group), and contextual variables (e.g., school experience & support) are particularly the key factors that contribute to the development of interest in STEM careers.

STEM majors have been popular fields of study for incoming freshmen (Chen, 2013). However, more than 38% of enrollees do not complete STEM undergraduate degrees (Chen, 2013). According to Hardin and Longhurst (2015), lack of interest in STEM is indirectly associated with the learning environment. The SCCT explains contractual factors that affect students' ability to succeed in STEM subjects, which decreases interest in the subjects (Hardin & Longhurst, 2015). The SCCT model

contains factors related to interest in these careers that are directly associated with individuals' self-efficacy or confidence in their ability to complete the relevant STEM tasks (Hardin & Longhurst, 2015). Lent et al. (1994) defined SCCT as the interplay between the person, environment, and behavioral variables that directly affect career interest, choices, and performance.

Hardin and Longhurst (2015) examined students' interest and persistence in scientific degree programs. Their research highlighted the importance of the self-efficacy model. Self-efficacy is an important factor that keeps students pursuing STEM tracks of education (Hardin & Longhurst, 2015). Conducting the current study using the lens of SCCT and using boys and girls attending middle and high schools allowed stakeholders to understand the trajectories and to pinpoint critical periods for STEM exposure in an effort to increase interest.

Nature of the Study

The study explored students 'aspiration change toward STEM-related specializations and careers among Qatari students before and after attending STEM-related extracurricular programs. Additionally, the study explored if the change in students' aspiration toward STEM-related specializations and careers depended on students' gender or their age group. In this research project I utilized the pre-experimental quantitative research approach that employed repeated-measures ANOVA with two between-subjects factors (i.e., gender and age group) and one within-subjects factor (pre- and post-aspiration scores). Pre-experimental designs lack the control group and/or have comparison groups that are formed nonrandomly (Dawson, 1997). One major type of pre-

experimental design is the one-group pretest-posttest design. In this design, a single group is investigated at two time points, one before the treatment and one after the treatment. Changes in the outcome of interest are presumed to be the result of the treatment (Dawson, 1997; Marsden & Torgerson, 2012). In this study, I investigated aspiration toward STEM careers and specializations among students who are nonrandomly enrolled in STEM-related extracurricular programs. Hence, the pretest posttest pre-experimental research design was the most appropriate strategy to investigate the relationship between attending STEM-extracurricular programs and students' aspiration toward STEM careers and specializations.

Definitions

A number of terms and acronyms were important to this study:

STEM: The term refers to science technology, engineering, and mathematics fields of study that could represent either an academic setting or employment/career setting (Krishnamurthi, Ballard, & Noam, 2014; Munce & Fraser, 2012).

STEM-related extracurricular programs: These programs are offered as extracurricular programs wither outside of the traditional school day or during the school day. These programs take the form of clubs or outreach programs and typically, they are student centered and provide cooperative learning strategies that foster learning through structured activities. The STEM-related extracurricular programs vary in length, but they are usually 4 to 6 weeks long.

STEM-related careers and majors: There are many definitions for STEM-related majors and STEM-related careers. However, this study adopted the definition provided

by (Deming & Noray, 2018) who defined STEM majors and STEM careers as all careers and majors directly related to science, technology, engineering and mathematics. Deming and Noray further classified STEM majors into two groups: "applied" science, which include computer science, engineering and engineering technologies, and "pure" science, which includes biology, chemistry, physics, environmental science, mathematics and statistics.

Aspirations toward STEM-related specializations and careers: in general, career aspiration is described as the strong commitment or orientation toward a particular career path (Kim, O'Brien, & Kim, 2015). Additionally, career aspiration is described as the extent to which people aspire to take a lead role and continue their education in a given career (Cozart & Rojewski, 2015). Therefore, aspiration toward STEM specializations and careers in this study can be operationally defined as the strong desire for high achievement within a STEM specialization or a STEM career field (Kitchen, Sonnert, & Sadler, 2018; Mau & Li, 2018).

Assumptions

Two assumptions were assumed for this study. Students provided anonymous, self-reported information about their aspiration using the STEM career survey (STEM-CIS) inventory, therefore, my first assumption is that students provided honest responses to the pretest and the posttest when they completed the study's questionnaire.

STEM education in its nature, is a framework of practices that utilize inquiry and project-based learning to foster the twenty-first century skills such as communication, collaboration, problem solving, design thinking, and innovation (English, 2016;

Katzenmeyer & Lawrenz, 2006; Zeidler, 2014). In governmental schools in Qatar, students attend many types of project-based, STEM-related programs that are delivered by different facilitators and have different content knowledge. Therefore, in the second assumption, I assumed that the facilitators and mentors of the various STEM-related extracurricular programs provided students with similar experiences due to the fact that regardless of the subject matter focus, STEM-related programs provide students with a similar range of experiences and skills such as problem solving, design thinking, collaboration and teamwork, communication and innovation (English, 2016; Katzenmeyer & Lawrenz, 2006; Zeidler, 2014).

Scope and Delimitations

The current study was delimited to Qatari boys and girls enrolled in middle and high governmental schools and at the same time are enrolled in STEM-related extracurricular programs. The in STEM-related extracurricular programs are held during the normal school hours or out of the school hours and take the form of clubs or outreach programs. Students formally enrolled in curricular STEM classes at their school and receive a grade for their courses were not included in the study. These students are members of a different population and were not the focus of the study.

This study was limited to the STEM-extracurricular programs that take the form of school STEM-related clubs and universities' or companies' STEM-related outreach programs. In the governmental schools in Qatar, the STEM-related extracurricular clubs and outreach programs are transdisciplinary, project-based programs that use the engineering design approach, technology tools, and science and mathematics principals

to solve real life problems. The investigated programs in which students are enrolled did not include any biomedical program.

This study included students attending various types of STEM-related extracurricular program. These STEM programs focus on fostering students' skills in design thinking, problem solving, and innovation regardless their content focus. Hence, information about the quality of STEM-related programs provided to the students in the study were not be collected because this information is out of the study scope. In the governmental schools in Qatar, students receive a uniform, standard-based curriculum. Therefore, information about the students' normal school curriculum, their participation in that curriculum, and their grades received from participation in that curriculum were not collected; because this set of information is not within the scope of the current study. Finally, the amount of involvement of the students' parents or guardians in their children's STEM activities have not been considered, since the parental effect was not measured in the study.

Limitations

This research was limited by using pre-experimental research methodology with a single group pretest-posttest design. The participants for the study were given a pretest and a posttest assessment to record their aspiration toward STEM-related specializations and careers based on participation in STEM-related extracurricular programs. This posed some concerns based on the lack of a control group with the students who do not participate in the STEM-related programs. Data collected from a control group would provide another level of data for analysis and comparison purposes (Sloane-Seale, 2009).

This study is limited to Qatari students in governmental schools in Qatar attending STEM-extracurricular programs. Therefore, results cannot be generalized to students attending different types of schools such as a private or international schools, and to students who attend STEM-focused schools. Moreover, students self-reported on their aspiration, therefore, participants may have answered the STEM-CIS questions according to what they felt the correct response should be, or they might responded by marking the most neutral answer (Coughlan, Cronin, & Ryan, 2009). Thus, the data will be valid only if the participants were completely honest.

Significance

Preparing students for careers in STEM is at the forefront of educational reform movements in the Arabian Gulf region (Said, 2016; Sellami & Kimmel et al., 2017; Al-Maadheed, 2017). All Arabian Gulf countries, including Qatar, are investing in education to build their indigenous STEM-literate human capital. Building the graduates' capacities in STEM disciplines is particularly important for Qatar, which plans to shift its economy from the dependency on oil and gas to the knowledge-based economy (Almoli, 2018; Nite & Aggie; 2017; Pasha-Zaidi & Afari, 2015). To fulfil such goals, there must be an increase in participation by both men and women in STEM-related postsecondary specializations and careers. Considering the tremendous increase in common use for technology, subject matter experts in technology are needed to combat the imbalance and decline of science and technology workforce professionals.

This study was designed to help understand if attending STEM-related extracurricular programs would affect students' aspirations toward STEM majors and

careers, and may help educators understand how to increase the successful enrolment in STEM-related specializations in the postsecondary education institutes (Sahin, 2013; Wladis, Hachey, & Conway, 2015). Conclusions drawn from this study may provide useful information to educators, parents, and educational policymakers and serve as a catalyst for conversations on STEM curricular and extracurricular programs.

Summary

Much concern surrounds the growth in STEM careers and the need for an increase in the number of professionals in the industry. Therefore, researchers are keen to investigate the impact of students' involvement in STEM program and their ability to develop and sustain interest in STEM professions. Because the strongest influences in individuals' decisions to enter STEM-based professions occur before they enter college, educators, technology professionals, and community organizers have created partnerships to address the need for increased interest in STEM majors by implementing STEM programs for high school students. Students involved in high school STEM programs show more positive STEM-related interests and attitudes than other students enrolled in science and mathematics classes in the same schools.

Only half of students who enroll in postsecondary STEM majors complete a degree in a STEM field (Wilson et al., 2012). In many instances, undergraduate women, in comparison with their men classmates, have less self-efficacy in their ability to succeed in STEM classes and lower interest in pursuing a STEM degree (Hardin & Longhurst, 2015). Researchers have suggested that intervention is needed in secondary school or earlier to prevent these types of gender gaps. The purpose of this study was to

determine the relationship between attending STEM-related extracurricular programs and students' aspirations toward STEM careers and STEM majors, and to determine if that relationship is affected by students' gender and students' age group. Chapter 2 contains a review of the literature relevant to the social cognitive career theory. Chapter 2 also includes literature themes related to impact of different STEM programs on students' aspiration toward STEM careers, gender gap in STEM, and factors shaping aspiration toward STEM.

Chapter 2: Literature Review

Introduction

In the current era of globalization, preparing learners for the future global competitiveness is core to educational reforms in many countries around the world. For example, the Arabian Gulf countries are anticipating a transformation of their national economy from oil-based to knowledge-based economy. Hence, these countries are seeking to better prepare students for careers in STEM.

STEM, however, may not be the educational trajectory of choice for students in Arabian Gulf countries. According to a 2016 report issued by the Ministry of Development and Planning in Qatar, some Arabian Gulf countries have experienced a downward trend in the numbers of indigenous students enrolling in tertiary education, in general, and, more specifically, in STEM-related careers such as science and engineering. Additionally, Said et al. (2016) found that Indigenous students in an Arabian Peninsula country showed more negative attitudes toward science subjects compared to their nonindigenous peers.

One method of attracting students to STEM careers is the use of STEM programs and activities. Attending STEM-related programs researchers argued that attending STEM programs and STEM-focused schools enhances students' readiness for postsecondary STEM majors, positively impact their engagement, and increase the likelihood of completing postsecondary education (Means, Wang, Young, Peters, & Lynch, 2016; Sass, 2018). The effectiveness of STEM-related projects on students' learning, achievement, motivation, and career paths was investigated only once in one of

the Arabian Gulf countries by Abdulwahed, Ghani, Hasna, and Hamouda (2013). Also, Abdulwahed and colleagues' study included only 48 male indigenous students from high schools, who participated in a customized engineering-based project. Their study did not include the students' aspiration toward STEM-related specializations and careers. Abdulwahed et al. (2013) emphasized that studying students' aspirations toward STEM-related specializations and careers is essential to evaluate the feasibility of increasing STEM-related outreach programs for K-12 students.

This literature review includes an investigation of how participation in STEM programs affects participants' aspirations toward STEM-related careers and specializations. The reason for this focus is the need for increased interest in STEM from students, particularly students in the Arabian Peninsula, due to their low projected attitude toward science and mathematics (Abdulwahed et al., 2013; Said et al., 2016). Recruiting Arabian Peninsula students into the STEM fields has been a challenge (Sellami et al., 2017; Sellami, El-Kassem, Al-Qassass, & Al-Rakeb, 2017). The reviewed literature in this section showed a decline in postsecondary enrollment in STEM-related majors among Arabian students in the Arabian peninsula. The current study addressed whether exposure to STEM programs would affect students' aspirations toward STEM-related majors and careers. The literature review section will explore three primary areas or themes related to STEM career aspiration including (a) curricular versus extracurricular STEM programs as influences to students' decision to major in STEM fields, (b) the gender gap in STEM, and (c) STEM career aspiration.

Literature Search Strategy

The databases I used to locate the literature for this review included Education Source, ERIC, Academic Search Complete, SAGE Journals, ProQuest Central, Dissertations & Theses, and Google Scholar. The following keywords were used: *STEM education, career aspiration, STEM programs, STEM career aspiration, gender gap in STEM education and STEM careers, STEM career choices, relationship between STEM aspiration and age group, link between STEM aspiration and gender, relationship between STEM aspiration and STEM programs or STEM courses, social cognitive theory AND STEM education, career social cognitive theory AND STEM education,* and *STEM pipeline*. To search for current and relevant papers that support my knowledge of the study topic, I used different qualifiers such as peer-reviewed, full text, and from the year 2014 to the year 2019.

Theoretical Framework

This study used the framework of the SCCT (Lent, Brown, & Hackett 1994). SCCT explains the ability of students to learn by observing model behaviors in a specific context. SCCT posits that students develop career interests, career choices, and academic and career success based on social interaction with role models. The role models affect career choices, development of self-efficacy, and outcome expectations (Lent, Brown, & Hackett, 2000).

The SCCT was selected as a theoretical framework for this study because it constitutes the underlying theory explaining the reliability and validity of STEM-CIS inventory that was used to collect data about students' aspiration in this study. STEM-

CIS was derived specifically from the SCCT theoretical constructs (Kier, Blanchard, Osborne, & Albert, 2013; Mau, Chen, & Lin, 2019; Ünlü, Dököe, & Ünlü, 2016). STEM-CIS has four discipline specific subscales (Appendix A), each subscale has 11 items. Kier et al. (2013) Mau et al. (2019) and Ünlü et al.(2016) reported that the 11 items of each subscale of STEM-CIS address the 6 constructs of the SCCT including self-efficacy, outcome expectations, goals selection, interests, contextual factors, and personal inputs.

Self-efficacy and outcome expectation are two major pillars of SCCT affecting career choices (Falco & Summers, 2017; Nugent, Barker, Welch, Grandgenett, Wu, & Nelson, 2015). According to the SCCT model, the development of educational interests, career choices, and professional performance, are critically affected by learner's self-efficacy, outcome expectations and personal goals. Lent et al. (2000) suggested that interests in career-relevant activities are seen as the outgrowth of self-efficacy and outcome expectations shaped by the exposure to a variety of occupationally relevant activities in school, at home, and in their communities. Learning is a complex process that depends on many underlying factors such as motivation, outcome expectation, self-efficacy, personal beliefs and goals, teaching and learning approaches, as well as the pressure or support from peers, family, teachers, and community (Cook & Artino, 2016; Lent et al., 2000). Career aspiration is equally complex and involves the interaction of many of the same behavioral, contextual, and psychological factors (Nugent et al., 2015).

The SCCT is a career-oriented theory which posits that self-efficacy and outcome beliefs combine to predict career aspirations. SCCT links career aspiration and achievement performance with career expectancy beliefs, which concern youth's

motivation to select a specific career based on the expected financial, social, and personal results (Fouad & Santana, 2016; Turner, Joeng, Sims, Dade, & Reid, 2017). My research demonstrated and analyzed the relationship between attending STEM programs and STEM career aspirations. Therefore, this study was conducted through the lens of the SCCT, which focuses on three fundamental tenets –self-efficacy, goal expectancy, and outcome expectancy. These self-beliefs represent the underlying motives for engaging in certain behaviors or activities.

