11-4-2022

A Mixed Methods Study: How Cultural messages Through Experiences Influence Occupational Pursuit of Muslim Female Computer Science Students

Maral Kargarmoakhar
mkargarm@fiu.edu

FLORIDA INTERNATIONAL UNIVERSITY

Miami, Florida

A MIXED METHODS STUDY: HOW CULTURAL MESSAGES THROUGH EXPERIENCES INFLUENCE OCCUPATIONAL PURSUIT OF MUSLIM FEMALE COMPUTER SCIENCE STUDENTS

A dissertation submitted in partial fulfillment of the

requirements for the degree of

DOCTOR OF PHILOSOPHY

in

COMPUTER SCIENCE

by

Maral Kargarmoakhar

2022

To: Dean John L. Volakis
College of Engineering and Computing

This dissertation, written by Maral Kargarmoakhar, and entitled A Mixed Methods Study: How Cultural Messages through Experiences Influence Occupational Pursuit of Muslim Female Computer Science Students , having been approved in respect to style and intellectual content, is referred to you for judgment.

We have read this dissertation and recommend that it be approved.

Mark Allen Weiss

Leonardo Bobadilla

Nagarajan Prabakar

Zahra Hazari

Monique Ross, Major Professor

Date of Defense: November 4, 2022

The dissertation of Maral Kargarmoakhar is approved.

Dean John L. Volakis
College of Engineering and Computing

Andrés G. Gil
Vice President for Research and Economic Development
and Dean of the University Graduate School

Florida International University, 2022

DEDICATION

This dissertation is dedicated, from the bottom of my heart, to my best friend and loving husband, Dr. Masood Hajali, for his unconditional support and sacrifices which made this dissertation possible. I would also like to express my deepest appreciation to my parents, Dr. Rohani Kargarmoakhar and Mrs. Masrooreh Hashemizonoz for treating me like a princess throughout my life and providing me with unfailing support and continuous encouragement throughout my years of study and research while writing this thesis. I am extremely grateful to have supportive brothers Mr. Roozbeh Kargarmoakhar, and Dr. Ramtin Kargarmoakhar, who did not allow me to give up when the chips were down. Lastly, a special thanks to my wonderful in-law Dr. Maryam Asghari Mooneghi for her endless love and encouragement.

ACKNOWLEDGMENTS

I would like to express my gratitude and appreciation to everyone who helped me and contributed to this research project; without them I would not have been able to complete this research and would not have made it though my PhD degree. First and foremost, I would like to say a special thank you to my major professor Dr. Monique Ross for her support, guidance, valuable advice, mentorship, and - most importantly - for believing in me and treating me like her friend.

Addtitionally, I would like to sincerely thank the members of my doctoral committee, Dr. Mark Allen Weiss, Dr. Zahra Hazari, Dr. Leonardo Bobadilla, and Dr. Nagarajan Prabakar for their willingness to help, valuable advices, inputs, and constructive feedbacks.

Furthermore, I would like to thank the Listening and Engaging with Alternative Research Narratives in Computer Science (LEARN-CS) team members for all their friendship, support, and feedback during this time. I truly enjoyed working with each and everyone in our LEARN-CS group during the last five years. I also want to say thanks to all women who participated in the interviews and enabled this research to be possible.

In addition, I would like to convey my appreciation for the love and support I've received from my beloved husband, dear parents, and truly amazing brothers. I can't thank you enough for encouraging me throughout this experience.

ABSTRACT OF THE DISSERTATION

A MIXED METHODS STUDY: HOW CULTURAL MESSAGES THROUGH EXPERIENCES INFLUENCE OCCUPATIONAL PURSUIT OF MUSLIM FEMALE COMPUTER SCIENCE STUDENTS

by

Maral Kargarmoakhar

Florida International University, 2022

Miami, Florida

Professor Monique Ross, Major Professor

Women are underrepresented in the field of computer science in the United States. However, this is not a new problem as female participation in computer science has been experiencing a steady decline over the last three decades. Current reporting on women's participation in this field has been published as steadying at around 18 percent. Meanwhile, there are varying levels of participation in other countries, particularly in Muslim majority countries. For example, women in Bahrain, Morocco, Palestine, Oman, Saudi Arabia, Iran, and Tunisia earned more than half of the total number of science degrees in their respective nations. This stark contrast between the United States and these other countries has prompted an exploration into the factors that contribute to women's participation in computer science.

This thesis focuses on understanding how cultural environment can affect the participation of women in computer science, specifically with respect to individual, household, community, country, and global influences on occupational pursuit. The guiding theoretical framework is multi-level (micro and macro) cultural theory, to answer the following research questions: 1) How do micro and macro level cultural influences impact Muslim identified women's intention to pursue a computer science undergraduate degree? 2) How do experiences differ in their impact on pursuing a

computer science degree for Muslim women as compared to non-Muslim women in the United States? To answer these questions, I employed a sequential exploratory mixed methods design that leveraged interviews, a survey, qualitative analysis, as well as statistical analysis. The results of this work are important to shedding light on the ways to increase engagement of women in computer science in the United States.

TABLE OF CONTENTS

CHAPTER PAGE

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

The computer science field is at the vanguard of innovation, which means it has a great influence on future advancement [Panchanathan, 2022]. Nearly all industries have become international in today's digital age, which has accelerated the speed of improvement and increased competition for discoveries [Schwab, 2016]. Furthermore, the accelerated pace of growth in a rapidly changing world necessitates immediate and detailed examination of numerous large-scale challenges, such as climate change, population patterns, disease control, and so on [Mynatt et al., 2020, Kunkle et al., 2016]. In short, computer science employment is in high demand since these are the jobs that have the greatest immediate and long-term impact on the future.

"Globally, computer science and information technology majors in universities are dominated by men" [Alhashmi, 2018]. However, in the Middle East, 40 percent of university students specializing in computer science and IT are women [Alhashmi, 2018]. The percentage is even higher in Saudi Arabia and the United Arab Emirates, where women represent 70-80 percent of computer science and IT students compared to 15-20 percent in the United States despite women making up 60 percent of enrolled college students [World Bank, 2022, Belkin, 2021]. Thus, in order for the United States to remain competitive in this important sector, there is a strong need to have more females in the computing fields. In the next section, I will describe the problem, review the literature, and give more information about Muslim women in the computer science field.

1.1 The Problem

Women's underrepresentation in computer science in the United States and other Western countries is not a new issue. According to the data, American women's graduation rates in computer science have dropped since the mid-1980s [Snyder, 2012]. Women's participation and representation in computer science is critical because "greater diversity among those who create computing technology ensures that those technologies are relevant to and usable by a wider range of people" [Roberts, 2003]. Despite the efforts of government, public, and private groups, women continue to be underrepresented in this well-paying, in-demand, and respected occupation in the United States. In some nations, such as Muslim-majority countries, women have high participation percentages in computer science. Women account for about half of all computer science students in Muslim-majority nations such as Iran, Oman, Saudi Arabia, and many more [UNESCO, 2021].

It is critical to comprehend how a perceived gender-biased society, such as Saudi Arabia, achieved gender parity in the field of computer technology [Quraishi-Landes, 2016]. On the other hand, the United States, which ranks among the top 55 countries in terms of gender equality, has yet to achieve that level of parity [World Economic Forum, 2021]. Leveraging the guiding theory of *micro-macro level cultural influences* I designed a study that explores the different factors that influence a Muslim woman's path towards pursuing computer science as a major.

1.2 Literature Review

It is very crucial to make efforts across the computing landscape and across industries to increase participation in computing given the chronic underrepresenta-

tion of female students in computer science education and the computing workforce. Workforce development opportunities, regulatory initiatives, and in-school and out-of-school interventions can contribute to increasing engagement in computing [Kargarmoakhar et al., 2021, Scott et al., 2017].