Many previous studies investigated the use of SCCT as a theoretical frame to explain the development of learners' interest in STEM majors and STEM careers. For example, Nugent et al. (2015) used the SCCT as a foundation to develop and test a model of factors contributing to STEM learning and STEM career choices among middle school students. The researchers aimed to investigate whether the model they proposed to predict students' aspirations toward STEM learning and STEM careers based on SCCT fit the data collected from middle school students in an informal learning environment. Nugent et al. received data from 800 middle school students enrolled in STEM camps focusing on robotics learning. Using the lens of SCCT, the researchers used a survey that allowed them to measure participants' interest, self-efficacy, knowledge, career orientation, and career outcome expectancy for each of the STEM disciplines. The data analysis revealed that educators, peers, and family played the most influential factors fostering students' interest in STEM, which in turn predicted students' STEM self-efficacy and career outcome expectancy. Due to these findings, Nugent et al. concluded that youth-expected outcomes promoted STEM career orientation for such careers and

that students' pathways to STEM careers and learning can be largely explained by the outcome expectancy and self-efficacy constructs. As noted, outcome expectancy and self-efficacy are the primary constructs of the SCCT.

Turner et al. (2017) carried out a study that used SCCT to guide the exploration of understating how high school students become interested in, set goals for, and take actions consistent with pursuing STEM careers. Turner et al. used an online survey to collect data from 366 high school students. The researcher collected data about students' demographics, career development barriers, STEM career self-efficacy, interests, choice goals, and actions and peer support for pursuing STEM careers, and father support, mother support, and outcome expectations for pursuing math-related careers. The researchers then examined the STEM career development pathway for both lower and higher socioeconomic status of high school students based on SCCT. The data analysis showed that higher SES covaried with lower perceived career barriers, and with greater mother, father, and peer support. In turn, higher SES also predicted greater outcome expectations but not self-efficacy. Efficacy predicted STEM career interests, choice goals, and choice actions (defined as intentions to take advanced math and science courses). Outcome expectations predicted interests but no goals or actions. Barriers, as well as, father and peer support, predicted efficacy, while mother support predicted outcome expectations. The findings of this study affirmed SCCT as a relevant model that can be used to describe the STEM career development of young people, although not all expected associations among variables were significant. Nevertheless, links among efficacy, outcome expectations, and interests were supported, and efficacy, along with

interests, was shown to predict choice goals and along with goals to predict choice actions.

Fouad and Santana (2016) carried out a literature review study for the research that has used SCCT as a frame to investigate factors that may explain STEM choices and STEM career barriers among minorities and girls. The authors organized the research studies they reviewed by age groups and aimed to analyze the stability of the SCCT to predict STEM choices based on gender, ethnicity, and age groups. The researchers concluded that the SCCT is a stable lens that allows researchers to predict STEM career choices among the various groups and especially among women and racial-ethnic minorities. The researchers also highlighted that the literature they reviewed showed that from the SCCT perspective, educators need to continuously support the contextual learning experiences that promote self-efficacy and outcome expectations in different STEM disciplines, especially in mathematics and science.

The SCCT is a trusted theory for investigating the role of personal beliefs, contextual conditions, and cognitive processes in career choices. In their SCCT theory, Lent and Brown (2016) argued that the decision of career development results from the interaction between the individual's self-efficacy and expected outcomes from one side and the individual inputs and contextual variables on the other side. Fouad and Santana (2016), Nugent et al. (2015), and Turner et al. (2017) concluded that SCCT could be used as a lens to understand the role of self-efficacy, outcome expectation, and personal goals in shaping the youths' interest in STEM careers and STEM-related majors. The authors of the three research articles reviewed in this section suggested that individuals are more

likely to develop a long-term interest in a particular program or profession when their performance in that program or profession enhance their self-efficacy and results in the valued outcomes they are expecting.. However, while Fouad and Santana and Nugent et al. argued that self-efficacy and outcome-expectations equally and directly influence STEM career choices among the different age groups, genders and ethnicities, Turner et al. argued that STEM career choices are more influenced by self-efficacy as compared to outcome-expectation.

Themes in the Literature

In this section, I analyzed the relationships between attending STEM programs (curricular & extracurricular) and STEM career choices among boys and girls in middle and high school students. As well, I discussed the predictors of STEM-careers aspiration based on prior literature. Therefore, I explored three themes in this section, including curricular versus extracurricular STEM programs influences to major in STEM fields, the gender gap in STEM, and STEM career aspiration.

Curricular Versus Extracurricular STEM Programs Influences to Major in STEM Fields

The world's economy is increasingly becoming dependent on science and technology experts who have the required skills to build a knowledge-based economy. Therefore, in the last decade, many countries have become more interested in STEM education programs to leverage students' interest in STEM-related careers (OECD, 2008; Xie et al., 2015). Different schools and different educational systems deliver STEM learning experiences in various ways that range from formal curricular education to

extracurricular and informal education. Many studies have investigated the impact of STEM formal and informal programs on students' skills, achievements, and interest in STEM careers. In the following section, I discussed the findings of recent research studies that have explored the impact of STEM curricular and extracurricular programs on learners' interest in STEM majors and careers.

Bottia, Stearns, Mickelson, and Moller (2018) studied the impact of attending STEM-focused high schools that deliver formal STEM education through an integrated curriculum. One of the focuses of these programs is to boost the number of students enrolling in STEM majors in postsecondary education. The longitudinal study that included 26,650 students revealed that attending STEM-focused high school is positively associated with STEM-related outcomes such as the intention to major in STEM, odds to declare a major in STEM and aim to persist in STEM careers. However, the researchers found that the positive effect of attending STEM high schools was not significantly different compared to the impact of attending conventional high schools when it came to the declaration of STEM majors or intention to pursue and persist in STEM careers. The authors restricted the sample to include only students attending STEM-focused high schools in a southern U.S. state who took the SAT in their senior year and/or pursued undergraduate studies at a major university in the same state. The small sample restricted application to other populations.

Sahin, Ekmekci, and Waxman (2017) carried out a descriptive, correlational study to investigate the relationship between selecting STEM majors at the college level and students' high school experience. The authors analyzed data collected from a large

sample of 2,246 college-level STEM students. The findings of this study suggested that STEM-focused high schools that deliver STEM education through curricular and extracurricular activities positively influenced students' selection of STEM majors at the university. Generalizability of the findings is limited because the study took place in urban areas and included many participants whose parents' have degrees in STEM fields, which may have an impact on students' selection of university majors (Craig, Verma, Stokes, Evans, & Abrol, 2018; Whitehead, 2018). Additionally, the collected data depended on self-reporting, and the response rate for the survey from students who attended STEM-focused high schools was 31%, which may have decreased the reliability of data due to the small sample size and the high possibility of self-reporting errors.

Means, Wang, Young, Peters, and Lynch (2016) carried out quasi-experimental research to study the effect of attending STEM-focused high schools on enhancing students' readiness for postsecondary STEM programs as compared to students who do not participate in STEM-focused school. The authors collected data on students' outcomes such as STEM course taking, STEM achievement, STEM interest, and STEM career aspiration from 12 STEM-focused schools and 16 non-STEM schools using student and principal surveys and schools' databases. Using hierarchical linear modeling and propensity-score weighting, the researchers found that attending the STEM-focused schools positively affected students' choices of STEM course taking and enhanced their enrollment in out-of-class STEM activities and interest in STEM careers and/or higher degrees as compared to students from non-STEM schools. On the other hand, the longitudinal findings showed that students attending STEM-focused schools tend to gain

higher GPA scores but not higher ACT scores when compared to non-STEM students. Despite their efforts to control the variables in the students' backgrounds, achievement, and socio-economic factors, Means et al.'s study failed to randomly assign students into comparison groups, which means that they would not be able to control many variables affecting students' outcomes.

Erdoğan and Stuessy (2015) carried out a quasi-experimental study to investigate the role of STEM-focused schools in enhancing college and career readiness. The researchers collected data from 28,159 high school students in 106 schools identified as either STEM-focused or traditional. Erdoğan and Stuessy found that the difference in students' attainment in high-stake tests was not significant for students from STEM-focused high schools compared to students from traditional high schools. However, the researchers argued that despite the minor differences in test attainment, students from STEM-focused high schools showed more positive interest in STEM majors when compared to students from traditional schools. Erdoğan and Stuessy's findings were consistent with the results of Means et al. (2016) and the outcomes of Sahin et al. (2017) regarding the positive impact of STEM-focused schools on students' aspiration toward STEM majors and regarding the insignificant effect of STEM-focused schools on students' attainment in high stakes tests such as the SAT or the ACT. However, and despite a large number of participants, Erdoğan and Stuessy s' study was limited to small-sized STEM-focused schools in urban areas that are populated by students from historically underrepresented populations, which makes the results difficult to generalize.

Huziak-Clark, Sondergeld, van Staaden, Knaggs, and Bullerjahn (2015) investigated the impact of undergraduate STEM majors' participation in STEM research activities on their confidence and attitudes toward STEM careers. Using a mixed-methods approach with 240 participants, the researchers found a significant change in students' measures of confidence and attitudes toward STEM careers due to their research involvement. Huziak-Clark et al.'s study showed a robust design in the use of pre and post evaluation that enhanced the validity in addition to a triangulation of multiple data sources that allowed for drawing a full picture about the role of engaging students in STEM programs on their attitudes toward STEM careers. Participants received money incentives, which may make the generalizability of findings questionable.

Phelps, Camburn, and Min (2018) investigated the association between enrollment in high school engineering and engineering technology (E&ET) courses and subsequent registration in two- or four-year undergraduate STEM majors. Researchers utilized data from longitudinal educational studies for 2,889 students who attended E&ET classes at high schools. The researchers controlled many interfering factors that may affect major choices, including early postsecondary educational experiences, socioeconomic background, academic preparation, attitudes, and college choice consideration. Phelps et al. found that there was a significantly positive association between E&ET courses taken during high school and enrollment in postsecondary STEM majors. However, the researchers did not indicate if there was a significant difference between E&ET takers and non-takers regarding the selection of a postsecondary major.

Vennix, den Brok, and Taconis (2018) carried out a quantitative study to investigate the impact of STEM outreach activities co-created by schools, different companies, and universities among 729 high-school students in 12 different schools. The authors utilized multivariant analysis to explore the associations between students' perceptions of the outreach learning environment, motivation, attitudes towards STEM, and future STEM career intentions. Vennix et al. found that there was a positive association between autonomous-motivation and students' attitudes toward STEM careers. However, the association between controlled-motivation and students' attitudes toward STEM careers was negative. Thus, outreach learning environments can create opportunities to increase students' motivation in STEM activities and attitudes towards STEM careers and STEM social implications. Still, the effect varies according to the characteristics of the activities. While Vennix et al.'s study included many students from different after school programs, the researchers failed to use a comparison group; using a control group may have improved the reliability of their findings.

Ozis, Pektas, Akca, and DeVoss (2018) carried out a quantitative study that included 1,167 students from K-12 schools that offered several types of extracurricular STEM clubs. The researchers utilized an online survey to measure the impact of attending the STEM extracurricular clubs on STEM-career perception and compared it with the career perception of students who did not participate in the STEM clubs. Results showed that there was a significant difference in students' STEM-careers perception between students who attended the STEM clubs and those who did not. Ozis et al. utilized the data collected from students who did not participate in the STEM clubs as

baseline data to make the comparison possible. However, the researchers failed to carry out a controlled study because they only measured the impact of attending or not attending a STEM club on students' attitude toward STEM careers without controlling the other intervening factors such as the extent to which the sample schools emphasized STEM in curricular programs, students' achievement, socioeconomic factors, and parental effect.

Nite and Aggie (2017) investigated the influence of university STEM enrichment programs on students' intention toward enrollment in STEM disciplines and engineering careers. The researchers used a survey to collect quantitative data form 61 high school students before and after enrollment in a two-week STEM enrichment program. The data analysis showed that STEM enrichment experiences could positively impact students' perceptions of the prestige of engineering careers. However, the study was limited to a small population size of 61 students, one grade level, and one branch of STEM discipline that is engineering.

Young, Ortiz, and Young (2017) carried out a meta-analysis of 84 peer-reviewed research articles about the role of out-of-school time (OST), including after school programs, summer camps, enrichment programs, etc. in fostering students' interest in STEM. The researchers determined the effect size of each study they reviewed. The results analysis revealed that OST significantly impacts students' interest in STEM. The researchers concluded that that the positive impact of OST on interest in STEM can be explained by the positive impact of OST on students' academic performance and the role

of OST in enhancing students' understanding of real-life applications of science and mathematics learning.

Kitchen, Sonnert, and Sadler (2018) carried out a quantitative study to investigate the impact of attending high school STEM summer programs on learners' aspiration to pursue STEM careers. The researchers utilized an online survey to collect data about STEM career intentions from 15,847 first-year college students enrolled in required English courses. The analysis of responses revealed that 845 students participated in a STEM-related summer course before joining the college, while the other 15,002 students did not attend such classes. The researchers then utilized logistic regression modeling with propensity weighting to address differences in group characteristics to model the impact of attending the STEM courses on students career aspirations, and found that students who participated in STEM summer courses had 1.4 times the likelihood of wanting to pursue a STEM career, after controlling for background characteristics. The researchers further concluded that students experiencing the real-world relevance of STEM had 1.8 times the probability of aspiring to STEM careers at the end of high school compared with the students who did not attend STEM summer programs.

Synthesis

Several factors might affect students' aspiration toward a university major or a career choice. Researchers identified the school learning experience as one of the vital factors that impact the choice of post-school majors and career paths (Chang et al., 2016; Galliott & Graham, 2015). Therefore, and to foster STEM interest among the youth, different educational systems around the world adopted different formal and informal

educational approaches including: STEM-focused schools that deliver STEM subjects in an integrated curricular way, project-based STEM curricular, project-based extracurricular out-reach programs, and STEM mentorship programs (Blackley & Howell, 2015; Moore & Smith, 2014).

Many researchers investigated the impact of different STEM educational approaches on students' aspirations toward STEM majors and careers to inform policymakers about the effectiveness of these approaches in enhancing students' interest in STEM majors and STEM careers (Holmes, Gore, Smith, & Lloyd, 2017; Lynch et al., 2017; Means et al., 2016). Compared to conventional schools, in STEM-focused schools, students experienced more intensive hands-on and minds-on activities that integrate science, technology, engineering design, and mathematics in contextual and real-life applications (Bottia et al., 2018; Means et al., 2016). Therefore, students tended to have positive attitudes toward STEM majors and STEM careers when attending STEM-focused high schools (Bottia et al., 2018; Erdoğan & Stuessy, 2015; Means et al., 2016; Sahin et al., 2017). However, while Bottia et al. (2018) found that attending STEM-focused high schools significantly affected students aspiration toward STEM majors and careers, Sahin et al. (2017), Means et al. (2016) and Erdoğan & Stuessy (2015) did not find a significant difference between students who attended STEM-focused schools and students attending conventional schools regarding aspiration toward STEM majors. The researchers explained that the slightly higher aspiration of students toward STEM majors after attending STEM-focused schools is not attributed only to the high school learning

experience but to other factors such as the pre-high school experience, parental impact, and other socio-economic factors.

Other approaches to enhancing students' aspirations and attitudes toward STEM majors and careers are the STEM enrichment programs such as STEM afterschool activities, STEM clubs, and outreach programs created by universities or companies. Vennix et al. (2018) argued that the effectiveness of the outreach and extracurricular programs on students' attitudes toward STEM courses, majors, and careers vary according to the characteristics of the offered activities and their impact on students' autonomous motivation. While Phelps et al. (2018), Huziak-Clark et al. (2015), and Ozis et al. (2018) found that the enrollment in extracurricular STEM activities significantly enhanced students' attitudes toward STEM majors and careers, Vennix et al., (2018) and Nite and Aggie (2017) showed that the extracurricular activities positively affected students' attitudes toward STEM careers though there was no comparison performed with students who did not take such activities.