Research examining the large disparities in computing disciplines has shown convergent barriers, including structural barriers in access and opportunity, as well as social and psychological barriers in individual attitudes and responses to social and environmental factors in the United States [Kargarmoakhar et al., 2020, Scott et al., 2016]. These social and psychological barriers include misconceptions about the field of computing, stereotype threat associated with being a member of a marginalized group, and stereotypical cues in classrooms and workplace environments [Scott et al., 2016].

According to the literature, the culture of practice within computer science in the United States excludes women [Ong et al., 2011]. The practice and norms of the computing occupation have been referred to as masculine, which means that there are different expectations of men and women that inequitably impact different populations. This has frequently created barriers for those who are not aligned with the masculine technological culture [Faulkner, 2001, Frehill, 2016].

Curricula, programming languages and environments, faculty and student belief systems, and learning spaces are all mediated by a culture defined by the gendering of computer programming that began in the 1970s [Ensmenger, 2010]. Today, software and computer clubs are viewed as male-oriented, and computer games with violence, militarism, and sexualized pictures perpetuate sex-role stereotypes [Peckham et al., 2007]. When companies arrange their labor division, norms and practices become gendered, which has a negative impact on women [Peckham et al., 2007]. Computer science is also seen as lacking in creativity, as

well as interpersonal or social importance, which discourages women from pursuing careers in the industry [Rich et al., 2004]. As a result, girls start college with little desire to pursue computer technology in the United States.

According to the available research, when people are placed in situations where they are underrepresented, and prevailing preconceptions predict that people from their group of identification will not do as well as those from the majority group, their performance suffers [Peckham et al., 2007]. The stereotype thus becomes self-fulfilling. Underrepresented groups in computer science, such as women, persons of color, and first-generation college students, are perceived as having less interest in and affinity with the profession [Peckham et al., 2007]. This discourages participation and performance, especially given the existing dominance of white males in CS. As a result, even well-intended recruitment and retention initiatives might be undermined by stereotype threat.

Studies revealed that classroom teachers pay less attention to girls than boys and act in ways that indirectly reduce the potential of female students [Elkjer, 1992, Sadker, 1986]. These dynamics, however more subtle, are still present in today's classrooms. Computer science classes are frequently "bastions of poor pedagogy," according to the American Association of University Women's Technology Commission [Commission On Technology and Education, 2000, Margolis and Fisher, 2002]. A cold environment for women in computer classrooms may occur despite awareness and education on more gender equitable teaching practices because of how teachers continue to "do gender" in their interactions with students [West et al., 1987]. According to social science theory, "gender" is not a biological sex category but rather the way that men and women behave in social situations in accordance with recognized cultural standards [Cislaghi and Heise, 2020]. As such, gender is a construct that both defines and is defined by social interaction. What is missing is a

serious effort to match positive attitudes and good intentions with actions that do not subtly reflect traditional ideas about women, minorities, and computer science.

Gender roles are separated in Muslim majority countries [Hamdani, 2004]. However, there is a common misconception that Muslim women do not pursue STEM degrees since science and mathematics are only for men [Islam, 2017]. In fact, it is premature to posit the ways in which gender plays a role in how Muslims choose to live, but there are clear differences between the choices women and men make [Hamdani, 2004]. For example, Muslim women wearing hijabs has become a symbol of confrontation and cultural difference between the West and the Muslim world [Aquil, 2011].

Women's education has been affected by Islamic customs and traditions, and researchers agreed that primary aspects of society and cultural factors affecting female education are religion and family [Harvil, 2015, Al Alhareth, 2013]. Family and parenthood remain important social foundations in Muslim society[Islam, 2017]. Traditionally, women are responsible for taking care of the home, which hinders their professional development [Islam, 2017].

Education policies in nations with a majority of Muslims argue that there should be a gender divide in the classroom and that female education should create suitable employment for female students [Ministry of Education, 2022]. These strict Islamic principles lead to gender segregation from primary school [Findlow, 2008]. Depending on rules in each Muslim country, students are segregated until high school or in some cases even at the university level [Shahrokni, 2020, Sergon, 2022]. Additionally, females have limited access to several university domains that are believed to be masculine fields [Findlow, 2008, Herrera, 2007]. The literature claims that female students choose computer technology because of the support of their families

and the stable computing work environment in nations with a majority of Muslims [Alghamdi, 2017].

According to UNESCO and World Bank data, Muslim women are increasingly interested in STEM disciplines provided by institutions in the region [UNESCO, 2021, World Bank, 2022]. In 2014, for example, women made up 59 percent of total student enrollment in computer science at Saudi government universities. By contrast, in the United Kingdom and the United States, female enrollment in computer science was 16 percent and 14 percent, respectively; these figures include international students, some of whom were from Muslim countries [UNESCO, 2021, World Bank, 2022, Universities UK, 2022].

The study's findings discussed above add to our understanding of ways to increase engagement and highlight the importance of assessing and disseminating effective intervention strategies to increase minority students' involvement and readiness in computing. In the following section, I go into greater detail on Muslim female computer science students.

1.2.1 Muslim Identified Women in Computer Science

Islam, the world's second largest religion, has a large number of followers. One study found that the Muslim population in 2020 was estimated to be 1.9 billion people, making up around 24.7% of the world's population [United States Census Bureau, 2022]. Islam is prevalent across the Middle East, North Africa, and throughout the Sahel, as well as in various East Asia and South Asia sub-regions. According to the Pew Research Center there are 50 Muslim majority countries including Saudi Arabia, Iran, Morocco, Jordan, Tunisia, Malaysia, and Qatar [Pew Research Center, 2009].

It is worth mentioning that individuals born into a Muslim family are ascribed the identity of Muslim from birth, and are not allowed to change their religion. It is considered acceptable for an individual to self-identify as any of the branches of Islam (mainly Sunni or Shia); however, if an individual does try to change their religion it is perceived as a shameful act which is called Apostasy in Islam; there is no one written consensus on its consequences [Saeed, 2018, Beehner, 2007]. There are also people who accept the identity of Muslim based on their birth certificates but do not practice Islam [Montgomery, 2016]. For those people that elect to practice Islam, they are governed by the rules and norms of the religion, including customs like - wearing a hijab (for women), praying, fasting in accordance with the religious days of obligation, abstaining from alcohol, eating halal food, paying the zakat, and many more [Montgomery, 2016]. For example, a hijab is mandatory for Muslim females to wear in front of all males excluding immediate family members [Montgomery, 2016]. There are also people in Muslim-majority countries who do not practice the religion at all – not adhering to its customs or rules. For example, there are females who do not wear a hijab when it is not mandated by the government. Thus, those that identify as Muslim may or may not practice Islam. However, the people who identify as Muslim can still share the same cultural values of that society, since it is heavily influenced by religion (namely, Islam) (see 2.2 Culture and Religion). For the purpose of this study, I look at the cultural values that lead to high participation of female students in computing fields, while avoiding a deep exploration into students' religious practices (whether they practice Islam or not).

Previous studies have examined the relationship between religion and occupational pursuit in other disciplines including physics and engineering [Moshfeghyeganeh and Hazari, 2021, Kranov et al., 2015]. Moshfeghyeganeh and Hazari looked at the cultural experiences of Muslim female physics faculty members

in the United States [Moshfeghyeganeh and Hazari, 2021]. They focused on how cultural experiences shaped participants' gender and physics identity using a qualitative approach and precisely phenomenological interviews [Kranov et al., 2015]. In another study, researchers focused on factors which impact the educational and occupational trajectories of women in engineering in Middle Eastern countries and the United States. All the Middle Eastern countries that were the focus of this study (Saudi Arabia, Jordan, Malaysia, and Tunisia) are identified as Muslim majority countries.

1.3 Research Purpose and Goals

This is a critical juncture in computing education, with enthusiasm soaring yet hampered by disproportionate representation across societal groups. Numerous groups, including women, African Americans, Hispanics, American Indians, Alaska Natives, Native Hawaiians, Native Pacific Islanders, and those with disabilities, have historically been underrepresented in the field of computing [World Bank, 2022]. Women are underrepresented in all of the cultural groupings described above. As previously stated, although women represent 60% of all college enrolled students they make up fewer than 20% of all computer science students in the United States [UNESCO, 2021, World Bank, 2022].

Over 410,000 computer jobs are vacant nationwide due to a skills gap that prevents firms from finding enough skilled people to fill all of these positions [Hutchinson, 2021]. State leaders want to make sure that graduates have the skills they need to secure high-paying employment without leaving the state, particularly as more remote working options emerge [Hansen, 2021, Allen Smith, 2022]. At the same time, global competitiveness is escalating. The majority of H1B (or

"skilled worker") visas are for computer science positions, since employers will go outside the country if they are unable to fill their slots with local talent [Ruiz and Krogstad, 2018]. Thus, if we can attract more women into the field there will be more skilled people available domestically to occupy the positions.

As mentioned earlier, although women are underrepresented in computer science in the United States, women's participation rate in Muslim majority countries is near or even exceeds parity. Drawing on a theoretical framework of *micro-macro level cultural influences* and leveraging a *sequential exploratory design*, my goal in this study was to better understand the engagement and persistence of women from Muslim majority countries in computer science. In order to achieve parity in the United States, we must first understand the breadth and depth of the computer science diversity problem. Without attempting to understand the experiences of those that have filled the gender gap in computer science, we are essentially misinformed designers coming up with poor solutions to attract women to the computer science field. We can not fix a problem that has not been properly defined. Exploring the experiences of Muslim female students will provide their unique perspective in creating a more comprehensive solution to the diversity problem. Next, we can begin to shape policies, programs, and initiatives to attract more female students to the computer science field.

I designed a study to collect and deeply understand Muslim female students' experiences that could shed light on their journey in pursuing computer science as a major. The existing body of literature helped in identifying my research questions and in bolstering the analysis of my data (See CHAPTER 3). My study is motivated by the limited research around Muslim women who initially started studying computer science in a Muslim majority country and immigrated to Western countries (e.g., the United States) for completing their education. Information

on students who compare and reflect on cultural differences and their experiences between studying computer science in a Muslim majority country and United States is limited.

1.3.1 Research Questions

This study aims to answer the following research questions (RQs) using a sequential exploratory mixed methods study:

RQ1: How do micro and macro level cultural influences impact Muslim identified women's intention to pursue a computer science undergraduate degree? RQ2: How do experiences differ in their impact on pursuing a computer science degree for Muslim as compared to non-Muslim women in the United States?

This study has three phases including Pre-Phase 1 (qualitative), Phase 1 (qualitative), and Phase 2 (quantitative). In CHAPTER 3 there is a detailed description of the methods, both qualitative and quantitative, utilized for conducting this study. And in CHAPTER 4, you can find the results of the study. The conclusion, discussion, implications, and limitations of the study are discussed in CHAPTER 5. The results of this study are important for shedding light on the ways to increase engagement of women in computing in the United States.

CHAPTER 2

THEORETICAL FRAMEWORK

The theoretical framework is the structure that can hold or support a research study's theory [Lederman and Lederman, 2015]. The theoretical framework presents and describes the theory that explains why the research problem under consideration exists [Imenda, 2014]. A theory serves as a tool to explain the meaning, nature, and challenges associated with a phenomenon that is frequently experienced but unexplained in our world, so that we can use that knowledge and understanding to act in more informed and effective ways [W.Creswell, 2013]. In this study, I have identified multi-level cultural theory as an appropriate tool for framing my study examining how cultural messages through experiences impact occupational pursuit of Muslim female computer science students [Erez and Gati, 2004]. In the next two subsections, I will describe the framework itself and how I used it in my study.

2.1 Multilevel Therorizing

Multilevel theorizing is influenced by general systems theory principles of interdependence and hierarchy [Rousseau and House, 1994]. General systems theory emphasizes that levels are nested structures organized hierarchically. Multilevel perspectives help to illustrate the multitude of factors that shape individuals' communication, as well as how individual behaviors socially construct organizational, community, and cultural systems. However, multilevel frameworks do pose simultaneous challenges and burdens centering on research concerns and practical applications. For example, when conducting multilevel research, several factors need to be considered: (a) the overwhelming amount of potentially relevant concepts and variables, (b) the difficulty of determining the scope of multilevel theory that is not overly simple or overly complex, and (c) the difficulty of multilevel data collection

and analysis [Klein et al., 1999, Stokols, 2016]. In addition, multilevel research can be limited due to interests, values, and purpose of the research [Klein et al., 1999]. Thus, multilevel frameworks have complexities that single level approaches do not have. However, this complexity represents social reality and potentially provides rich theoretical and practical insight into the layered human cognition, affect, and behavior [Klein et al., 1999].

Multi-level cultural theory is associated with two (macro and micro) main perspectives [Erez and Gati, 2004]. The macro perspective assumes people behave similarly in a set of conditional constraints and demography [Mee Thien and Abd Razak, 2012]. Thus, the focus of macro perspective is more on the aggregate or collective responses compared with the individual variation. In contrast, the micro perspective assumes that there are variations in individual behaviors [Mee Thien and Abd Razak, 2012]. With this assumption, the focus of the micro perspective is more on variations within individual characteristics that affect the individual reactions. It is worth mentioning that the macro perspective neglects the individual differences in behaviors, perceptions, emotions, and interactions that will potentially influence the higher-level group [Mee Thien and Abd Razak, 2012]. On the other hand, the micro perspective neglects the contextual factors from the higher-level group which can significantly influence the individual differences at the lower level. Overall, the focus of these levels shows that neither micro nor macro perspective can adequately account organizational behaviors as a hierarchically nested system. In addition, as emphasized in the principle of a multi-level framework, it is rather difficult in practice to find single-level relations that are unaffected by other levels [Klein and Kozlowski, 2016]. Equivalently, it seems unlikely for the macro level to be completely uninfluenced by the lower level. Considering this, organizational theorists developed this theory in order to bridge the micro and

macro perspectives [Klein and Kozlowski, 2016, Rousseau and House, 1994]. As such, the main focus of this theory is strongly related to relationships between phenomena at the higher and lower levels of analysis such as the individual and group level. Extending the point of view above this theory specifies the relationships between the higher and lower levels of analysis by highlighting the bottom-up and top-down processes [Erez and Gati, 2004]. The dynamic dimension pertains to the interrelationships among the levels of culture and the way they impact each other. Though the top-down approach, individuals internalize the shared meaning system of the culture and society to which they belong, and its values are represented in the individual self. On the other hand, through the bottom-up approach of aggregation and shared values, higher level entities of culture are formed, at the group, organizational, and national levels.

Below you can see how the layers of culture are nested within each other and the dynamics between micro and macro levels. At the micro level, the individual reflects the cultural values as they are represented in the self. Furthermore, the group level reflects shared values by family members and friends. At the macro level, the organizational culture defines a set of beliefs and values shared by members of the same organization. In our case, organizational culture reflects the school setting, and according to the literature the strength of this level depends on the homogeneity of its members' participation and beliefs. National culture defines a society, which is defined by shared agreement on desired values or the existing values in the society. Finally, the global culture is the most macro level of culture; all levels of culture are nested inside this level.