The literature reviewed in this section showed varied impacts of STEM programs (both curricular and extracurricular) on students' attitudes and aspirations toward STEM careers and STEM majors with a noticeable positive impact of most of the curricular and extracurricular STEM programs on students' aspirations toward STEM majors and STEM careers. Young et al. (2017) and Kitchen et al. (2018) argued that despite the type of the STEM program (curricular or extracurricular), it is the relevance of STEM activities and their applicability to real-life situations that play the significant role in shaping students' aspiration toward STEM careers and majors. However, there are no available studies that

compare the impact of curricular and extracurricular STEM programs on students' aspiration toward STEM majors or STEM careers

Gender Gap in STEM

The disparity of gender representation in STEM fields is one of the most studied topics regarding STEM education and STEM careers. Many studies highlighted the gender gap in STEM fields and tried to explain the reasons behind that gap (Reinking & Martin, 2018; Wang & Degol, 2017; Xu, 2015). Brotman and Moore (2008) carried out an extensive literature review of 107 studies about females and science education. This seminal study was one of the first systematic and comprehensive literature review studies about the relationship between gender and science education during the era of fundamental growing interest in STEM education between 1995 and 2007. Brotman and Moore (2008) found that females' attitudes toward sciences are either significantly less than males or significantly decline with time.

Similarly, Wang and Degol (2017) carried out a meta-analysis of about 30 years of research outcomes about the gender gap in STEM education. They found that despite their dominant representation in the medical and health sciences sectors, females remain underrepresented in other STEM fields, especially the areas that require intensive mathematical skills. Wang and Degol (2017) concluded that the underrepresentation of females in the STEM fields was due to different cognitive and societal factors, including cognitive abilities, occupational preferences, work-family balance factors, field-specific ability beliefs, and gender-related stereotyping and bias at the workplace.

Zhou, Fan, Wei, and Tai (2017) utilized a follow-up regression analysis to analyze the results of the mathematics component of the cross-national Program for International Student Achievement (PISA) exams from the 2009 and 2012 cycles, to investigate gender gap among high achievers in math and implications for the STEM pipeline. The researchers found that there was a consistent male advantage among the top achievers in mathematics. Zhou et al. concluded that the gender gap in mathematics achievement was due to the sociodemographic and schooling/attitudinal variables, including out-of-school lessons, math self-efficacy, math anxiety, and attitude toward school. The findings of Zhou et al. are consistent with the results of Doerschuk et al. (2016), who argued that the gender disparity in mathematics achievement is one of the significant factors contributing to the gender gap in the STEM pipeline. Both Doerschuk et al. and Zhou et al. explained that students with higher achievement in mathematics tend to have a higher chance of enrolling in STEM-focused colleges at universities, especially in physics, engineering, and technology majors.

Bergeron and Gordon (2015) investigated how males and females might enroll and perform differently in STEM high school courses. The researchers utilized chi-square, descriptive statistics, hierarchical linear regression, and ANOVA to analyze the recruitment and achievement data of about 355,688 secondary students in higher-level STEM courses that follow the International Baccalaureate curriculum. Bergeron and Gordon found that while females enroll much less frequently in higher-level secondary STEM courses, there is no significant difference between males' and females' achievement in these courses. Bergeron and Gordon found that the gender gap in STEM

fields is not attributed to ability or academic achievement, but students' self-efficacy, preferences, and aspirations. Bergeron and Gordon's results contradict the findings of Zhou et al. (2017), Wang and Degol (2017), and Doerschuk et al., (2016) (2015), who found that the gender gap in STEM fields can be partially explained by the lower performance and cognitive abilities of girls compared to boys.

Mann, Legewie, and DiPrete (2015) used a logistic regression analysis to analyze achievement and aspirational data collected through the 2006 PISA program from 331,834 15-year old students from 55 countries around the world. The researchers aimed to investigate the impact that peer ability has on gender differences in the formation of STEM orientations. The researchers defined peer ability as the school's standardized, average grade in mathematics and science, assuming that high academic performance raises the competition within the school environment. Researchers in this study found that, overall, boys have a significantly higher aspiration toward STEM careers compared to girls even among high performing students. However, the gender gap shrinks in high-performing environments. The researchers speculated that the shrinkage in the gender gap might be explained by girls who perform well in environments filled with other strong-performing students behave more similarly to boys in the formation of their STEM aspirations due to increased self-confidence and self-efficacy. Mann et al.'s conclusions further support the findings of Bergeron and Gordon (2015), who suggested that the gender gap in STEM is attributed to self-efficacy and self-confidence factors rather than academic abilities.

Contini, Tommaso, and Mendolia (2017) carried out a cross-sectional regression study of students' performance in mathematics as a significant factor contributing to the readiness of students to enroll and succeed in STEM majors. The researchers aimed to analyze the gender gap in mathematics test scores across the different grade levels from the elementary school stage to the high school stage for about a half-million students. The authors did not disclose the exact participant numbers. The results revealed that the gender gap exists in mathematic performance form grade two and continues to the secondary stage. The results also showed that the gender gap in performance in mathematics increases with age, with a prominent advantage for males over females. Contini et al. indicated that studying the reasons behind that gender gap is beyond the scope of their study. However, they suggested that the gender gap can be attributed to the traditional gender-related stereotyping in STEM disciplines as described in the OECD reports (OECD, 2015, 2016).

Sáinz and Müller (2017) carried out a quantitative study that included 796 students at a school to investigate the impact of gender and family on students' aspirations toward STEM and the intrinsic and extrinsic values associated with these aspirations drawing on the expectancy-value theory. The researchers used descriptive statistical analysis and ANOVA for the data analysis. They found that there is a significant gender gap in students' aspirations toward STEM careers based on gender and family factors. However, the gender gap favored the boys in engineering and technology STEM careers, while it favored girls in the health and experimental sciences STEM careers. Additionally, the researchers found that the aspiration toward STEM careers is

highly linked to the family factors, especially the educational levels of mothers and extrinsic motivation.

Bottia, Stearns, Mickelson, Moller, and Valentino (2015) carried out a longitudinal analysis of a STEM program dataset related to school experience and academic performance of about 19,000 high school students. The researchers utilized the multilevel multinomial logistic model with linear predictors to investigate the impact of having high school female STEM/science teachers on students' dispositions toward STEM career choices. The data analysis showed that girls who attend high schools with a high percentage of female mathematics and science teachers showed significantly higher positive dispositions toward STEM careers and STEM majors at colleges. Bottia et al. (2015) did not examine the reasons behind the increased positive dispositions toward STEM careers in this study. Still, they speculated that the presence of the high percentage of female STEM teachers removes the psychological barriers and fear of social sanctions females face when taught by male teachers.

Christensen, Knezek, and Tyler-Wood (2014) collected quantitative attitudinal data from 354 high school students attending a residential mathematics and science camp on a university campus. The researchers assessed students' dispositions toward STEM subject content and STEM careers. The researchers then compared data about dispositions collected from the research participants with dispositional data collected from conventional high school students and STEM professionals. The results of Christensen et al. showed that females had more positive dispositions toward STEM content and STEM careers than their male peers in the residential program and the

conventional high schools. However, Christensen et al. did not explain the reasons behind the increased interest of females in STEM. They suggested that further studies should be carried out to find if this increased interest in STEM is due to specific characteristics of the females participated in their research or due to other external factors. The results from Christensen et al.'s study are consistent with the findings of Said et al. (2016), who reported that females had more positive attitudes toward science when compared to their male peers in the study. Additionally, Mann et al. (2015) reported that despite the overall males' advantage in STEM orientation in the 55 countries included in the study, there were still some individual differences in some countries where girls had a higher aspiration toward STEM compared to boys due to sociodemographic factors.

Stoeger, Hopp, and Ziegler, (2017) carried out an empirical study to investigate the impact of extracurricular, online group mentoring programs on females' aspiration and performance in STEM as compared to one-to-one mentoring programs. The researchers were particularly interested in understanding the role of group mentoring on the width and breadth of communication between students in STEM and on the ability of students to gain more knowledge and skills in the STEM disciplines. The research sample included 374 high schools, high achieving girls receiving an online mentorship program in STEM by female mentors for six months. The mentee girls were divided into two groups, where 156 girls received one-to-one online mentorship, while the remaining 191 girls received online group mentorship. The researchers then collected data using an online questionnaire asking the mentees about their academic and professional intentions before the mentoring year and after six months of mentoring. Between the two times,

program participants' platform communication was recorded via log files. The data analysis of the recorded logs and responses to the survey questions revealed that group mentoring was significantly more effective than one-to-one mentoring in fostering females' interest in STEM. However, despite the empirical support of results in this research, the research results cannot be generalized because of the special nature of the mentoring that included a many-to-many approach in which two mentoring dyads formed one four-person mentoring community. Additionally, the research did not shed light on the impact of such mentoring programs on boys' aspiration and performance in STEM to provide a gender-related perspective of the study.

In summary, the reviewed literature in this section established the presence of the gender gap in STEM fields by showing that males in STEM courses, STEM majors, and STEM careers outnumber females. However, reviewed studies showed that the gender gap in STEM fields can be closed in many ways including fostering STEM programs and activities in early grades in the primary or preparatory stages to increase the retention rates of interest in STEM especially among females (Bottia et al., 2015; Christensen et al., 2014). Additionally, Ozis et al. (2018) showed that immersing students in both STEM-focused schools and STEM out-of-school clubs would play a significant role in closing the gender gap in STEM aspirations. Finally, Stoeger et al. (2017) who studied the impact of one-to-one versus group online STEM mentoring by role model STEM females on girls' performance in STEM programs, found that group mentoring programs, in particular, have a significant positive impact in enhancing STEM aspiration among female high school students.

STEM Career Aspiration

To succeed in the current quickly changing, technological world, students need to develop their capabilities in STEM to levels much beyond what was considered acceptable in the past (Holmes, Gore, Smith, & Lloyd, 2017). Therefore, fostering STEM education and studying the factors contributing to the development of STEM career aspiration among students became very important for both educators and researchers. The following section explores the recent literature exploring the factors contributing and shaping students' aspirations toward STEM careers.

Lee, Capraro and Viruru (2018) carried out a qualitative research study to investigate students' perceptions in science concerning their aspirations toward STEM-carriers. The researcher collected data from 44 high-achieving male and female high school students using open-ended survey questions. The researchers analyzed the data using thematic analysis and frequencies distribution analysis to figure out how students' participation in STEM camps and their perspective of science affected their decision to pursue or avoid STEM-related careers in the future. Lee et al. found that 79.4% of the participants showed interest in STEM-related careers, and when they analyzed the reasons behind students' choices, they found that different personal and contextual motives motivated students who selected to pursue STEM careers. Students' motivations included positive emotions toward science disciplines, positive views about the role of science careers in developing their personalities, and positive views about the role of scientific knowledge in helping them to develop the career tools they needed. On the

other hand, the societal contextual factors included positive opinions about the role of STEM professionals in helping people, interacting with others, and impacting the world.

Wiebe, Unfried, and Faber (2018) carried out a cross-sectional study to investigate the role of demographic factors such as age, gender, and ethnicity in shaping students' STEM attitudes and career interests. The researchers utilized Student Attitudes toward STEM (S-STEM) survey to collect data about the relationship of students' self-efficacy and outcome expectancy for STEM attitudes, and their interest in STEM career fields. The study was administered to over 15,115 students from grade four to grade twelve. The researchers used cluster analysis to examine how career paths cluster based on student interest and multiple regression analysis to explore the relationship between attitudes in STEM academic areas and STEM career interests. The researchers found that students across the different demographic factors develop their STEM-career interest around two significant clusters: biomedicine-related careers and physical sciences-related careers. Additionally, the researchers found that the career interest toward the different groups vary according to gender, as females tend to be more interested in biomedicine-related careers where males showed more interested in physical-sciences-related careers. Finally, Wiebe et al. found that interest in STEM careers is not static over time as it changes with age but becomes more stable and precise in the secondary stage.

Sax, Kanny, Riggers-Piehl, Whang, and Paulson (2015) analyzed enrolment datasets collected from about 1.5 million first-year students enrolled in 1305 higher education institutes over 40 years in the United States. Sax et al. aimed to investigate the relationship between students' self-concept in mathematics and the selection of STEM

majors. Additionally, the researchers sought to investigate how mathematics self-concept (MSC) has changed over time as a predictor of STEM major selection in five fields: biological sciences, computer science, engineering, math/statistics, and physical sciences. The results analysis revealed that there is a significant association between MSC and majoring in STEM. The results also showed that MSC is higher among males compared to females, which assisted in explaining the gender gap in STEM majors. However, the researchers found that salience of MSC in predicting STEM major selection has generally become weaker over time for females (but not for males), which suggests that womens' lower math confidence has become a less powerful explanation for their underrepresentation in STEM fields.

Mau and Li (2018) investigated the factors influencing STEM career aspiration among grade 9 students using a nationally representative sample of 21,444 students. The researchers sought to find if there were any differences between the investigated factors such as gender, ethnicity, parental/familial factors, academic/school factors, and personal/psychological factors in shaping students' aspirations toward STEM careers. Additionally, the researchers aimed to investigate how the factors affected students who pursued STEM careers. Self-reporting surveys collected data from students in grade 9, and a follow-up data collection took place from the same students two years later when students became in grade 11. The researches then used MANOVA, ANOVA, and logistic regression to analyze data. The researchers found that STEM career aspiration is significantly influenced by gender, race, and math/science self-efficacy, but to less

extent, is affected by familial influences such as parents' expectations and educational level.

Shin, Rachmatullah, Roshayanti, Ha, and Lee (2018) carried out a cross-cultural study to investigate the factors affecting high-school students' motivations toward STEM careers, including gender and the educational level in two Asian countries. The researchers utilized a STEM career motivation instrument to collect motivational data from 2,171 high school students. The data collected included educational experience, career value, academic self-efficacy, career self-efficacy, career interest, parental support, and goal setting. Shin et al. then analyzed the data using a 3-way ANOVA and correlation analysis to examine if there are any differences in STEM motivation among students from the two investigated countries and to examine the correlation between STEM career motivation, gender, and educational level. The analysis of data revealed that STEM career motivation is significantly affected by an interaction between the country, educational level, and gender. The researchers postulated that the differences between students in the two countries are explained by the socio-cultural contexts embedded in each country. Similar to Mau and Li (2018), Shin et al. showed that motivation toward STEM careers is affected by some contextual factors such as parental support and educational experience. However, the researchers only described the differences in STEM career motivation between countries but did not explain the causes of these differences.

Christensen and Knezek (2016) conducted a study that included 813 middle school students participating in a real-world STEM applications program. The students

were asked to answer a pre-program and post-program career interest questionnaire to examine the level of STEM career interest among them, the extent of alignment between students' interest in STEM careers and their intent to pursue careers in STEM fields, and finally, impact of gender on the level of alignment between STEM interest and intent. The statistical analysis of results showed that about 46.6% of students participating in the STEM program expressed the desire to pursue a career in STEM. The results also showed that students who showed intent to pursue STEM careers showed equal positive dispositions toward STEM and STEM measures. Finally, the researchers found that males' dispositions toward STEM and STEM careers and their intent to pursue STEM careers are significantly higher than their female counterparts.

Baran, Canbazoglu Bilici, and Mesutoglu (2016) carried out a qualitative study that involved 40 primary school students participating in out-of-school STEM activities. The study aimed to examine students' perceptions of STEM fields and careers upon participation in the out-of-school program. The results showed that the engagement in the real-life STEM challenges and hands-on activities enhanced students' perception toward STEM fields. Additionally, the researchers found that students showed enhanced cognitive, design, engineering, and computational skills. This study was limited by the small non-representative sample size and the lack of comparison groups. Therefore the results of this study cannot be generalized.

Holmes, Gore, Smith, and Lloyd (2017) utilized logistic regression to analyze data drawn from a longitudinal study that included 6,492 students from grades 3 to 12. The study aimed to understand the development of STEM career aspiration among

students and to examine the factors that predict interest in STEM careers. The researchers collected data at two time intervals, first when students are in grades 3, 5, 7, and 9 and three years later when students are in grades 6, 8, 10, and 12. The data analysis showed that interest in STEM occupations is significantly correlated to gender (higher for males), age (higher for older students), having a parent in a STEM field, high cultural capital, and prior high achievement in mathematics.