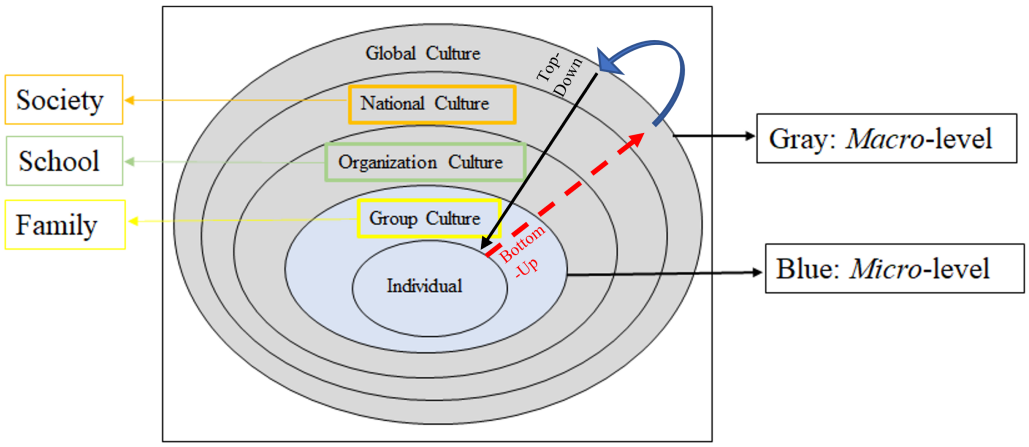

Figure 2.1: Multi-Level Cultural Theory

2.2 Culture and Religion

Culture and religion are very complex concepts, and these terms are open to various interpretations. However, as the goal of this study is to better understand the impact of these factors on students' educational outcomes, we will look at the intersection between these two terms. Culture can be interpreted both as a stable or a dynamic entity. Culture as a dynamic entity, can be shaped by those who occupy it. As denoted in the literature, culture can impact people and be impacted by people directly and indirectly to varying degrees [Ulloa et al., 2016]. On the other hand, as a stable entity there are core values and norms that shape a particular culture. According to the literature, a dominant culture can embrace and influence the community. By this definition and according to Saroglou Cohen, religious groups share the same values, norms, and beliefs that can be considered culture [Saroglou and Cohen, 2011].

The relationship between culture and religion can be interpreted in six different ways: "Religion may be part of culture, constitute culture, include and transcend culture, be influenced by culture, shape culture, or interact with culture in influ-

encing cognitions, emotions, and actions" [Saroglou and Cohen, 2011]. Religion has embedded meaning from the individual (micro) to the macro level [Park, 2014], and it can function as a macro social force affecting society [Van Buren Iii et al., 2020]. According to Cohen, as religious groups share the same values, norms, and beliefs they can be considered a culture [Cohen, 2011]. We can conclude from the accumulation of aforementioned relationships between culture and religion, individuals from similar culture and religion have comparable values, beliefs, and actions. Those that identify as Muslim may or may not practice Islam. However, the people who identify as Muslim can still share the same cultural values of that society, since it is heavily influenced by religion (namely, Islam).

Religion as a dominant cultural rule can impact behaviors, norms, and values shared by a community. Each religion has their own core values and beliefs that separate them from other religious groups. For example, in Muslim majority countries, some of the core values that are shared by its members (and are sometimes recognized by other people who do not identify as Muslim) include but are not limited to wearing hijab, eating Halal food, praying to God (Salah), fasting, and not drinking alcoholic beverages. Thus, these kinds of core values, beliefs, and practices establish each religious group as a unique community and cultural group that distinguishes them from other groups.

2.3 Approach

In this study, I am using the term culture to refer to the complex and broad set of relationships, values, attitudes, and behaviors that bind a specific community. For the purpose of this study I look at the cultural values that lead to high participation of female students in computing fields, while avoiding a deep exploration

into students' religious practices (if they practice Islam or not). This theoretical lens is helping me develop an understanding of how these layers influence women's educational paths and occupational pursuits. Although my positionality as a researcher impacted the understanding of the problem under investigation (see 3.2), this framework guided me through the path. It aided me in setting up a clear road for researching, analyzing, and interpreting the results. This framework helped me build my study's structure and determine a feasible path for the questions I had in mind. First, it helped me to shape and organize the research questions for the problem under investigation. Second, it assisted me in improving the interview protocol and capture the most critical evidence related to the problem from a clear point of view. Third, this framework allowed me to focus on the specific variables related to my research questions and analyze the interviews by limiting the scope of the relevant data. Furthermore, with clear boundaries during the analysis, this framework served me in interpreting the results.

CHAPTER 3

METHODS

For this research, I used a sequential exploratory mixed methods inquiry. The purpose of using sequential exploratory mixed methods is that the weakness of each (qualitative/quantitative) will be offset by the strength of the other (quantitative/qualitative) [Steckler et al., 1992]. Mixed methods design is a well documented approach with a history of effectiveness for conducting research compared to quantitative and qualitative approaches [Curry et al., 2009, Tashakkori and Teddlie, 1998, Good and Brophy, 1995]. Employing mixed methods gives the opportunity to integrate qualitative and quantitative methods together [McCusker and Gunaydin, 2015, Creswell, 2012]. Qualitative research provides a means of understanding students' experiences and gives much greater detail and depth than simply studying them with the numbers alone [Creswell, 2012]. Likewise, collecting statistics from a large group will provide a broader understanding of the results beyond interviews conducted with fewer people [Creswell, 2012, McCusker and Gunaydin, 2015]. One way that qualitative and quantitative methods can be integrated in research is to use qualitative methods to help develop quantitative measures and instruments [Steckler et al., 1992]. Sequential exploratory design uses both qualitative and quantitative data, consecutively (Figure 3.1, Phase 1 and Phase 2) [Creswell, 2012]. Sequential exploratory design involves gathering qualitative data to investigate a phenomenon, followed by gathering quantitative data to explain relationships discovered in the qualitative data [Creswell, 2012]. Through this work, I aim to triangulate the methods by directly comparing the qualitative findings and quantitative statistical results. The results of Pre-phase 1, Phase 1, and Phase 2 are compared during Phase 3 [Creswell, 2012]. Lastly, in Phase 4 there is the

interpretation of the comparison of the results from Phase 3 to understand if the results support or contradict each other [Creswell, 2012].

In preparation for the sequential exploratory design, a pilot qualitative study was executed to better evaluate the interview protocol. The results of that pilot study provided an opportunity to improve the questions flow for Phase 1 of the study, guiding a hypothesis for the quantitative study, and providing better understanding of the factors that influence Muslim women's educational paths. In Phase 2, I explored the population through a bounded data set from secondary quantitative data. In order to analyze the quantitative data, I used the findings from the qualitative data to enhance the meaningfulness of the quantitative data by identifying relevant variables and themes for investigation. The process of this design is shown below (Figure 3.1).

To answer the research questions for this study, a sequential exploratory mixed methods approach was necessary as the this design allows identifying measures which are actually grounded in the data obtained from the study participants during the interviews. [Sadan, 2014, Creswell, 2012]. In addition, it gives the researcher the opportunity to analyze the two parts independently before interpreting the results together [Sadan, 2014, Creswell, 2012]. The first research question -(***RQ1****:How do micro and macro level cultural influences impact Muslim identified women's intention to pursue a computer science undergraduate degree?*) can be best answered by collecting and analyzing qualitative data. The second research question -(***RQ2****: How do experiences differ in their impact on pursuing a computer science degree for Muslim as compared to non-Muslim women in the United States?*) is best answered by collecting and analyzing quantitative data (variables for analysis identified from the results of ***RQ1***). The results from the analysis of the two types of data, qualitative and quantitative, can be compared against each other to gain a deeper

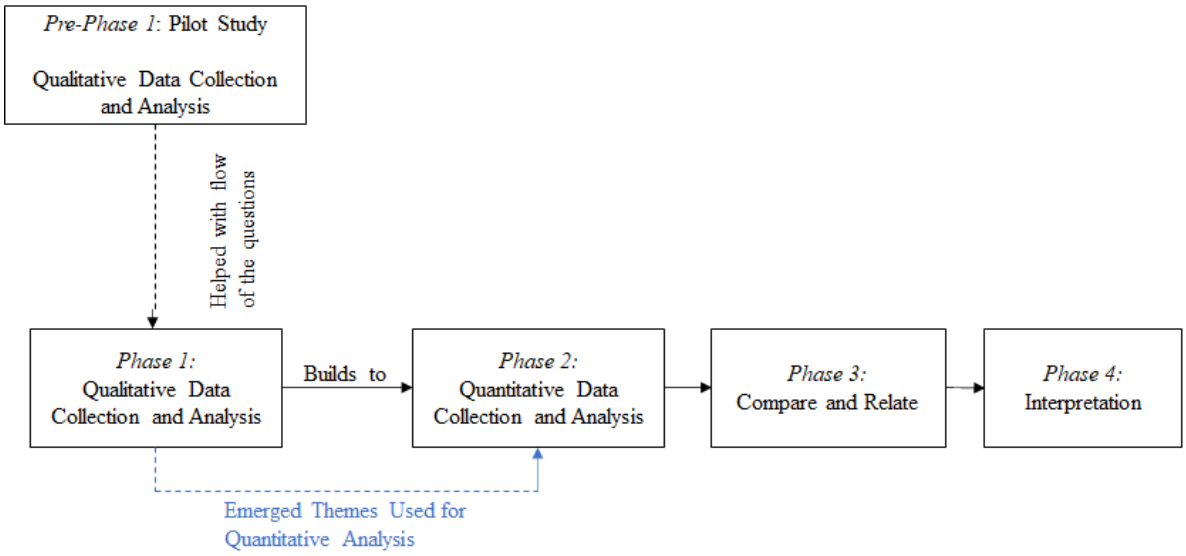

Figure 3.1: The Adapted Sequential Exploratory Mixed Methods Design

understanding about Muslim female students' paths towards pursuing a computer science degree. Figure 3.1 shows adapted sequential exploratory mixed methods design used for this study.

3.1 Positionality

Positionality refers to both a person's worldview and the stance they take on a research project, as well as its social and political setting [Secules et al., 2021]. The person's worldview, or where the researcher is coming from, includes beliefs about human nature and action, as well as ontological and epistemological assumptions [Gary and Holmes, 2020, Ritchie et al., 2013, Marsh and Furlong, 2002]. They are influenced by a person's values and views, which are impacted by their political stance, religious beliefs, gender, sexual orientation, historical and geographical location, ethnicity, race, and other factors [Wellington et al., 2005, Marsh and Furlong, 2002].

Positionality "reflects the position that the researcher has chosen to adopt within a given research study" [Savin-Baden and Essential, 2013]. It affects the initial research questions that a researcher selects to pursue [Secules et al., 2021]. It also affects the methods used in research, as well as the conclusions drawn [Secules et al., 2021]. Positionality is typically determined by situating the researcher in relation to the topic of interest, the research participants, and the setting and methodology of the study [Secules et al., 2021]. Some characteristics of positionality, such as gender, ethnicity, skin color, and nationality, are culturally assigned or usually perceived as being fixed. Others are more flexible, objective, and contextual, such as political opinions, personal life histories, and experiences. The fixed elements may drive someone to a specific point or perspective, but that does not indicate that those points or perspectives will necessarily result from the fixed characteristics [Damaskinidis, 2017, Chiseri-Strater, 1996].

I need to acknowledge that my actions will have an impact not only on the research process, but also on myself. Due to the fact that researcher bias has an effect on validity at every stage of the research process, it is impossible to ignore or postpone the discussion of this issue [Garcia and Quek, 1997]. Therefore, providing the audience with an honest reflection of my views and preferences adds both context and quality to the research that I have conducted [Altheide and Johnson, 2011]. It is appropriate that I discuss my position in this study, given that I am the instrument of interpretation of the experiences of Muslim women in the computer science field.

3.1.1 Researcher Role

In reflecting on my positionality, I acknowledge that my race, gender, and experiences in the computer science field, as well as living in both a Muslim majority

country and the United States are elements that influence my interpretation of the research findings. I am a woman who was born and raised in, and studied my undergraduate degree in, a Muslim majority developing country. I had to take English language (IELTS and GRE) exams and obtain a good GPA to be eligible to apply to pursue my master's in universities in the United States. Then I had to fill out applications, prepare a CV, and financial documents for each university in the United States in order to get admission. After getting an admission letter from a school, I had to apply for a U.S. visa. As there was no U.S. embassy in my country (due to political reasons), I had to go to another country. I was granted a visa after a few months and I came to the United States. In my first day I attended an orientation and met people from different fields, and countries. I learned that the institution I attended was one of the largest schools with a diverse population. However, in the first class of my master's program I was the only female student in the whole room, and I felt shocked. I had three courses in the first semester, and the other two classes had only a few female international students. Soon, I realized computer science is considered a masculine field and it was not typical for a female student to major in this field. It was a totally different picture from what I had in my mind about one of the most developed countries in the world. In the country I came from, the gender distribution in each computing class was 50 percent; sometimes there were even more women than men in the classroom. With a little research, I realized the gender imbalance in the computer science field in the United States is a known problem. However, from my experience and literature review, in Muslim majority countries the participation rate of women in the computer science field is equal and/or in some cases higher than men. Thus, I started my Ph.D. program with the intention to learn more about this phenomenon. I began to wonder if my experiences towards pursuing computer science were unique or the norm; I also wondered

what the cultural norms were and how they were impacting students towards pursuing this field. Additionally, I wanted to understand how the experiences of Muslim and non-Muslim students were different. Engaging in this study, I am aware of my preconceived knowledge of being a woman, coming from a Muslim majority country, and my previous experiences in the field. Constant reflection during the study process can reveal the impact on research interpretation, as well as influences on myself as the researcher. When conducting interviews, I needed to ask questions that were focused on the interviewees' experiences rather than being built around my own. I had to be mindful of reciprocity since I understood that the similarity of our situations may lend itself to conversational banter that could result in leading inquiries or statements. The same attentiveness was required when evaluating and interpreting data. My experience can give me perspective, but it can also make it difficult for me to recognize that each participant is on a different journey. Feedback from my research team and peers aided in acknowledging bias inherent to my participation in the study as a researcher. As previously mentioned, while performing interpretative research, recognizing bias does not get rid of prejudice; rather, it makes the study process more transparent [Secules et al., 2021]. Having described the appropriateness of mixed methods inquiry for this research study, I will now outline the research study including the three phases of pilot study, qualitative data collection and analysis, and quantitative data collection and analysis.

3.2 Data Collection and Analysis

Data collection is a process that can be described as a series of interrelated activities with the aim of gathering good information to answer emergent research questions [Rogelberg, 2004]. Data collection means gaining permission, conducting a good

qualitative/quantitative sampling strategy, developing means for recording information (both digitally and on paper), storing the data, and anticipating ethical issues that may arise [Creswell and Poth, 2016]. In this section I describe how I conducted my research and ensured the quality addressed in each section (data collection and analysis).

3.2.1 Qualitative Data Collection and Analysis: Pre-Phase 1 and Phase 1

The goal of qualitative research is to answer questions about the meaning and experience components of people's lives and social situations [Strauss and Corbin, 1990]. Qualitative research helps advance knowledge on people's difficult and poorly understood subjective experiences [Fossey et al., 2002]. Why Muslim women pursue computer science at higher rates in comparison to women in the United States is one of the subjects that is difficult to interpret and understand as discussed in CHAPTER 1 (see 1.1 and 1.2). Thus it is a necessity that I dig into Muslim women's experiences to better understand their path towards pursuing computer science.

Qualitative data describes qualities or characteristics and it is often collected using questionnaires, interviews, reviewing documents, observations, and other techniques depending on the method of inquiry established for the study. Recent works have begun to address components of the actual qualitative analysis in a way that is practical and useful for different kinds of research [Kegler et al., 2018, Smith and Firth, 2011] including having frameworks, themes, categories, and codes which can assist with better analysis and interpretation of the results [Lacey and Luff, 2009, Rogelberg, 2004]. The qualitative data collection and analysis is represented in the figure below (Figure 3.2).