In summary, the research studies reviewed in this section showed career aspiration could be predicted at early scholastic stages, especially when students are involved in relevant educational programs. Baran et al. (2016), Christensen and Knezek (2016), and Holmes et al. (2017) showed that students' aspiration toward STEM careers appears in primary and middle years but changes over time and stabilizes when students are in high school where they become more confident about their career choices (Sax et al., 2015; Wiebe et al., 2018). Additionally, the reviewed studies in this section consistently showed that students' aspiration toward STEM careers is affected by many contextual factors including, positive views about the contributions of STEM professionals to their societies (Baran et al., 2016; Lee et al., 2018), parental educational level and occupations, gender, and educational experience (Holmes et al., 2017; Mau & Li, 2018; Shin et al., 2018).

Summary and Conclusion

In Chapter 2, I summarized and discussed a comprehensive review of prior research conducted on the impact of STEM programs on students' achievement, and the gender gap in STEM education, and aspiration toward STEM careers. I discussed the

suitability of SCCT in explaining learners' aspirations toward STEM careers and STEM majors. Then I summarized and reviewed the most current and relevant research studies that investigated the impact of STEM curricular and extracurricular programs on students' achievements, attainment, career orientation, and university majors selection. Then I discussed the gender gap in STEM majors and STEM careers by exploring some of the recent studies that addressed the causes of this phenomenon. Finally, I summarized some of the recent studies that examined the factors fostering students' aspirations toward STEM careers and STEM majors.

The first theme is discussed in the literature review was the influence of STEM curricular programs versus extracurricular programs on students' aspiration toward STEM careers and STEM majors. The reviewed studies showed a clear overall positive impact of both curricular and extracurricular STEM programs on students' attainment, achievements, and aspirations toward STEM careers and STEM majors. None of the reviewed studies compared the impact of curricular and extracurricular programs on aspiration toward STEM careers. However, the studies revealed that the significance of the change in students' aspiration toward STEM careers and STEM majors depend significantly on the relevance of STEM activities and their applicability to real-life situations.

The second theme discussed in the current literature review was the gender gap in STEM education and STEM careers. The reviewed studies showed that a gender gap still exists in STEM fields. The studies showed that in most communities, women are still less represented in STEM careers due to several factors including them, mathematical skills,

spatial cognitive abilities, occupational performance, work-family balance, and stereotyping at workplaces. Despite that, the studies showed that women predominate some STEM sectors such as the medical and health sectors. However, the gender gap is reversed in some socialites due to demographic factors. Finally, the third theme presented in this literature review discussed the factors affecting aspiration toward STEM careers and STEM majors. The reviewed studies showed that that aspiration toward STEM careers and STEM majors is affected by many personal, social, and economic factors, but most impotently are self-efficacy, parental impact, and educational experience.

In this chapter, I also analyzed those research methods and sample selection procedures and found that most of the prior studies collected data about STEM career interest or impact of STEM programs by surveying students after they actually finish high school or by analyzing secondary data from other cross-sectional studies. Therefore, there is a gap in the literature regarding providing empirical evidence on the impact of enrollment in STEM programs on students' aspiration toward STEM careers and STEM majors. Hence, the current study investigated the impact of STEM extracurricular pogroms on students aspiration toward STEM careers and STEM majors by comparing the aspiration scores before and after attending STEM extracurricular programs using repeated-measures ANOVA with two between-subjects factors (i.e., gender and age group) and one within-subjects factor (pre- and post-aspiration scores).

Chapter 3: Methodology

Introduction

All around the world, STEM professions are recognized by educators and business leaders as pillars to national economies. STEM professions help people to strive for wealth and prosperity. Based on the changing nature of knowledge-based jobs and continuing growth in STEM occupations, STEM educational programs' role in advancing STEM careers in the 21st century is gaining increased significance (Waite & McDonald, 2019; White & Shakibnia, 2019). Therefore, understanding the role of schools in fostering students' interest in STEM is gaining more attention worldwide, especially for the role of schools to academically prepare students for STEM careers (Sahin et al., 2017; Schwartz, 2016). The purpose of this quantitative study was to investigate the change in students' aspirations toward STEM-related specializations and careers. The focus of this study was to assess the change in student aspiration before and after attending STEM-related extracurricular programs. The study also aimed to examine if changes in students' aspirations depended on the following factors. (a) students' gender (males or females) or (b) students' age group (middle school or high school).

In this chapter, I discussed the methods of data collection and analysis in detail. In this quantitative study, I employed repeated-measures ANOVA with one within-subject factor, the pretest and the posttest aspiration scores. I also employed repeated-measures ANOVA with two between-subject factors, gender and age group. I investigated the relationship between attending STEM-related extracurricular and students' aspirations toward STEM majors and STEM careers. Then, I compared how aspiration scores were

affected by age and gender, for example, middle school versus high school, and boys versus girls. The variables in this study included enrollment in STEM-related extracurricular programs, gender, and age group.

Research Design and Rationale

A quantitative, pre-experimental design was used in this study. Notably, pre-experimental research designs follow an essential experimental step excluding a control group (Dawson, 1997; Marsden & Torgerson, 2012). Quantitative research focuses on questions relating to the relationship that exists between the measured variables to describe, forecast, and control events (Leedy & Ormrod, 2014). The use of quantitative research design involves many advantages as it depends on statistical data. These advantages include saving time and resources (Bryman, 2001) and minimizing the instances of probable bias through examination of the subjects' responses without the need for interpretation (Denscombe, 1998; Fairbrother, 2007). I used a paper-based version of the STEM-CIS with closed-ended questions to collect data from the target population under study. In this study, the dependent variable was students' aspiration toward STEM-related specializations and careers. Students' aspiration was measured by the STEM-CIS developed by Kier, Blanchard, Osborne, and Albert (2013). The independent variable in this study was the attendance of STEM-related extracurricular programs. The independent variable had one within-subject factor for research question 1 that is the pretest and posttest aspiration scores, and two between-subjects factors for Research Questions 2 and 3. In Research Question 2, the between-subjects factor was

students' gender (boys and girls), and in research question 3 the between-subjects factor was students' age group (middle school and high school).

The pre-experimental design is commonly used in the social sciences and provides a simplified and beneficial approach for measuring social variables (Creswell & Creswell, 2017; Hordósy, 2011). Notably, this study has only a treatment group, which is made of students attending the STEM-related extracurricular programs at governmental middle and high schools in Qatar. Therefore, the research approach in this study is known as one-group pretest-posttest pre-experimental research.

In the one-group pretest-posttest, pre-experimental research design, researchers aim to study a single group where a baseline is determined using a pretest and posttest. This design uses a pretest posttest where the dependent variable is calculated prior to, and following the independent variable being introduced to determine if a suggested treatment makes a difference (Creswell & Creswell, 2017; Dawson, 1997; Hordósy, 2011). If the rates of the pre-experimental, one group pretest posttest show a statistically significant difference, and if there are no other explanations for the difference, the researcher can conclude that the treatment caused the difference (Babbie, 2003). In the present study the independent variable was attending STEM-related extracurricular programs and the dependent variable was students' aspiration toward STEM-related careers and specializations. Aspiration of students who attended the STEM extracurricular programs was compared with the baseline aspiration score. The aspiration score, defined as the aspiration of students toward STEM careers and specializations, the

comparison points are the scores before attending the STEM extracurricular programs (the baseline score) and the score after attending the program.

In educational situations, the arbitrary assigning of groups is frequently characterized by limiters such as inconvenience, unforeseen difficulties, or illegalities (Brewer & Kuhn, 2010). The biggest limitation of the pre-experimental design is that it is limited to validity. Pre-experimental design is prone to numerous threats of validity making it challenging to dismiss rival hypotheses or explanations, these threats include history, maturation, and testing (Dawson, 1997; Hordósy, 2011). Campbell and Stanely (as cited in Dawson, 1997) argued that history in pretest-posttest design is referred to as the set of unseen events that might affect the change in the dependent variable beside the investigated treatment. Similarly, Campbell and Stanley explained that subjects' scores on the posttest might change over time due to their physical and/or psychological maturation, or due gaining experience on the test from the pretesting event.

The researcher should understand the parameters within which the pre-experimental research design is limited. However, despite the limitations, the pre-experimental, one-group, pretest-posttest design is a convenient research tool when it comes to hypotheses testing and making inferences about the effect of treatments in educational studies, especially when true experiments are not valid due to the absence of randomization, inconvenience, or illegalities of forming treatment and control groups (Drew, Hardman, & Hosp, 2007; Gribbons & Herman, 1997; Thyer, 2012). Gay and Airasian (2000) stated that although the validity of the pre-experimental design result

seems challenging, researchers can use the results to support testable hypotheses. The testable hypotheses are essential in developing comparisons in educational research.

To collect the data for this study, the researcher used a paper-based version of STEM-CIS with closed-ended questions. The survey was used as a pretest and a posttest tool to measure aspiration scores toward STEM-related careers and specializations from the same group of students enrolled in the STEM-related extracurricular programs (one-group, pretest-posttest). The independent variable in this study was the attendance of STEM-related extracurricular programs. In the present study, STEM extracurricular programs are a group of existing programs, which the researcher did not design or introduce. The STEM extracurricular programs take the form of afterschool clubs or outreach programs. Therefore, participants in the extracurricular STEM programs were preselected by teachers who nominate students to participate in the STEM program based on their academic achievement. Due to the lack of comparison group and the nonrandom assignment of students into the study groups, the researcher used repeated measures ANOVA with two between-subjects' factors namely gender and age group in research question 2 and 3 respectively, and one within-subject factor in research question 1. The one within-subjects factor also considered in this research is pretest and posttest aspiration scores to analyze the data collected by the STEM-CIS tool.

Methodology

Population and Sample

The population for this study is Qatar national students enrolled in STEM-related extracurricular activities in public schools in Qatar. This population of middle and high school students is selected by their teachers to participate in extracurricular STEM activities. The activities are organized by the school or by other outreach organizations and universities in Qatar. The extracurricular STEM programs included robotics, digital fabrication, materials science, and engineering-related applications.

There are 125 middle and high schools in Qatar. In each school, an average of 10 to 15 Qatari national students are usually selected to participate in STEM extracurricular activities, which made the population size for this study ranged approximately from 1250 to 1875 students. A sample of Qatari national students from public schools participating in the extracurricular activities was recruited to participate in this study. In Qatar, schools are of separated genders; the demographics of the schools in Qatar are shown in Table 1. Importantly, the table includes both Qatari and non-Qatari students. The Qatari education system is international; hence, it is vulnerable to attracting non-Qatari learners whose parents work and live in Qatar as expatriates, as shown by the statistics in the table below.

Table 1

Demographics of Governmental Schools in Qatar to be Included in the Study.

	Girls		Boys		
Stage	Qatari	Non-Qatari	Qatari	Non-Qatari	Total
Middle school	8,244	6,652	7,016	6,525	28,437
High school	5,592	6,595	6,475	6,488	27,150
Total	14,732	13,247	13,491	13,013	55,587

Sampling Procedure

In this research, I used a convenience sampling method to select participants. In convenience sampling, the researcher seeks out individuals from a given population of interest that possess certain types of characteristics defined as inclusion and exclusion criteria (Tongco, 2007). Further, convenience sampling is usually used when the participants are conveniently available, easy to access, willing to participate in the research, and are available at the right time at the right place (Acharya, Prakash, Saxena, & Nigam, 2013). In this study, the sample was drawn from the population at hand which has met the inclusion criteria defined in the research such as being at a middle or a high governmental school in Qatar and attending an extracurricular STEM-related program. In the current study, participant selection was based on three inclusion criteria: (a) the grade level (middle or high school), (b) gender (boys or girls), and (c) enrollment in STEM-related extracurricular programs. A priori power analysis was conducted using G*Power (Version 3.1.9.4; Faul, Erdfelder, Lang, & Buchner, 2007). The analysis tests the influence of STEM extracurricular activities on students' aspirations toward STEM

careers before and after attending the programs, using repeated measure ANOVA with between-subjects factors and within-subjects factor. A small treatment effect ($f = 0.1$), and an alpha of .05 was used based on the thumb rule and the best practices recommended by Kline (2017). In this study, the first research question focuses on the relationship between enrollment in STEM extracurricular programs and students' aspiration before and after attending the program, therefore it has a within factor and investigates one group of students. On the other hand, Research Questions 2 and 3 focus on the interaction between within and between subject factors, and each question has two groups, boy and girl students in Question 2, and middle and high school students in question 3. Table number 2 below shows the input parameters used to calculate the sample size using G*Power software. Results showed that a total samples of 199 and 200 participants are required to for questions 1 and questions 2 and 3, respectively to achieve a power of 0.8. (see Appendix B).

Table 2

*Input Parameters used to Calculate the Sample Size using G*Power Software.*

Input Parameter	Values for Research Question 1	Values for Research Questions 2 & 3
Number of Groups	1	2
Number of Measurements	2	2
Correlation Among Repeated Measures	0.5	0.5
Nonsphericity Correction	1	1

Procedures for Recruitments, Participation and Data Collection

After obtaining approval from the Walden Institutional Review Board (IRB), I asked for the necessary permissions from the Ministry of Education and Higher

Education in Qatar (MOEHEQ) to apply the data collection instrument to the Qatari students enrolled in extracurricular STEM programs at each school. However, the researcher is a vice principal in one of the government schools in Qatar; students in the researcher's school were not included in the study for two reasons. Firstly, to eliminate potential bias from the researcher. Secondly, the researcher's school is a STEM-focused school, and therefore his students did not belong to the research population. The MOEHEQ provided an approval letter in both Arabic and English stating that the researcher has permission to apply the STEM-CIS to students in governmental schools. The provided letter informed the school principals about the study. the MOEHE also asked the school principals to facilitate the task of the researcher to undertake the necessary actions in the school to collect the required data.

To measure students' aspirations toward STEM careers and specializations, students were asked to respond to a paper-based version of the STEM-CIS. The paper version was written in the English language with Arabic translation to ensure students' understanding of the questions when they responded to them. The researcher gained approval (see Appendix C) to use a STEM-CIS study by email from Dr. Kier, the primary author of Kier et al.'s (2013). In their study, Kier et al. (2013) included the development of STEM-CIS. Additionally, the researcher gained the license to use and embed the STEM-CIS tool in this dissertation from Springer Nature Publishers with a license number 4687710923310, dated October 14, 2019 (see Appendix D).

STEM-related extracurricular programs at governmental schools in Qatar usually start in the second month of each semester. To recruit the target schools who were

involved in the research sample, I sent an email (see Appendix E) to 40 school principals two months before the start of the semester (about 3 months before the launch of the STEM programs), asking them to voluntarily participate in the research. In the invitation email, I attached the IRB approval, the MOEHE approval, the parents' consent form, the students' assent form, and the STEM-CIS. All forms and approval letters were translated to Arabic language to ensure that school principals, STEM programs facilitators, students, and parents can understand the wording of each letter. The target schools included 10 middle schools for girls, 10 middle schools for boys, 10 high schools for girls, and 10 high schools for boys.