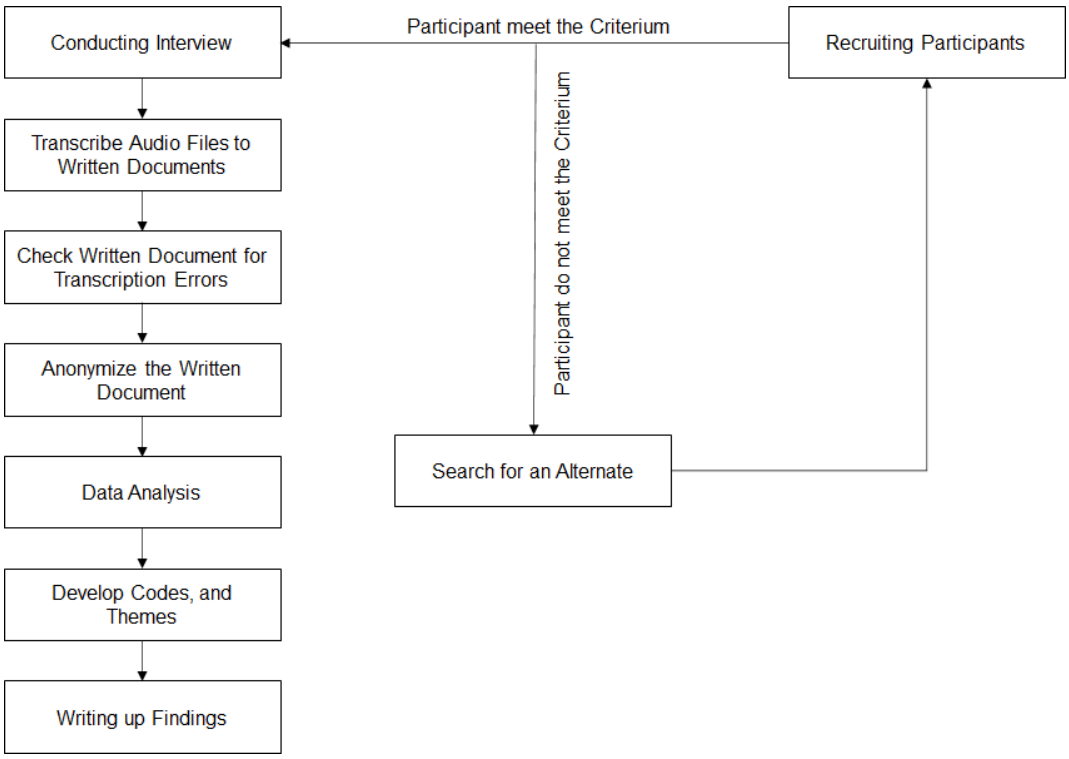

Figure 3.2: Qualitative Data Collection and Analysis Process

There are a few pitfalls that can occur in qualitative research: 1- equipment failure (e.g., failure of a tape recorder), 2- environmental hazards (e.g., noise in the place that interview is conducted), 3- transcription errors (e.g., mistyped words that change the entire meaning of a sentence) [Easton et al., 2016], and 4- the amount of information (e.g., rich interview data) [Dickson-Swift et al., 2016]. However, there are strategies to avoid these problems. Thus, analyzing and interpreting qualitative data is a very difficult process [Easton et al., 2016]. In this section, I present how I gathered the data, prepared it for analysis, and analyzed it considering the above mentioned pitfalls (See 3.2.2 Data Collection: Interview Protocol/ Pre-Phase 1).

Recruiting Participants

A critical stage in the data collection process is finding people or places to study and gain ample amount of information for the question(s) under examination [Rogelberg, 2004]. Purposive sampling is one approach that enables researchers to intentionally sample a group of people that can best inform the researcher about the phenomena under investigation. Although purposive sampling is subject to researcher and sampling biases, it allows the researcher to target niche demographics to obtain specific data for the research study. Thus, purposive sampling allows the researcher to collect qualitative information from the best fit participants and lowers the margin of error in the data because the participants are a close fit with the research context. Researchers can recruit participants via fliers, newspaper advertisements, emails, and letters [Alkassim et al., 2016]. For this work, I recruited Muslim female students who: 1) had an undergraduate degree from a Muslim majority country and 2) were in a computer science graduate school program in the United States for at least one semester. These specifications served three purposes:

1) Reflection on experiences: Reflection is the "process of creating and clarifying the meaning of experience in terms of self (self in relation to self and self in relation to the world)" [Bourner, 2003]. I explicitly wanted students to have an undergraduate degree in computer science so students could better reflect on their experience of being a female student in a computer science field in a Muslim majority country.

2) Retention in the field: Pursuing a graduate degree is a sign of retention in the field [Peters and Daly, 2013]. I wanted students to be in a graduate program to ensure that students who I interviewed were retained in the computer science program and had an ample amount of understanding about the field.

3) Being aware of the intent of the research: Interviews are purposeful interactions in which an investigator attempts to learn what another person knows about

the topic, to discover and record what that person has experienced, what she/he thinks about it, and what significance or meaning it might have [Arthur et al., 2012]. Thus, I wanted students to be aware of the drastic gender gap in computer science programs in the United States and have a better understanding of the underlying intent of this research to provide clearer answers to the interview questions.

Participants

In this study I recruited students from two Muslim majority countries including Iran and Saudi Arabia. Iran and Saudi Arabia are the two largest countries by area in the Middle East, and they are both major powers in the region [University of Cambridge, 2020]. Additionally, both Iran and Saudi Arabia are presumed as not being gender equal countries [Seifi, 2021]. However, Iran and Saudi Arabia are not alliances and there is no diplomatic relations between the two countries [World Politics Review, 2019]. The Islamic religion has five major branches and there are more than two billion people who practice Islam world wide [Pariona, 2017]. It is worth mentioning that more than 95 percent of Muslim people identify as Sunni or Shia [Pariona, 2017]. In Iran the majority of people are Shia, while in Saudi Arabia the majority of people are Sunni [Marcus, 2019]. Thus, for the purpose of this study I selected students from these two countries which have a diverse representation from among Muslim culture to better understand the impact of Islam on women students towards pursuing a computer science field (see Table 3.1).

Pre-Phase 1

For the purpose of this study, I used different approaches to recruit participants. In the Pre-Phase 1 stage, I sent out an invitation for participation to seven Muslim

female students I knew (had previously met while at university and at conferences) through email. The email had the participant recruitment document, amount of incentive for participating in the study ($25 Amazon gift card), and possible benefits or harms (See APPENDIX B). However, only four of the students met the criteria and were willing to participate in the study. I invited the four that met the criteria to participate in the study. All the participants were from Iran, graduated with undergraduate degrees in computing from their home country, and were pursuing graduate degrees at one U.S. computer science program.

Phase 1

In Phase 1, I prepared a flyer and stated the criteria of the candidates for the study (See APPENDIX C). I first sent the flyers to two other researchers for review. After receiving feedback from two researchers, I made minor grammatical and visual changes for a smoother flow to the flyer. Then, I posted the flyer online using Twitter. Only a dozen people emailed and wanted to participate in the study. However, from those people only two met all the criteria in the flyer. Next, I reached out to an organization called Iran Women in Computing (IranWiC) and requested they share the flyer. They shared the flyer with their members through email. I was able to identify three students who met the criteria. Thus, in total five Muslim female students participated in Phase 1 of this study. Combined between the Pre-Phase 1 and Phase 1, in total I interviewed 9 Muslim female students who were pursuing a graduate degree in a computer science field in the United States and had an undergraduate degree in the computer science field from a Muslim majority country.

Data Collection: Interview Protocol

In order to collect the most appropriate information from the participants it is important for the researcher to develop an interview protocol [Turner, 2010]. An interview protocol is an instrument of inquiry - asking questions about particular information related to the aims of the study [Turner, 2010]. There are three types of interview protocols including structured, unstructured, and semi-structured [Turner, 2010]. Each of these interview types has their own advantages and disadvantages. Selecting one of these approaches depends on the research design and the data the researcher intends to collect from the interviews [Turner, 2010]. For the purpose of this study, and in order to answer the mentioned research question, I developed a semi-structured interview protocol. This approach gave me the benefits of both protocols as having questions written (structured) and asking follow-up questions that emerged during the conversations (unstructured interviews) [Cohen and Crabtree, 2006]. I started preparing my interview protocol by conducting a thorough review of the literature about Muslim female students in computer science, female students in computer science, cultural factors in education, and Western female students in computer science. Next, I started adding open-ended questions (questions that cannot be answered with a simple 'yes' or 'no') to my interview protocol (see APPENDIX A). To help build a comfortable space for the participant, I started out the interview protocol with basic background questions (e.g., name, year in the graduate program, their likes and interests, etc.). My interview protocol consisted of 27 open ended questions and I organized them from easy to answer to more difficult and abstract questions [Castillo-Montoya, 2016]. I additionally prepared an informed consent document. I submitted the informed consent and interview protocol to the Institutional Review Board (IRB) and received approval (See APPENDIX A and APPENDIX B).

Student Pseudonym	Country of Origin	Year in Ph.D. Program	Important Things in Life	Other Interested Discipline	First Generation in Computer Science
Sania	Iran	5	Family/ Education	Electrical Engineering	No
Sara	Iran	4	Family/Husband/Parents	Architecture	Yes
Lily	Iran	2	Freedom	Information Technology Management	Yes
Mona	Iran	3	Health/Education/ Independent Job and Life	Industrial Engineering	No
Maya	Iran	2	Family/health	Physics	Yes
Ava	Saudi Arabia	5	Education/Family	Medicine school	No
Ruby	Saudi Arabia	2	Education	Math	Yes
Mahi	Saudi Arabia	2	Family/ My children/ Education	Math or Chemistry	Yes
Kate	Saudi Arabia	3	Education, Self care, Family, Religion	Medicine school	No

Table 3.1: Participant Information

Pre-Phase 1

The data for this phase were collected through one 60-minute in-depth interview. Each student signed a consent form for the interview (see APPENDIX). I scheduled a meeting time with each student and reserved study rooms on campus. Interviewing in a quiet place gave us the opportunity to focus on the conversation with no background noise (overcoming pitfall #2) (see page 13). I recorded the interviews using a tape recorder. It is worth mentioning that I had an extra tape recorder during each interview in case of an equipment failure (overcoming pitfall #1) (see page 13). Additionally, I took detailed field notes during the interview [Phillippi and Lauderdale, 2018]. In order to analyze the data I submitted the recorded interviews to a transcription service company. The transcription company transcribed the audio files to text files. In order to have high data accuracy I listened to each interview separately and compared it with the transcript I received from the third party (overcoming pitfall #3) (see page 13). Next, I re-reviewed the

transcripts to make sure there were no misalignments between the audio and text files. Then to establish anonymity of the participants in the study I redacted the written documents. I removed all identifiable information including name, school name, names of colleagues, and any other identifiable data from the documents. Having my final version of data in text file I moved to the data analysis phase.

Phase 1

The data for this phase were collected at the height of the Covid-19 pandemic and shutdown. Due to the challenges related to Covid-19 (e.g., restrictions on in-person gatherings, travel restrictions), I had to conduct the interviews over the phone instead of having face-to-face interviews. Each participant was interviewed for one hour and the interviews were audio recorded with a special ear-bud and audio recorder that allowed for the capture of the phone conversation. All the audio files gathered were saved in a secure folder. Same as the Pre-Phase 1 stage, the audio folder was sent to a third party transcription company. I verified the transcripts for accuracy, anonymized the documents, and made a final document for analysis.

Analysis

Qualitative data analysis is the process of bringing order, structure, and meaning to the mass of collected data [Hilal and Alabri, 2013]. As the content of qualitative data is rich and disordered in text, it is not an easy task to analyze it [Hilal and Alabri, 2013, Lacey and Luff, 2009]. Analyzing qualitative data is the process of establishing relationships between categories and themes of data seeking to increase the understanding of the phenomenon [Lacey and Luff, 2009]. To analyze the qualitative data, I used thematic analysis (overcoming pitfall #4) (see page 13) [Guest et al., 2012]. It is a highly beneficial technique because it allows the

researcher to divide and categorize large amounts of data [Guest et al., 2012]. The volume, complexity, and varied formats of qualitative data (e.g., audio recordings, transcriptions, documents, and field notes) often lack consistent structure; however, all are useful and imperative for conducting a comprehensive analysis [Dey, 2003]. To become immersed in the data involves the repeated reading of the data in an active way, searching for meanings and patterns. Braun and Clarke (2011) recommend that researchers read through the entire data set at least once before beginning coding, as ideas and identification of possible patterns may be shaped as researchers become familiar with all aspects of their data [Braun and Clarke, 2011]. Thematic analysis is particularly useful for analyzing subjective information such as participants' experiences, views, and opinions. That is why thematic analysis is usually conducted on data derived from, for example, open-ended surveys, social media posts, and interviews.

It is worth mentioning that thematic analysis is an iterative and reflective six-step process that evolves over time and entails constant back and forth between phases. This six-step process includes: 1- Getting familiarized with the data, 2- Generating initial codes, 3- Searching for themes, 4- Reviewing themes, 5- Defining and naming themes, and 6- Producing the report [Nowell et al., 2017]. In the table below (Table 3.1) you can find a brief description of each step [Braun and Clarke, 2011, Nowell et al., 2017].

In this technique, the first step consists of identification of themes through careful reading and re-reading of the data [Braun and Clarke, 2011]. It is a form of pattern recognition within the data to answer the research questions. Emerging themes through the data (e.g., interview data) become the categories for analysis. Researchers code qualitative data either by hand, using highlighters, colored pens,

Steps of Thematic Analysis	Brief Description of Each Step
Step 1	Identification of themes through careful reading and re-reading the data
Step 2	Initial production of codes from the data
Step 3	Sorting and collating all the potentially relevant coded data extracts into themes
Step 4	Review of the coded data, check for the validity of the codes and themes
Step 5	Check how each theme fits to the overall story about the entire dataset
Step 6	Provide a concise, coherent, logical, and non-repetitive report

Table 3.2: Six-Step in Thematic Analysis.

and colored paper or by using technology and utilizing help from software like NVivo, Dedoose, etc. [Lacey and Luff, 2009, Hilal and Alabri, 2013, Salmona et al., 2019].

There are several approaches to thematic analysis such as inductive, deductive, semantic, or latent approaches. Selecting a particular approach (or approaches) depends on the research design, as the importance of this part is in identifying codes that accurately describe the content. For the purpose of this study I used a hybrid approach. A hybrid approach means incorporating both a data-driven inductive approach and a deductive priory template of codes approach. Inductive coding involves deriving meaning and creating themes from the data without any preconceptions [Fereday et al., 2016]. In addition to the inductive approach of Boyatzis (1998), I also used a template approach in this study [Boyatzis, 1998, King, 2004]. Templates force the researcher to justify the inclusion of each code and clearly define how it should be used [King, 2004]. This approach involved a template in the form of codes from a codebook to be applied as a means of organizing text for subsequent interpretation. When using a template, a researcher defines the template (or codebook) before commencing an in-depth analysis of the data. The codebook is sometimes based on a preliminary scanning of the text, but for this study, the template was developed based on the research questions and the theoretical frame-

work. The deductive approach involves jumping to the analysis with a set of codes already expected to be found, i.e., the codes already in mind from previous literature or prior knowledge [Fereday et al., 2016]. This hybrid approach addressed the research questions by incorporating social phenomenology tenets into the process of deductive thematic analysis while allowing themes to emerge directly from the data using inductive coding.

Prior to the interpretation step, the coding process required recognizing (seeing) a crucial moment and encoding (viewing it as something) it. A "good code" is one that captures the qualitative richness of the phenomenon [Boyatzis, 1998], (p1). The data is organized by encoding it, which allows you to recognize and generate themes from it. A theme, according to Boyatzis, is "a pattern in the information that at minimum describes and organises the possible observations and at maximum interprets aspects of the phenomenon" [Boyatzis, 1998](p161).

It should be noted that the 'themes' must be reviewed as part of the thematic analysis process to ensure that they represent the entirety of the text. Validating themes in the early and late stages of data analysis, according to Miles & Huberman (1994), is critical [Miles and Huberman, 1994]. It is advised that the researcher should seek the advice of an outside reviewer to examine and identify themes at this early stage. To put it another way, the goal is to see if the themes discovered by the researcher are coherent with the rest of the text. After that, the researcher should take the assistance of an independent reviewer for criticism. The researcher will be able to compare the two sets of feedback as a result of this [Miles and Huberman, 1994]. The major goal of this approach is to improve the consistency of themes analysis coding. Any contradicting results (if any) about any topics that were added or removed by outside and independent reviewers are now better known to the researcher [Miles and Huberman, 1994, Ibrahim, 2012].