I asked the schools to respond to the invitation email within two weeks. After two weeks of sending the invitation email, I sent a reminder email to the principals of the schools who did not respond to know if they are willing to participate in the research or not. Then, I created a list of the schools who volunteered to participate in the research and contacted each school by phone to agree for a time where I visited the school and met with the principal and the STEM-extracurricular program facilitators. The meetings were arranged to be at least one to two months before the launch of the STEM programs at each school. During the meeting at each school, I explained the research aim and procedures to the principal and the facilitators, and I gave them hard copies of the consent form, the assent form and the STEM-CIS survey as well as enough number of sealable envelopes. Each school received enough number of copies to make sure that schools do not assume any photocopying cost. In that meeting, I shared my contact information with the STEM programs facilitators and asked them for their phone number or email so that I

may contact them throughout the research process, and I collected information about the exact date when each school started the STEM extracurricular program. The STEM programs facilitators were asked to hand the consent and the assent forms to the students who joined the STEM-related extracurricular programs at least one month before the launch of the STEM programs. The facilitators were asked to tell the students that they should take the consent and assent forms home for review by their parents/guardians. For students whose parents/guardians did not give the permission for their child to be in the study, the consent form should be completed and signed. Additionally, students should sign the assent form. Students brought the completed consent and assent forms back to the school in a sealed envelope at least two weeks before the launch of the STEM-extracurricular program and dropped them in to a locked box that was fixed at the school front desk (reception office) until collected by the researcher. I visited the schools to collect the sealed envelopes, collected the consent and assent forms, explore them, and created a list of students' who approved the participation in the study. I used the information provided in the consent forms to create a list of students who accepted to participate in the research, then I generated a unique identification number for each student to be used in the STEM-CIS responses.

I contacted the STEM programs facilitators one day before the launch of the STEM extracurricular programs at each school and reminded them that I visited the school in the next day to distribute a hard copy of the STEM-CIS instrument for each participating student during the morning assembly time of the first day in the STEM-extracurricular program. I kept a list of students' information for the students

participating in the study, including a unique identification number against each student name. Students were asked to fill that number in the allocated box on the top of the survey cover page before responding to the pretest on the first day of the program, and the posttest survey on the last day of the program. I used the students' information list to remind the students of their identification number if they forget it during the posttest administration. During the last week of each program, I contacted the facilitators to remind her/him that I will visit the school again to apply the STEM-CIS to the target students one day after the end of the STEM program. The survey was administrated to students during the morning assembly time. In both the pretest and the posttest, I asked students to insert the surveys in a sealable envelop and seal before returning it to me. The unique identification number given to the students during the pretest and the posttest were used for matching purposes of the pretest and posttest surveys.

To maintain the confidentiality and privacy of the participants, responses to the STEM-CIS surveys were voluntary and deidentified through the use of unique identification numbers instead of the names. Schools, STEM facilitators, and students received a letter of thanks (see Appendix F). In the letter, I thanked them for cooperation in participating and contributing to the study. The message informed all stakeholders that they will receive emails containing a summary of the study findings after completion and approval of the dissertation.

Instrumentation

The development and subsequent use of STEM-CIS was pioneered by Kier et al. (2013) which aimed at measuring learners' interest in STEM classes and related careers,

especially among middle school students. From the social learning career theory, the STEM-CIS consists of four subscales namely science, technology, engineering, and mathematics. Each subscale has 11 items that measure students' aspiration toward a particular subject. For each item (e.g., "I can get a good grade in my science class"), students were asked to respond to a paper-based version of STEM-CIS. Each question is a Likert scale with the following choices: *Strongly Disagree* (1), *Disagree* (2), *Neither Agree nor Disagree* (3), *Agree* (4), *Strongly Agree* (5).

Kier et al. (2013) indicated that there is a strong latent correlation between the four subplaces scores that ranged from r =.72 to .82. Kier et al.'s findings suggested that researchers can use the four subscales independently to measure students' aspiration scores toward the corresponding STEM career, but they still can use all the items from all four subscales as a single factor to measure the average aspiration score toward STEM careers in general. In this study, students attended different domain-oriented STEM-programs. However, they are assumed to receive similar STEM-related experiences as explained earlier in the assumptions section of chapter 1. Hence, in this study, I used the 44 items of the STEM-CIS inventory as a single factor to measure the average aspiration score toward STEM-related careers and specializations.

Reliability

Reliability of a survey refers to the extent that the survey yields the same results over multiple trials (Creswell & Creswell, 2017). Kier et al. (2013) reported that STEM-CIS had a satisfactory level of reliability using based on the Cronbach's alpha values of internal consistency. Keir et al. reported that the Cronbach's alpha values were 0.77 for

the science subscale, 0.85 for the mathematics subscale, 0.89 for the technology subscale 0.86 for the engineering subscale, and 0.84 for the whole instrument with the 4 subscales combined.

STEM-CIS reliability was further investigated by Ünlü, Dököe, and Ünlü (2016), who aimed to adapt the STEM-CIS for the Turkish students. Ünlü et al. used the internal consistency and the test-retest methods. Ünlü et al. calculated the Cronbach's alpha value to measure the internal consistency of STEM-CIS. The Cronbach's alpha was 0.93, 0.86, 0.88, 0.94, and 0.90 for the whole scale, the science subscale, the technology subscale, the engineering subscale, and for the mathematics subscale, respectively. In the test-retest method, Ünlü et al. calculated Pearson product-moment correlation coefficients and found that the correlation coefficients were 0.87 for the entire scale, 0.67 for the science subscale, 0.73 for the technology subscale, 0.89 for the engineering subscale, and 0.85 for the mathematics subscale. Further, STEM-CIS was reported as a reliable instrument for measuring change in students' aspiration toward STEM-related careers by Gardere, Sharir, and Maman (2015), Shahali, Halim, Rasul, Osman, and Zulkifeli (2016), and Vaino, Vaino, Rannikmäe, and Holbrook (2015).

Correlation between the Four Domains and the whole Score

In this study, the four subscales of STEM-CIS inventory were used as combined tool to measure students' aspiration toward STEM-careers. Therefore, it is important to ensure that the four subscales are correlated and that they can be combined to measured students' aspiration. Kier et al. (2013) measured the correlations between the four subscales to test if they may work together as a single measure. Kier et al. reported a

correlation that ranged between 0.72 and 0.82. The results indicated the existence of a solid, substantial, and positive correlation between the four subscales and that they can be efficiently in combination as one tool to measure students' aspiration toward STEM-related careers and specializations in general.

Validating the Content of STEM-CIS

Validity is the extent to which the scores from a measure represent the variable they are intended to. Kier et al. (2013) followed several steps to construct and validate the content of STEM-CIS. First, they conducted a literature review of 130 research articles related to STEM interest, STEM careers perception, and the relationship between STEM career perception that the constructs of the social cognitive career theory (SCCT). The literature review allowed Keir and her colleagues to create a broad pool of questions/items that measure students' interest/aspiration to STEM-related careers. Second, Kier et al. asked a panel of experts that included a three science educators, one faculty member in educational psychology, and a faculty member in STEM career counseling to review if the STEM-CIS items are accurately linked to all of SCCT aspects, and if the items are understandable to students. Third, Kier et al. conducted a pilot study with 61 students representing middle school students involved in STEM programs. The pilot study allowed Kier and her colleagues to evaluate the clarity of the items to the students and consequently they were able to eliminate or reword the ambiguous items. Based on the literature review, experts' feedback and the pilot study, Kier et al. reported that STEM-CIS is valid for the content of each item in each subscale and is understandable by middle school students.

Fourth, Kier et al. (2013) checked STEM-CIS statements against the constructs of the social cognitive career theory (SCCT), which represent the conceptual framework of STEM-CIS construct. STEM-CIS statements were checked against the SCCT constructs including self-efficacy, interests, outcome expectations and personal goals, personal inputs, and contextual support and barriers. Kier et al. reported that STEM-CIS items were linked appropriately to all of the constructs of the SCCT with a correlation ranging from 0.56 to 0.76 indicating a strong positive correlation between STEM-CIS items and the SCCT constructs. Fifth, the content of STEM-CIS was further verified through a confirmatory factor analysis for the content scales in science, mathematics, engineering and technology using AMOS (AMOS is the structural equation modeling software produced with IBM/SPSS; Kier et al., 2013). Kier et al. concluded that STEM-CIS is a psychometrically valid tool predicting students' interest in STEM careers.

Criterion validity is defined as the extent to which subjects' scores on a measure are correlated with other variables (criteria) that one would expect them to be correlated with. Evidences for criterion validity involves the correlation between the survey and a criterion variables taken as representative of the construct (Taherdoost, 2016). Kier et al. (2013) tested the STEM-CIS's criterion validity thought testing the correlation between STEM-CIS items and the items from the mathematics and science self-efficacy scale developed and validated based on SCCT by Fouad, Smith, and Enochs (1997). Kier et al. reported a moderate to strong positive correlation between STEM-CIS items and mathematics and science self-efficacy scale with a correlation coefficient ranging from 0.579 to 0.762.

STEM-CIS criterion validity was further investigated by Ünlü, Dököe, and Ünlü (2016). Ünlü et al. tested the criterion validity of STEM-CIS by correlating the STEM interest/aspiration scores from STEM-CIS to those of the Interest in Science Scale (ISS). The results showed that there was a moderate, significant and positive correlation between STEM-CIS and ISS ($n = 34$, $r = .47$, $p < .001$). These results indicate that the STEM-CIS has criterion validity.

Data Analysis Plan

Unit of Analysis

The aim of this study was to investigate the change of students' aspiration toward STEM-related careers and specializations prior to and after attending STEM-related extracurricular programs. Additionally, in this study, I compared the aspiration scores between the pretest scores and the posttest scores for research question 1, and compared the changes between the pretest scores and the posttest scores among middle and high school students (for RQ3) and among boy and girl students (for RQ2). For all research questions, the average aspiration score was be calculated for the participating students before and after attending the STEM-programs. Hence, the unit of analysis in this study was the individual participants enrolled in STEM-related extracurricular programs.

Quantification of variables

This study included one dependent variable and one independent variable with within-subject factor and two between-subject factors. the dependent variable is the STEM aspiration scores measured through STEM-CIS, while the independent variable is the attendance of students in STEM-extracurricular programs. Research Question 1 was

tested based on the within-subject factor that is time indicating the two times the dependent variable STEM aspiration score has been collected the pretest and the posttest. Research Questions 2 and 3 have two between-subject factors that are gender and age group, respectively, and the interaction between each between-subjects factor and the within-subjects factor was tested to address research question 2 and 3.

I used the Statistical Package for Social Sciences (SPSS) software (Version 27) to quantify the variables, In SPSS, the between-subject factors in research questions 2 and 3 were quantified and coded as nominal data and were given numerical values. For gender, girls were coded as "0" and boys were coded as "1". Similarly, for the age groups, high school students were coded as "1" and middle school students were coded as "0". On the other hand, the dependent variable (aspiration scores) was measured using STEM-CIS on a Likert scale of 1 through 5. I calculated the overall aspiration of students toward STEM-careers and specializations as the mean score of the 44 items in the STEM-CIS. Hence, the aspiration scores were quantified as "scale/ratio" value using SPSS.

Collected data were analyzed by SPSS to compare aspirational scores to STEM careers utilizing a repeated-measures ANOVA. For research question 1, I conducted repeated-measure ANOVA analysis with one within-subject factor that is time between the pretest and the posttest to measure the change of students' average aspiration scores before and after attending the STEM-related extracurricular programs. The results of the repeated-measure ANOVA with one within-subject factor were used to indicate if the attendance of STEM-extracurricular programs significantly changed students' aspiration toward STEM careers or not.

For research question 2, I conducted the repeated measure ANOVA analysis with pretest and posttest as the within-subjects factor, and gender as the between-subjects factor to test if the change in aspiration scores depended on students' gender (boys or girls).

For research question 3, conducted repeated-measure ANOVA analysis with the same within subjects factor, and age group as the between-subjects factor to test if the change in aspiration scores depended on students' age group (high school or middle school). All significantly associated tests were evaluated using $\alpha = .05$.

The researcher analyzed the collected data to answer the following research questions and associated hypotheses:

Research Question 1: Is there any significant difference in students' aspiration toward STEM-related specializations and careers among Qatari students before and after attending STEM-related extracurricular programs?

$H_0 1$: There is no significant difference in students' aspiration toward STEM-related specializations and careers among Qatari students before and after attending STEM-related extracurricular programs.

$H_1 1$: There is a significant difference in aspiration toward STEM-related specializations and careers among Qatari students before and after attending STEM-related extracurricular programs.

Research Question 2: Is there any significant difference between boy and girl students regarding the changes of their aspiration toward STEM-related specializations

and careers measured before and after they attend STEM-related extracurricular programs?

$H_0$2: There is no significant difference between boy and girl students regarding the change of their aspiration toward STEM-related specializations and careers measured before and after they attend STEM-related extracurricular programs.

$H_1$2: There is a significant difference between boy and girl students regarding the change of their aspiration toward STEM-related specializations and careers measured before and after they attend STEM-related extracurricular programs.

Research Question 3: Is there any significant difference between middle school students and high school students regarding the changes of their aspiration toward STEM-related specializations and careers measured before and after they attend STEM-related extracurricular programs?

$H_0$3: There is no significant difference between middle school students and high school students regarding the change of their aspiration toward STEM-related specializations and careers measured before and after they attend STEM-related extracurricular programs.

$H_1$3: There is a significant difference between middle school students and high school students regarding the change of their aspiration toward STEM-related specializations and careers measured before and after they attend STEM-related extracurricular programs.

Threats to Validity

Internal validity considers all the factors that may contribute to an overall difference in the study which may affect the validity of the research findings (Baldwin, 2018). The most common threat to the internal validity of the present study is the differences in the STEM-extracurricular programs among the governmental schools that are going to be included in the study. The difference in studying the STEM extracurricular heavily relies on the program (engineering, robotics, digital fabrication, science, among others). Other factors include the type of instructional design, quality of program mentors or instructors, and the curriculum used before data collection exercises commenced. The researcher did not make any changes or make requests for the modification of STEM programs. The differences in the nature of the STEM courses could influence learners' aspirations during the data collection process. Therefore, the responses given by the learners may be subjective thereby affecting the validity of the information given. However, I avoided this threat to the research validity by calculating the mean aspiration score toward STEM careers regardless the specific STEM area the attended programs focus on. The use of the integrated aspiration score calculated by the mean score of the 44 items of STEM-CIS is supported by the fact that all the items of the four content areas of STEM-CIS are significantly correlated as stated by Kier et al. (2013).

Another internal validity threat is the selection bias. All the participants who were recruited for this study were selected by their teachers to participate in the different STEM extracurricular programs. The samples in this study were the pre-existing groups,

which makes it impossible for the researcher to separate the participants into randomized groups. Additionally, randomization is not possible for this study because boys and girls, middle school, and high school students attend different schools. According to Karatas and Baki (2017), the learning environment has a significant influence on the performance of learners. In this study, I did not consider how the environmental factors such as parental impact and school experience would affect the aspirations of the students attending the STEM extracurricular programs. Thus, the findings of the research cannot rule out alternative explanations due to these factors.

This study utilized the pretest-posttest design to collect data about students' aspiration before and after attending the STEM-extracurricular programs. Pretest-posttest research design is traditionally subjected to three major threats to internal validity, these threats include history, testing, and maturation (Baldwin, 2018; Taylor, 2013). History is referred to as the set of events that might affect students' aspiration toward STEM careers between the pretest and the posttest events other than the attendance of STEM programs (Baldwin, 2018; Dimitrov & Rumrill, 2003; Taylor, 2013). Similarly, Baldwin, Dimitrov and Rumrill, and Taylor, explained that students' responses to the posttest compared to pretest might be affected by their physical and/or psychological maturation, as well as the experience they gain by the pretesting event. The impact of history, maturation and testing on internal validity is a function of time. The longer the time between the pretest and the posttest will result in higher threat of internal validity (Shrout, 1980). However, the effect of history and maturation on this research validity could be reduced or eliminated by limiting the time interval between the pretest and the posttest.

Ethical Procedures

Once I obtained the approval from the institutional review board (IRB) at Walden University, and the Ministry of Education and Higher Education (MOEHE) in Qatar, I sent letters of consent to parents or guardians seeking their approval to allow their children to take part in the study. The students were sent home with the letter of consent at least one week before starting the STEM extracurricular programs. The STEM-CIS were administered to students who provided a written consent form and who signed the assent form. The written consent form used in the study came from the learners' parent or guardian. The parent or guardian also signed the assent form for his or her child to participate in the study.

Researchers should ensure that the privacy or confidentiality of the participants (Drew, Hardman, & Hosp, 2007). To ensure privacy and/or confidentiality I kept the responses to STEM-CIS anonymous. Anonymity was preserved by asking for no names, students' personal identification numbers, or other information that could identify single individuals. However, the STEM-CIS administrators (teachers or STEM mentors) assigned each student a unique identification number for matching purposes of the pretest and the posttest as described earlier in the sampling procedures section. The schools and STEM-Extracurricular programs were not identified. After the STEM-CIS surveys were completed, they were collected, scanned, and stored in a secure, password-protected folder on my computer and cloud storage folders. The paper-based hard copies of the surveys will be also kept in a passcode-protected safe at my office.

The data collected will be used and reserved for five years. However, the data will be destroyed after the five years following procedures outlined by the American Psychological Association (2009). All the stakeholders in the study such as teachers, sponsors, parents, or students are allowed to ask the results of the study. The researcher collected the email addresses of individuals interested in the findings of the survey. The email addresses were collected and kept in a separate file and will be used by the researcher to send a summary of the results after completion of the dissertation for the interested stakeholders.

Summary

A quantitative, pre-experimental study were conducted to determine whether there is a significant change in students' aspirational scores toward STEM careers. This research focused on periods before and after attending STEM-related extracurricular programs and utilized repeated measures ANOVA to compare students' aspiration before and after attending the STEM programs. The study also investigated if the change in aspirational scores was affected by gender and the grade level. Using the G*Power 3.1.9.4 software, the sample size of students participating in the study was estimated to be 200 Qatari boys and girls. The learners must be attending middle and high schools and enrolled in STEM-related extracurricular programs. The aspiration toward STEM careers was measured using a paper-based version of the STEM-CIS survey. Importantly, this section recognized that STEM-extracurricular programs are essential in the Qatar education system. STEM professions are recognized in the world for wealth creation and prosperity. Therefore, educational stakeholders must understand the role of schools in

fostering students' interest in STEM-related professions. Unequivocally, STEM continues to gain more attention worldwide, especially the role of schools in academically preparing students for STEM careers. This research is concentrated in Qatar. I used the best statistical tools to analyze the data collected from selected schools. Precisely, this chapter discussed the research procedures, validity and reliability of the data collection tool. The subsequent Chapter 4 consists of an interpretation and description of the results based on the analysis of the data collected during the data collection exercise in this study. The results are a reflection of the answers given by learners for the research questions.

Chapter 4: Results

Introduction

The purpose of this study was to investigate the change in students' aspiration toward STEM-related specializations and careers before and after attending STEM-related extracurricular programs. The study also aimed to investigate whether changes in students' aspiration could depend on (a) students' gender (males or females) or (b) students' age group (middle school or high school). Limited research in this area in Qatar makes this a timely and valuable study for providing initial insights in an area given little focus to date, namely the impact of attending STEM programs on students' aspiration toward STEM careers. Three research questions were posed and served as the primary nodes for considering results, which related to the differences in students' STEM aspirations before and after STEM-related programs and potential differences based on gender and grade level. In this chapter, the presentation of the results of this pre-experimental quantitative study started with a description of the data collection process including the timeframe and the participant recruitment procedures. Individual, group, and school demographics relevant to the study were also be presented, followed by a thorough data analysis and presentation.

Data Collection

To collect the data for this study, I used a paper-based version of STEM-CIS, which is made of 44-items of closed-ended 5-point Likert scale questions that measure students' aspiration toward STEM careers and specializations. The survey was used as a pretest and a posttest tool to measure aspiration scores toward STEM-related careers and

specializations from the same group of students enrolled in the four-week long STEM-related extracurricular programs (one-group, pretest-posttest). The data collection process lasted for 8 weeks between September and October 2020 as STEM programs did not start and end on the same week in different schools.

Data collection began after Walden University IRB approval (04-28-20-0478435) was received and authorization was granted from the director of policy analysis and research office at the Ministry of Education and Higher Education in Qatar. First, I reached out to 40 different middle and high school boys' and girls' governmental schools in Qatar to ask for school principals' cooperation in the data collection process. Thirty-six schools responded and gave me the permission to access the school and collect the data from students. The non-responding schools were all girls' middle schools.

Visits were scheduled throughout the weekdays to the different schools, and matched pre- and post-responses were received from 254 student participants. A priori power analysis called for a sample of at least 200 students. In the proposed data collection, I assumed that I would receive responses from equal numbers of boy and girl students and equal numbers of middle and high school respondents. However, the actual numbers were different due to four girls' middle schools not responding to the invitation to participate in the study. Additionally, some schools had more or less participating students in the STEM-extracurricular programs than others. Table 3 shows an analysis of how the actual sample compared to the projected minimum sample.

Table 3

Comparison of Actual Sample of Student Participants to Projected Minimum Sample

Group	Projected	Actual
Middle school girl students in STEM-extracurricular programs	50	39
High school girl students in STEM-extracurricular programs	50	70
Total number of girl students	100	109
Middle school boy students in STEM-extracurricular programs	50	53
High school boy students in STEM-extracurricular programs	50	92
Total number of boy students	100	145
Total number of participants	200	254

The 254 students were Qatari students enrolled in STEM-extracurricular programs. About 57% of the participants were boys (57.09%), and the rest (42.91%) of them where girls. Table 4 shows the percentage demographics of student participants.

Table 4

Description of the Sample

	Enrolled un STEM-extracurricular programs	
Group	*N*	%
Middle school	92	36.22
High school	162	63.78
Boys	145	57.09
Girls	109	42.91

The reliability of the STEM-CIS scale was calculated using Cronbach's alpha coefficient. The alpha coefficient was calculated using data that included responses to all items. Alpha coefficients were obtained for the total group, gender, and program type (see Table 5).

Table 5

Reliability of STEM-CIS Scale by Grade Level and Gender

Group	*N*	Cronbach's α
Middle school	92	0.945
High school	162	0.926
Boys	145	0.926
Girls	109	0.943
Total	254	0.934

The overall aspiration toward STEM-related careers and specializations was calculated by finding the mean aspiration score for the 44 items on STEM-CIS inventory. All the 254 students responded to all items on the pretest and the posttest, and their responses were matched as described in the data collection section in Chapter 3.

Results

Research Question 1

The first research question asked whether there was any significant difference in students' aspiration toward STEM-related specializations and careers among Qatari students before and after attending STEM-related extracurricular programs. For the hypothesis, the independent variable was the attendance of STEM extracurricular programs between the time of the pretest and the posttest. To test this hypothesis, a repeated measures ANOVA was performed for the two repeated average aspiration scores. Table 6 shows the mean and standard deviation for the average aspiration scores toward STEM-related careers and specializations for the pretest and posttest administrations of the STEM-CIS survey.

Table 6

Descriptive Statistics of the Pre- and Posttest Scores

	Mean	Std. Deviation	*N*
Pretest average aspiration score	3.9665	.49129	254
Posttest average aspiration score	4.2634	.49259	254

A repeated measures ANOVA was conducted (Table 7) with time between the pretest and the posttest used as a within-subject factor. The repeated-measures ANOVA showed that the mean aspiration towards STEM-related careers and specializations differed significantly between time the pretest and the posttest ($F(1, 253) = 56.325$, $P < 0.001$). The repeated-measure ANOVA results showed that attending the 4-week long STEM-related extracurricular program increased students' aspiration toward STEM-careers and specializations (3.97 ± 0.49 vs 4.26 ± 0.49 for the pretest average aspiration and the posttest average aspiration respectively), which was statistically significant ($p < 0.001$). Therefore, I concluded that attending the 4-week long STEM-related extracurricular programs elicited a statistically significant increase in students' aspiration toward STEM-related careers and specializations.

Table 7

Tests of Within-Subjects Contrasts

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Time	Linear	11.191	1	11.191	56.325	0.000	0.182	56.325	1.000
Error (Time)	Linear	50.269	253	0.199					

a. Computed using alpha = .05

Research Question 2

The second research question asked whether there was any significant difference between boy and girl students regarding the changes of their aspiration toward STEM-related specializations and careers measured before and after they attend STEM-related extracurricular programs. For this question, the dependent variable was students' aspiration toward STEM-related specializations and careers, and the independent was the attendance of STEM-related extracurricular programs. The independent variable had one within-subject factor (pretest and posttest aspiration scores) and a between-subjects factors (gender). To answer this research question a repeated measures ANOVA with one within-subject factor (time) and one between-subject factor (gender) was carried out. For the analysis purposes, the girls were coded as "0," and boys were coded as "1." Table 8 shows the mean and standard deviation for the average aspiration scores toward STEM-related careers and specializations for the pretest and posttest administrations of the STEM-CIS survey among girls (coded as 0) and boys (coded as 1).

Table 8 shows the mean and standard deviation for the average aspiration scores toward STEM-related careers and specializations for the pretest and posttest administrations of the STEM-CIS survey among girls (coded as 0) and boys (coded as 1).

Table 8

Descriptive Statistics of the Sample by Gender

Gender		Mean	Std. Deviation	*N*
Pretest average Aspiration	Girls	3.9697	0.52573	109
	Boys	3.9641	0.46558	145
	Total	3.9665	0.49129	254
Posttest Average Aspiration	Girls	4.2119	0.53207	109
	Boys	4.3021	0.45878	145
	Total	4.2634	0.49259	254

Table 9 shows the results of the effect of interaction between the within-subjects factor (time) and the between-subjects factor (gender). The repeated-measures ANOVA showed that the interaction effect of time and gender was not significant F (1,252) = 1.44, p > .05 , Eta-squared = .006. Figure 1 represents the interaction relationship between time and gender and it shows that the change in students' aspiration was higher among males at the end of the STEM program compared to girls. However, there was no significant difference in the change of aspiration scores based on gender.

Table 9

Interaction Between Within-Subjects Factor (Time) and Between-Subjects Factor (Gender)

Source	Type III sum of squares	df	Mean square	F	Sig.	Partial eta squared	Noncent. parameter	Observed power[a]
Time	10.471	1.000	10.471	52.791	0.000	0.173	52.791	1.000
Gender	0.222	1.000	0.222	0.779	0.378	0.003	0.779	0.142
Time * Gender	0.285	1.000	0.285	1.437	0.232	0.006	1.437	0.223
Error(Time)	49.984	252.000	0.198					

Note. a. computed using alpha = .05

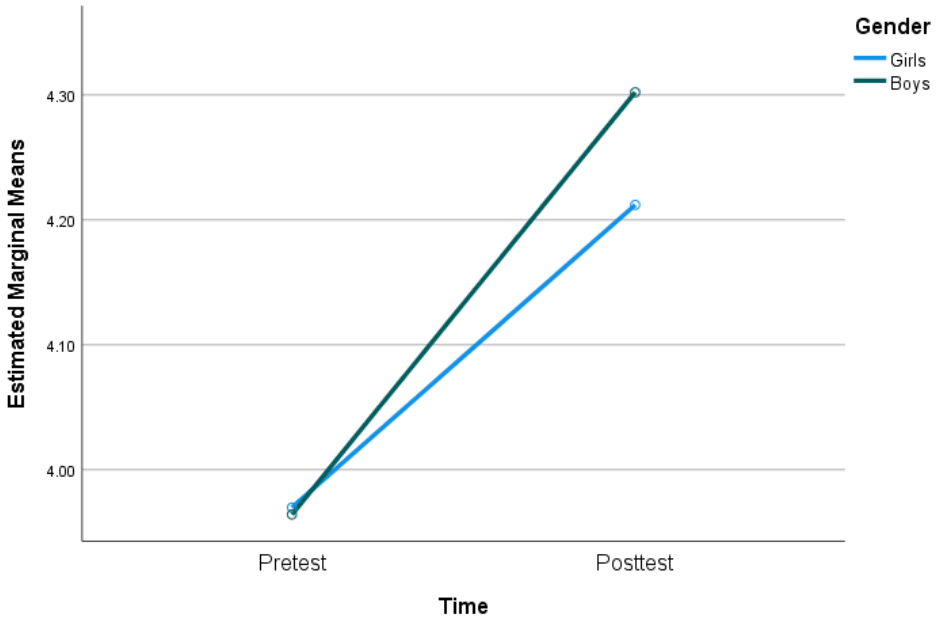

Figure 1. Estimated marginal means in STEM aspiration scores for boy and girl students.

Research Question 3

The third research question asked whether there was any significant difference between high school and middle school students regarding the changes of their aspiration toward STEM-related specializations and careers measured before and after they attend STEM-related extracurricular programs. For this question, the dependent variable was students' aspiration toward STEM-related specializations and careers, and the independent was the attendance of STEM-related extracurricular programs. The independent variable had one within-subject factor (pretest and posttest aspiration scores) and a between-subjects factors (age group). To answer this research question a repeated measures ANOVA with one within-subject factor (time) and one between-subject factor (age group) was carried out. For the analysis purposes, the middle school students were coded as "0," and high school students were coded as "1." Table 10 shows the mean and

standard deviation for the average aspiration scores toward STEM-related careers and specializations for the pretest and posttest administrations of the STEM-CIS survey among middle school students (coded as 0) and high school students (coded as 1).

Table 10

Descriptive Statistics of Sample by Age Group

Age Group		Mean	Std. Deviation	*N*
Pretest	Middle school	3.9707	0.53975	92
average	High school	3.9642	0.46326	162
Aspiration	Total	3.9665	0.49129	254
Posttest	Middle school	4.2598	0.46600	92
Average	High school	4.2654	0.50848	162
Aspiration	Total	4.2634	0.49259	254

Table 11 shows the results of the effect of interaction between the within-subjects factor (time) and the between-subjects factor (age group). The repeated-measures ANOVA showed that the interaction effect of time and age group was not significant $F(1,252) = 0.022$, $p > .05$, Eta-squared = .000. Figure 2 represents the interaction relationship between time and age group and it shows that the change in students' aspiration was almost identical for middle and high school students at the end of the STEM program. Therefore, there was no significant difference in the change of aspiration scores based on the age group.

Table 11

Interaction Between the Within-Subjects Factor (Time) and Between-Subjects Factor (Age Group)

Source	Type III sum of squares	df	Mean square	F	Sig.	Partial eta squared	Noncent. Parameter	Observed power[a]
Time	10.225	1	10.225	51.265	0.000	0.169	51.265	1.000
Age group	1.902E-05	1	1.902E-05	0.000	0.994	0.000	0.000	0.050
Time * Age group	0.004	1	0.004	0.022	0.883	0.000	0.022	0.052
Error(Time)	50.264	252	0.199					

Note. a. computed using alpha = .05

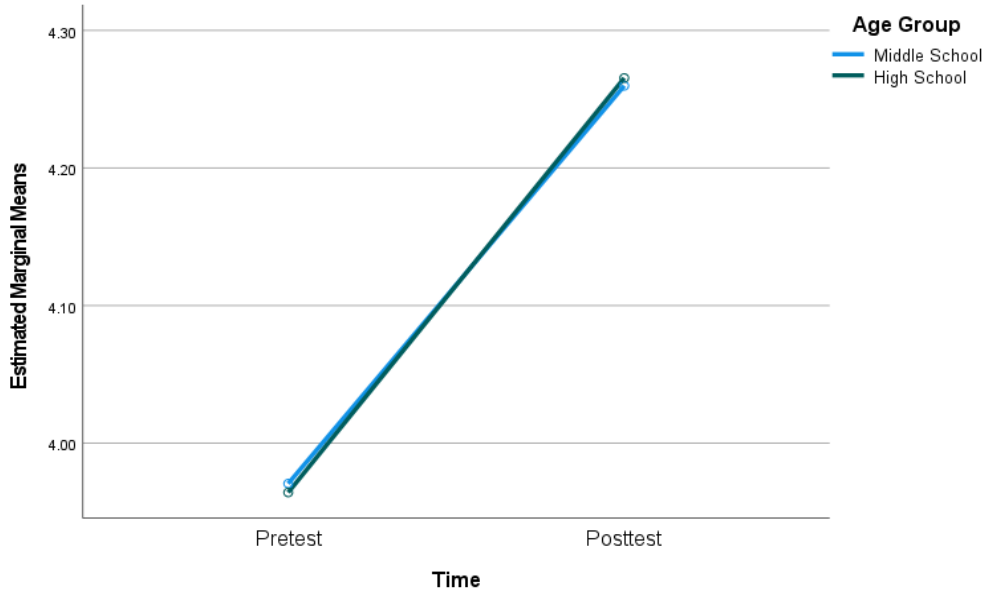

Figure 2. Estimated marginal means in STEM aspiration scores for middle and high school students.

Summary

Two hundred and fifty-four students from Grades 8 through 12 who participated in STEM-related extracurricular programs in 36 schools in Qatar were surveyed using a 44-item, STEM-CIS tool to measure their aspiration toward STEM-related careers and

specializations. A repeated-measures ANOVA with one within-subject factor and two between-subjects factors was used to analyze the survey results and to answer the three research questions. The repeated-measures ANOVA analysis revealed that the overall aspiration of students toward STEM-related careers and specializations was significantly higher after attending a 4-week STEM-related extracurricular program at their school compared to their aspiration before attending the program. The effect of gender and age group on the change of aspiration was tested to answers Research Questions 2 and 3, respectively. The results showed that aspiration toward STEM-careers and specializations was not affected by gender nor by the age group. The results of the analysis are discussed further in Chapter 5.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The continuous advancements in technologies and the increasing calls for a STEM-literate workforce that can handle the growing global challenges made the involvement of students in STEM-based learning experiences of upmost importance in many countries around the world (Krajcik & Delen, 2017; Shin, Rachmatullah, Roshayanti, Ha, & Lee, 2018; Kehdinga Formunyam, 2020). To prepare students for the future challenges and enhance their attitudes toward pursing studies in STEM fields, educators, policy makers and industrial sectors in different countries launched several initiatives including establishment of STEM-focused schools, STEM-based afterschool activities and summer programs as well as STEM-related outreach programs to attract students to engage in STEM-related learning experiences (Henderson & Greer, 2019; Means et al., 2017).

Researchers have found that attending STEM-related programs or STEM-focused schools fosters interest in STEM-related courses and careers at the post-secondary levels and workplaces among males and females (Bottia, Stearns, Mickelson, & Moller, 2018; Young, Ortiz, & Young, 2017). Qatar is one of the Arabian peninsula countries that is trying to develop a national workforce that transform the economy to a knowledge-based one instead of the oil and gas based economy. To achieve the transformation toward the knowledge-based economy Qatar's government and its industrial sector have been working in earnest to promote STEM educational pathways and careers for young people, and there are many ongoing collaborations and partnerships to entice and recruit Qataris

toward STEM-related education and careers (Nite & Aggie, 2017). Therefore, this study addressed the relationship between attending STEM-related extracurricular activities and students; interest towards STEM-related careers to provide insights for policymakers and educators about the impact of the STEM programs on interest toward STEM careers, and specializations among different age groups (middle and high school) and across genders (boys and girls).

Study Findings

The purpose of this quantitative, pre-experimental study was to investigate the change in students' aspiration toward STEM-related specializations and careers before and after attending STEM-related extracurricular programs. The study also aimed to investigate if changes in students' aspiration depended on (a) students' gender (males or females) or (b) students' age group (middle school or high school).

Responses from 254 students were used in the analysis of the research questions. A repeated-measures ANOVA indicated a statistically significant difference in the aspiration toward STEM-related specializations and careers among students who participated in a four-week STEM-related extracurricular program. The change of aspiration scores toward STEM-related specializations and careers was higher among boys as compared to girls but was not significantly different. On the other hand, the change of aspiration scores toward STEM-related specializations and careers was almost the same for middle and high school students.

Interpretation of the Findings

STEM-related extracurricular programs create an environment that allows students to develop and practice the 21st century skills including collaboration, communication, critical thinking, design thinking, problem solving, and innovation. In their proposal of the social cognitive career theory, Lent, Brown, and Hackett (1994) proposed that contextual factors, including training and simulation, improve a person's self-efficacy, beliefs, and outcomes and expectations, improving a person's interest in specific career paths. In STEM-related extracurricular environments, students are exposed to experiences and exercises that are linked to how their self-efficacy, beliefs about STEM jobs, skills, and expectations from STEM jobs are formulated and/or successfully developed.

Research Question 1

The current study results showed that students' aspiration towards STEM-related carriers and specializations significantly increased after attending a four-week STEM-related extracurricular program. The current study findings confirm the findings of Phelps et al. (2018), Huziak-Clark et al. (2015), and Ozis et al. (2018), who found that the enrollment in extracurricular STEM activities significantly enhanced students' attitudes toward STEM majors and careers. Researchers attributed the increased interest in STEM majors and careers after attending STEM-related programs to the nature of students' experiences while attending STEM activities, including hands-on activities and real-life applications of integrating science, technology, engineering, and mathematics. Young et al. (2017) and Kitchen et al. (2018) argued that the applicability

of STEM activities to real-life situations play a significant role in shaping students' aspiration toward STEM careers and majors. Bottia et al. (2018) and Means et al. (2016) also reported that STEM hands-on activities could transform traditional STEM subjects' conceptions into real-world understandings of unlimited possibilities for future careers. Other key components that illuminate the benefits of participation in STEM-related programs include the use of project-based learning, innovation, creativity, and hands-on technology (Huziak-Clark et al., 2015; Ozis et al., 2018; Phelps et al., 2018). The creativity aspect of STEM-related projects offers numerous benefits to students who have high levels of interest in engineering in particular (Nite & Aggie (2017).

Research Question 2

The second research question investigated the interaction effect between time and gender on the change of students' aspiration toward STEM careers and specializations after attending a four-week STEM-related extracurricular program. The results showed that there was insignificant effect of the interaction between gender and time on the change of students' aspiration toward STEM careers and specializations. However, the results showed the mean aspiration scores was higher for boy students after attending the STEM program as compared to girl students. Despite the established disparity of gender representation in STEM disciplines where males out number females especially in engineering, technology mathematics, and nonmedical fields (Reinking & Martin, 2018; Wang & Degol, 2017; Xu, 2015), many research studies confirmed that the gender gap in STEM fields can be minimized in many ways including engagement of female students

in STEM programs and at different grade levels and providing role-model mentoring (Bottia et al., 2015; Christensen et al., 2014; Ozis et al., 2018; Stoeger et al. 2017). Therefore, the current study findings agreed with previous studies that stated the gender gap in STEM fields and extend to the studies that argue that the STEM-training programs that immerse girl students in hands-on activities and real-life applications helps in closing the gender gap between males and females in their aspiration toward STEM careers and specializations.

Research Question 3

The third research question investigated the interaction effect between time and age group (grade level) on the change of students' aspiration toward STEM careers and specializations after attending a four-week STEM-related extracurricular program. The results showed that there was insignificant effect of the interaction between age group and time on the change of students' aspiration toward STEM careers and specializations.

Little is known about the impact of age group on the development of aspiration toward STEM careers due to the lack of research on the interaction between time and age group on the development of aspiration toward STEM-related careers and specializations. The literature review showed that career aspiration could be predicted at early scholastic stages, especially when students are involved in relevant educational programs. Baran et al. (2016), Christensen and Knezek (2016), and Holmes et al. (2017) showed that students' aspiration toward STEM careers appears in primary and middle years but changes over time and stabilizes when students are in high school where they become more confident about their career choices (Sax et al., 2015; Wiebe et al., 2018).

Therefore, the findings of the current study add to the body of knowledge about impact of the interaction between time and age group on the change of students' aspiration towards STEM careers and specializations by confirming that when students from different age groups are engaged in STEM-focused programs, their aspiration towards STEM careers and specializations develops independently from their age.

Limitations of the Study

A notable limitation of this study was the use of the single group, pre-experimental design due to the lack of the comparison control group. Additionally, students self-reported on their aspiration, therefore, participants might have answered the STEM-CIS questions according to what they felt the correct response should be, or they might have responded by marking the most neutral answer. Participants in STEM programs may have distinct personal or academic differences from students who do not participate in such programs, which may have affected the results. Other variables that may have affected the study findings, such as motivation and participants' academic record, were not examined.

Additionally, the sample demographics were not representative of the governmental schools' population. A larger percentage of boy students participated in the study than did girls, while girls outnumber boys in governmental schools in Qatar. A threat to validity was the fact that students self-selected to participate in the STEM extracurricular programs and in the study.

Recommendations

Recommendations for further research include a comparison of STEM aspiration among students who attend STEM-related programs and a control group. A comparative study would deepen the understanding of the relationship between attending extracurricular programs and the change of students' aspiration toward STEM careers and specializations. This study may be more productive using a longitudinal design, as collecting data may require an extended period.

Future research could be expanded to primary school students and college students, as well as to other school types in Qatar and the world. This expansion should focus on including diversified populations from different age groups, various socioeconomic backgrounds, and diversified cultures. The current research used data collected from Qatari middle & high school students in Qatar. Expanding the research to students from different nationalities and backgrounds in Qatar and/or in the other parts of the world would help to determine whether STEM programs would provide the same type of results as the current study. In addition, collecting data from primary and college students who participate in STEM-related programs during would present new factors in the analysis.

Despite that literature review showed an established gender gap in favor of males in STEM fields, the current study showed that this gap could be closed when girls are actively engaged in STEM-related programs. Therefore, I recommend fostering girls' aspirations toward STEM careers through the implementation of STEM-focused programs both in the curricular and the extracurricular contexts and to investigate the

factors that might contribute to the increased girls' aspirations towards STEM disciplines such as female role-models, small groups career guidance and parental support (Stoeger et al., 2017)

There is a need to promote high-quality teaching with well-planned STEM curriculum structure, expectations, and evaluations of student learning that correspond with Qatari student needs and abilities in order to engage students substantially and at the same time increase achievement in the STEM fields for all K-12 students. To accomplish this aim, STEM-focused instructional materials that can be modeled on world-class standards, including the implementation of new teaching strategies and methods, will be a potential choice to explore.

A hands-on approach to STEM teaching and learning topics that enhances the participation of students in STEM-focused learning activities must also be strengthened by application to real-life scenarios and realistic work to foster real interaction with fundamental science concepts and principles. In particular, realistic laboratory experience is of vital importance for both middle school and high school students. In tandem with this, inquiry-based learning must be emphasized by competitive activities such as science fairs at all K-12 levels of schooling and individualized and community experiences using project-based learning inside and outside the classroom. This approach can be combined with psychometric measures of longitudinal application that track the changes in the attitudes and interests of students towards STEM disciplines and examine the socioeconomic and contextual factors that lead to shaping the interests of students.

Implications

This study was designed to address the relationship between attending STEM-related extracurricular programs and aspiration toward STEM careers and investigate if the change in students' aspiration over time is linked to students' gender and age group. This study's results aligned with prior research and underscored the need for preparing students during middle and high school for careers in STEM fields. STEM extracurricular programs provide a platform where students can engage in project-based, hands-on and minds-on activities that relate abstract scientific knowledge to real-life applications and provide challenging learning experiences that enhance career readiness skills (Emaki et al.,, 2019; Stringer, Mace, Clark, & Donahue, 2019). Stakeholders including policy makers, educators, and industry and technology leaders must become aware of the need to increase the number of skilled STEM professionals by providing access to successful STEM programs, specifically during secondary school.

At present, Qatar's economy is heavily dependent on oil and gas, and this important sector of the Qatari economy is being driven by a large group of migrant workers. Through its vision of the future, Qatar seeks to localize jobs in the oil and gas sectors and gradually shift towards a knowledge-based economy, so the involvement of male and female Qatari students in STEM-based educational expertise and increasing their aspirations towards STEM disciplines and careers will contribute to the achievement of the desired positive social change for the Qatari people and economy. Without this action, Qatar may not be able to fulfill its national vision of transforming from the gas and oil economy to knowledge-based economy (Nite & Aggie, 2017). The objective of

many STEM-related extracurricular programs is to develop students' 21st-cenrty skills and capture and keep their interest in STEM-related career paths (Holmes et al., 2017; Lynch et al., 2017; Means et al., 2016). Through STEM programs, students are exposed to hands-on, project-based designs that translate scientific, mathematics and technological concepts into a real-world understanding of STEM subjects (Ekmekci et al., 2019). Using the engineering design process to create models promotes student interest and confidence in STEM subjects (Nite & Aggie, 2017; Phelps et al., 2018). STEM-focused programs and activities led to a new era for how students are affected by STEM by providing hands-on opportunities that link academia with real-life applications and career-related skills (Phelps et al., 2018). Findings of this study indicated that STEM-extracurricular programs provide positive influences that can transform students' interest in and future decision-making about STEM-related careers and specializations. This study's results may foster more conversation and action to broaden the implementation of STEM-related programs in schools in Qatar.

Exposure to STEM program provides appreciation and experiences that develop future interests among students, especially for girls (Blotnicky, Franz-Odendaal, French, & Joy, 2018; Christensen & Knezek, 2016; Van Aalderen-Smeets, Walma van der Molen, & Xenidou-Dervou, 2019). Stoeger et al. (2017) indicated that the gender gap in STEM fields is due to the lack of women role models in STEM fields in both the educational field and the workplaces. An environment that includes successful women may yield more female participation in the field. STEM industries need to increase female representation to counter the traditional gender biases that impede the

recruitment and retention of qualified professionals. Female representation would make an immediate difference in the number of successful workers who can make invaluable contributions to the STEM fields.

The need for an increase in students' immediate and future interest in STEM careers is an international concern. More information on the impact STEM curricular and extracurricular programs is needed to benefit different stakeholders inside and outside Qatar. Educators and stakeholders are communicating the need for more STEM programs for different groups including females and disadvantaged students, specifically in areas where resources are minimal (Hasanah & Tsutaoka, 2019). The goal is to formulate a STEM-oriented mindset among young people to prepare them for the 21st century challenges.

The results of the current study indicated that STEM-related extracurricular programs provide female and male students from different grade levels with a high level of STEM-related skills and enhance their aspiration toward STEM careers and specializations. STEM-related extracurricular program participation during pre-university education is a useful means of obtaining and maintaining the competencies necessary to succeed in STEM tertiary education and STEM careers (Means et al., 2016; Sahin et al., 2017). Findings from this study may inspire stakeholders, including educators, community leaders, parents, and policymakers, to begin or continue conversations about the benefits of STEM programs for school students to bring the desired positive social change of transforming their communities to become knowledge communities. The current study utilized repeated-measures ANOVA to compare the

pretest and the posttest overall aspiration scores of participating students. The aspiration scores were captured by the STEM-CIS survey which is made of four subscales. Each subscale measures students' aspiration in one of the four STEM disciplines. Educators can use the repeated measure ANOVA in combination with STEM-CIS subscales to collect longitudinal data about the impact of the STEM activities they implement in their normal science, technology, engineering or mathematics classes on students' aspirations toward these subjects. Using the STEM-CIS subscales to capture students' aspirations at multiple time points each year, will allow educators to understand the impact of their teaching practices and modify them to meet students need and nurture interest in the different STEM disciplines.

Conclusion

This research determined that students' aspiration toward STEM-related careers and specializations significantly increase after attending a 4-week STEM-related extracurricular programs that included project-based learning, engineering design and hands-on activities. The current research also showed that, the increase in students' aspiration toward STEM-related careers and specializations is not dependent on either gender or age group. The results suggested that both middle and high school, girl and boy students who participate in these programs benefit from favorable learning environments and STEM concepts which help them to develop their interdisciplinary knowledge and practical skills. Preparing students for STEM fields in Qatar is important. To increase the number of students interested in this field, more students from different age groups must be afforded more opportunities to participate in STEM

programs. The Ministry of Education has an obligation to increase the number of programs that directly affect the number of students in STEM careers. It is through the expansion of these programs that will make Qatar more competitive in STEM innovations and development. It is time for stakeholders to begin conversations to increase STEM programs in the country. Many educational institutions do not have access to these programs. Providing access STEM programs is a step forward to prepare more students in STEM fields. The earlier the exposure, the more successful students will be in STEM-related courses (Wiebe et al., 2018).

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Appendix A: STEM-CIS

Dear Student,

This survey is constructed to measure your aspiration towards the college specializations and careers related to science, technology, engineering, and mathematics (STEM-related careers and specializations). Please respond to all the questions in the survey by registering the first answer that comes to your mind without a lengthy thought. The researcher undertakes not to share your personal information or any other information reflecting your identity with any third party, and undertakes to provide a copy of the search results upon completion. If you would like to get a copy of the research, you can email the researcher on the following email: rani.altoum@waldenu.edu

Thank you for your contribution to answering the questions of this survey.

STEM-CIS

General Information

Unique ID (will be assigned by your teacher)			
School Name			
Grade level		Gender	☒ Boy
Date			☐ Girl

Instructions

This survey has four sections. For each item in each section, provide your answer by placing an "X" for each of the phrases, choose the first answer that comes to your mind. There is no right or wrong answer.

For example

#	Item	Strongly agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly disagree (1)
1	I enjoy the physical education lessons		X			

Section 1: For each item in this section about **Science**, provide your answer by placing an "X" for each of the phrases, choose the first answer that comes to your mind. There is no right or wrong answer.

#	Item	Strongly agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly disagree (1)
S1	I am able to get a good grade in my science class.					
S2	I am able to complete my science homework.					
S3	I plan to use science in my future career.					
S4	I will work hard in my science classes.					
S5	If I do well in science classes, it will help me in my future career.					
S6	My parents would like it if I choose a science career.					
S7	I am interested in careers that use science.					
S8	I like my science class.					
S9	I have a role model in a science career.					
S10	I would feel comfortable talking to people who work in science careers.					
S11	I know of someone in my family who uses science in their career.					

Section 2: For each item in this section about **Technology**, provide your answer by placing an "X" for each of the phrases, choose the first answer that comes to your mind. There is no right or wrong answer.

#	Item	Strongly agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly disagree (1)
T1	I am able to do well in activities that involve technology.					
T2	I am able to learn new technologies.					
T3	I plan to use technology in my future career.					
T4	I will learn about new technologies that will help me with school.					
T5	If I learn a lot about technology, I will be able to do lots of different types of careers.					
T6	My parents would like it if I choose a technology career.					
T7	I like to use technology for class work.					
T8	I am interested in careers that use technology.					
T9	I have a role model who uses technology in their career.					
T10	I would feel comfortable talking to people who work in technology careers.					
T11	I know of someone in my family who uses technology in their career.					

Section 3: For each item in this section about **Engineering**, provide your answer by placing an "X" for each of the phrases, choose the first answer that comes to your mind. There is no right or wrong answer.

#	Item	Strongly agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly disagree (1)
E1	I am able to do well in activities that involve engineering.					
E2	I am able to complete activities that involve engineering.					
E3	I plan to use engineering in my future career.					
E4	I will work hard on activities at school that involve engineering.					
E5	If I learn a lot about engineering, I will be able to do lots of different types of careers.					
E6	My parents would like it if I choose an engineering career.					
E7	I am interested in careers that involve engineering.					
E8	I like activities that involve engineering.					
E9	I have a role model in an engineering career.					
E10	I would feel comfortable talking to people who are engineers.					
E11	I know of someone in my family who is an engineer.					

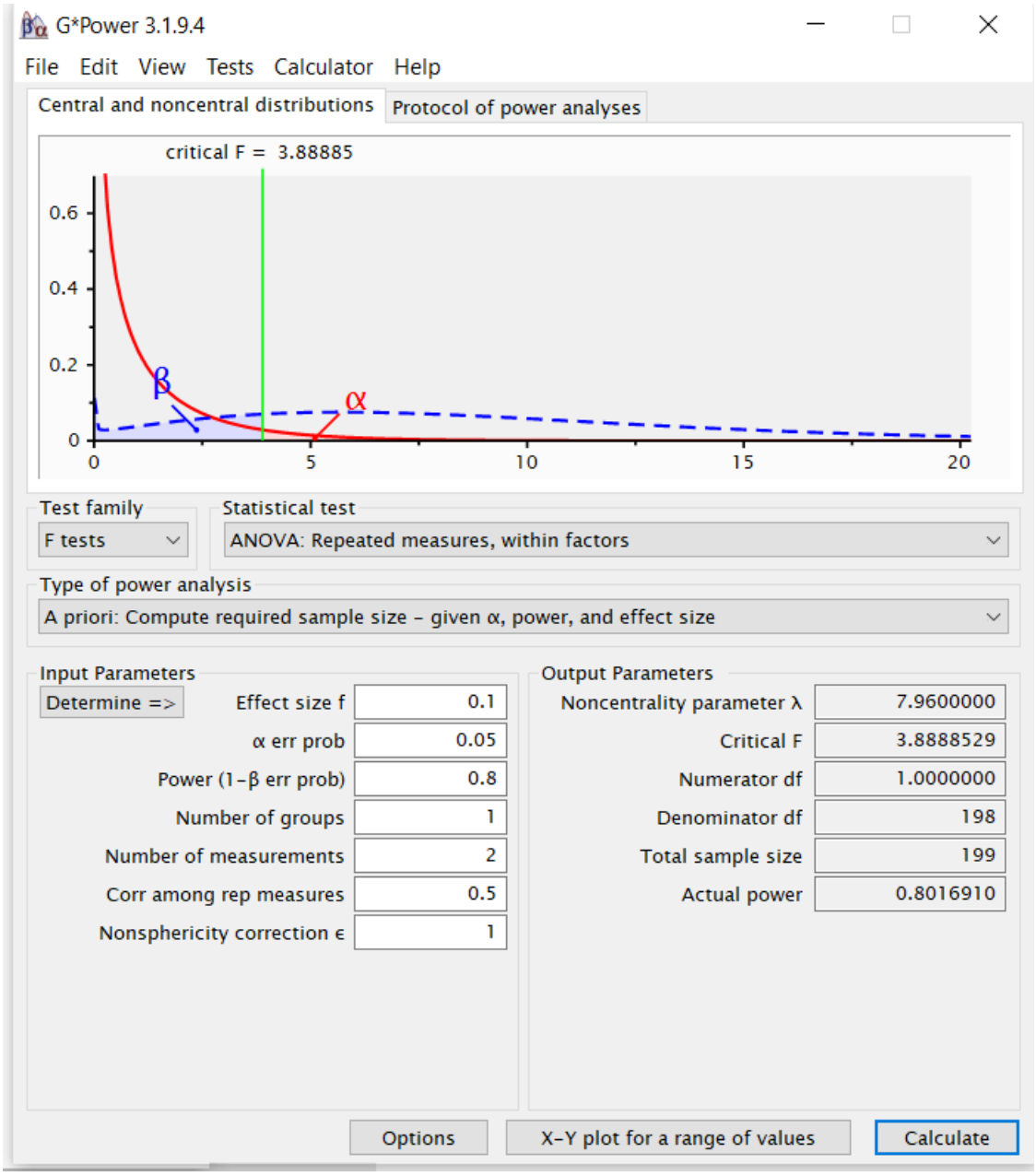
Section 4: For each item in this section about **Mathematics**, provide your answer by placing an "X" for each of the phrases, choose the first answer that comes to your mind. There is no right or wrong answer.

#	Item	Strongly agree (5)	Agree (4)	Neutral (3)	Disagree (2)	Strongly disagree (1)
M1	I am able to get a good grade in my math class.					
M2	I am able to complete my math homework.					
M3	I plan to use mathematics in my future career.					
M4	I will work hard in my mathematics classes.					
M5	If I do well in mathematics classes, it will help me in my future career.					
M6	My parents would like it if I choose a mathematics career.					
M7	I am interested in careers that use mathematics.					
M8	I like my mathematics class.					
M9	I have a role model in a mathematics career.					
M10	I would feel comfortable talking to people who work in mathematics careers.					
M11	I know someone in my family who uses mathematics in their career.					

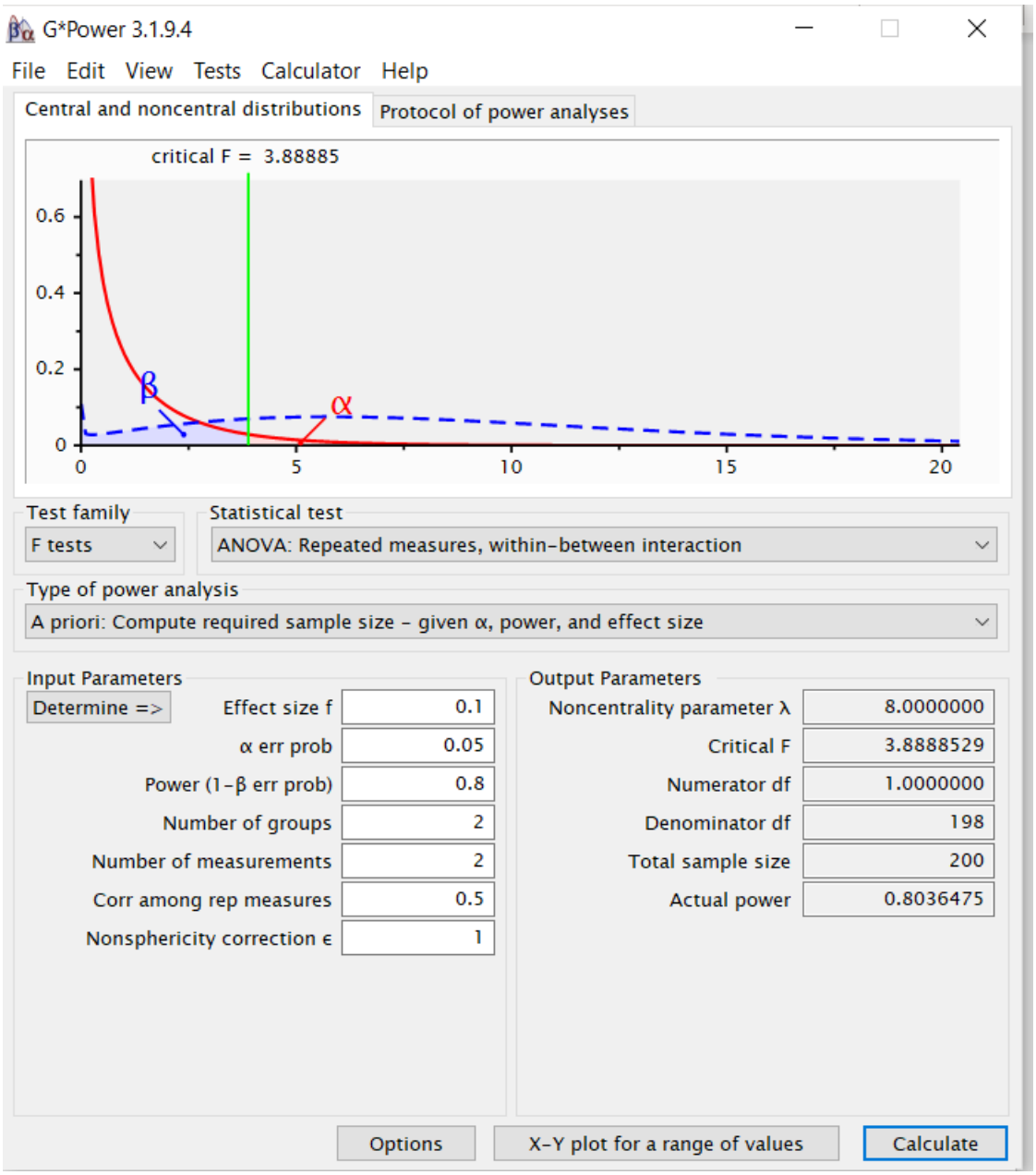
Thank you for completing the survey

Appendix B: G*Power calculations for sample size

a. G*Power calculations for sample size for research question 1.



b. G*Power calculations for sample size for research question 2 and 3.



Appendix C: Approval to use the STEM-CIS tool from the author

From: رانى محمد احمد التوم<r.altoum1512@education.qa>
Date: Thursday, October 3, 2019 at 1:03 PM
To: Meredith Kier <mwkier@wm.edu>
Subject: Permission to use STEM-CIS

Dear Dr. Kier,

My name is Rani Altoum, a Ph.D. candidate in learning, instruction, and innovation in education at Walden University.
I am carrying a dissertation research about the impact of attending STEM programs on students interest in STEM careers in Qatar, and I am planning to use the STEM-CIS tool you developed and published in your paper (Kier, M. W., Blanchard, M. R., Osborne, J. W., & Albert, J. L. (2013). The Development of the STEM Career Interest Survey (STEM-CIS). Research in Science Education, 44(3), 461–481. doi:10.1007/s11165-013-9389-3) as the main data collection tool about students' interest in STEM careers.

Therefore, I am kindly asking for the permission of using that inventory in my research. I wonder if there is a more official request form to submit.

I look forward to hearing from you soon.

Regards,

Rani Altoum

Re: Permission to use STEM-CIS

KM Kier, Meredith <mwkier@wm.edu>
To رانى محمد احمد التوم

Reply | Reply All | Forward | ...
Thu 10/3/2019 9:13 PM

You forwarded this message on 10/3/2019 9:25 PM.

You have my permission to use the instrument. Good luck with your study.

Warm regards,

Meredith

--
Meredith W. Kier, Ph.D.
Associate Professor, Curriculum and Instruction
Director of the Secondary Science Education Program
Project Investigator, NSF EAGER Grant
Project Investigator, NSF E-Communities Grant
Co-Director, Center for Innovation in Learning Design
Co-Project Investigator, WM Noyce Grant
William & Mary

Appendix D: license form Springer Nature to use STEM-CIS

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Oct 19, 2019

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Appendix E: Invitation letter to participate in a research study

Dear school principal,
Greetings,

My name is Rani Altoum, from Qatar Science & Technology Secondary School for Boys.
I am currently enrolled in an online Ph.D. program at Walden University, and to compete my dissertation I am carrying out a research study entitled " Relationship between Attending STEM Extracurricular Programs and Aspiration Toward STEM Careers".

I gained the approval to implement this research study at governmental should in Qatar from the Ministry of Education and Higher Education (MOEHE), and the Institutional Review Board (IRB) from Walden University. The study targets the middle and high school boys and girls enrolled in STEM-related extracurricular programs at the governmental school in Qatar.
Your school has been selected to apply the research study to your students, hence I am asking for your kind approval to implement the study at your school and to determine a time where I may visit your school and meet with you and with the STEM extracurricular programs facilitators to explain the aim of the study and the study procedures.
The participation in the study is voluntary and anonymous for the school and the students, so I hope that you may kindly approve the school participation in the study and reply to me within a week to know your decision.

Please find attached in this email the following documents:

- MOEHE approval.
- IRB approval.
- Parents' consent from.
- Students' assent from.
- STEM-CIS survey tool.

You may kindly contact me on my phone at 55458296, or email at:
r.altoum1512@education.qa

Thank you,
Rani Altoum

Appendix F: Thank you letter

Letter of Thanks

Date:

Dear Student,

Thank you for taking the time to respond to the STEM-CIS questionnaire.

The information you gave will make a valuable contribution to my study. This study investigates the relationship between enrollment in STEM extracurricular program and aspiration toward STEM careers. By responding to the STEM-CIS tool, you have helped us identify ways to improve other students' learning experiences and help them to decide their future academic paths.

Please note that you are welcome to receive a copy of the research results when it is completed. Should you have any enquiries about the research in the meantime, please contact the researcher [Rani Altoum, a doctoral student at Walden university] on [rani.altoum@waldenu.edu].

Once again, please accept our sincere thanks for so generously responding to the study questionnaire.

Kind regards

Rani Altoum
Doctoral student at Walden university
Email: rani.altoum@waldenu,edu
Phone number : 00974-55458296