Following that, the researcher should look to the list of topics agreed upon with the outside reviewer and find participant excerpts that support each theme. The impartial reviewer is tasked with evaluating the general themes, demonstrating and confirming the details of textual passages equivalent to validity in positivistic terms [Ibrahim, 2012]. According to Miles and Huberman (1994), involving outside/independent reviewers at two different stages would result in a strong procedure for analytical credibility equivalent to reliability [Miles and Huberman, 1994, Ibrahim, 2012]. Validation must be done early in the research process. During the first phase, the first level of themes must be validated, and the second level of themes must be validated during the second phase.

Furthermore, validation is good for the data, especially at the first level of themes, according to the researcher's experience, because it gives correct and dependable data for the second level. Furthermore, it reduces the likelihood of inaccuracies and mistakes in data at the second level of themes. This can be seen in the 'codes' of the second level of the themes.

In order to implement the afore mentioned best practices, I coded the interview data and generated themes from the codes for two randomly selected interviews. Next, I shared the anonymous data, research questions, and theory of the study with one researcher (Researcher 1) and assigned her an interview to analyze. I asked Researcher 1 to identify codes and themes. Then, I compared her codes and themes with my first level code. Furthermore, I identified similar codes and tried to make more generalized codes. Next, I shared another anonymous interview (a different interview from the previously shared with Researcher 1) with Researcher 2 and asked her to code and assign themes for the interview data. After that I compared my second level codes and themes with Researcher 2's findings and finalized my codes.

Following data collection from 9 Muslim female students (merging data from interviewing 4 students from Pre-Phase 1 and 5 students from Phase 1), the interview transcripts were entered into the NVivo 12 data management program, and a comprehensive process of data coding and identification of themes was undertaken. This process is described as a systematic, step-by-step process in the sections below. Although presented as a linear, step-by-step procedure, the research analysis was an iterative and reflexive process. This interactivity, applied throughout the process of qualitative inquiry, is described by Tobin and Begley (2004) as the overarching principle of "goodness" [Tobin et al., 2004]. The data collection and analysis stages in this study were undertaken concurrently, and I reread the previous stages of the process before undertaking further analysis to ensure that the developing themes were grounded in the original data.

3.2.2 Quantitative Data Collection and Analysis: Phase 2

In quantitative research, researchers frequently test theories as explanations for their findings [Creswell and Creswell, 2017]. As such in this section, with the help of quantitative methods, I describe the relationship between students' religion and pursuing computer science as a degree. I use logistic regression and the Wilcoxon rank sum test to answer my second research question. Logistic regression was developed by David Cox in 1958 and has been used in varied areas of research since then [Cox, 1958, Edgar and Manz, 2017] and aims to predict the probability of an event that occurs depending on the values of the independent variable(s). Wilcoxon rank-sum tests were used to compare values from two populations and determine whether there were significant differences [Mangiafico, 2016]. To answer RQ2, I employed logistic regression from generalized linear models. The Logistic Regression

Qualitative Themes	Questions	Responses
Playing Computing Games	Play Video/Computing Games	(0=No, 1=Yes)
Family Role	Father Career in the computer science field	(0=No, 1=Yes)
Family Role	Mother Career in the computer science field	(0=No, 1=Yes)
Expectations and Unspoken Rules	Want to live near home	(0=No, 1=Yes)
Expectations and Unspoken Rules	Please my parents	(0=No, 1=Yes)
Educational Foundation	Mathematical ability	(1=Below 10%, 5=Highest 10%)

Table 3.3: Relevant items for work from questionnaire
Note: The qualitative theme "early exposure to programming" was not found in the quantitative survey from HERI

is a regression model in which the response variable (dependent variable) is binary (*True/False*, *0/1*, *Yes/No*) [IBM, 2021]. It measures the probability of a binary response as the value of response variable based on the mathematical equation relating it with the predictor variables [IBM, 2021]. I used logistic regression models to examine the relationship between women pursuing a computer science major (binary dependent variable) and 6 (independent variables) different factors (see Table 3.3). The independent variables consist of 5 categorical variables and 1 continuous variable (see Table 3.3). In other words, logistic regression modeling was used to examine how different factors (see Table 3.3) predicted pursuing a computer science major for Muslim women and non-Muslim women students focusing on religion. Additionally, to analyze the results, I applied Wilcoxon rank-sum tests to compare Muslim and non-Muslim students on specific variables. A more detailed description about the analysis of the data and findings are discussed in CHAPTER 4.

Quantitative data collection

For the quantitative part of this study, I used data from the Higher Education Research Institute (HERI). HERI is a "research institute [that] serve[s] as an interdisciplinary center for research, evaluation, information, policy studies, and research training in post-secondary education" [HERI, 2022]. Every year, HERI collects data from faculty, college seniors, and freshman students. The freshman survey examines *academic preparedness, interactions with peers and faculty, student's values and goals,* and *student's demographic characteristics*. HERI does not share unique identifying information in the data files at either the individual or the institutional level. Thus, the names of the universities' students who participated from are unknown; however, all the students are studying in schools in the United States. The survey contained questions about student's gender, religion, student's probable major, parents' career, and background and experiences in school. From *2000* to *2010*, more than 2 million female students participated in the survey. The questions and the distribution of female students by religion and major used for the purpose of this inquiry are shown in the tables 3.3, and 3.4.

Quantitative data analysis

After I received the HERI data through SPSS, I loaded the data into R version 4.0.5 in R Studio version 1.2.5042 for cleaning and analysis. The HERI data contained information on more than 2 million (n= 2,128,590) women with more than 95% being identified as citizens of the United States. From the sample received from the HERI institution, the number of Muslim versus non-Muslim students was unequal and there was a large difference between the religion groups (non-Muslim $> 99\%$, Muslim $< 1\%$) and the students majors (non-CS $> 98\%$, CS $< 2\%$), resulting in imbalanced data (see Table 3.4 and Table 3.5). The imbalanced data is

a common feature of data, such as fraudulent credit cards, where the number of fraudulent cards is usually very small compared to the number of non-fraudulent cards [Brownlee, 2020]. The problem with imbalanced data is that the majority class dominates the research [Cao and Shen, 2022]. In statistical surveys, when sub-populations within an overall population vary, it could be advantageous to sample each sub-population independently [Daniel, 2014, Parsons, 2017]. One way to ensure each subgroup within the population receives the proper representation within the sample is to use *disproportional stratified sampling* [Iliyasu and Etikan, 2021]. In *disproportional stratified sampling* subjects are selected from *strata* or *groups* of the population. *Stratified random sampling* is illustrated in Figure 3.3 [Daniel, 2014]. There are four major steps in conducting a *disproportional stratified sampling* from a survey [Daniel, 2014]:

1- Define the population: The population was female students pursuing a degree in the United States.

2- Separate the population into *strata*: The population was divided into two different religion groups, then by major.

3- Decide the sample size from each *stratum*: I used disproportionate sampling to ensure Muslim students and students in the computer science field were represented in the data for analysis. Additionally, the sample size for logistic regression has been discussed in the literature [Austin et al., 2017, van Smeden et al., 2019, Bujang et al., 2018]. According to the literature a large sample size (preferably 500) will increase the accuracy of the estimates [Bujang et al., 2018]. As there were 4 groups I divided the 500 by the 4 groups evenly and got n=125 sample from each group.

4- Randomly sample from each *stratum*: Once the groups were *stratified* I used *simple random sampling* to choose subjects from each of the 4 groups, selecting an

Female students	Non-CS	CS
Non-Muslim	n= 2,107,351 (>99%)	n= 21,239 (<1%)

Table 3.4: Number and percentage of non-Muslim female students by major

Female students	Non-CS	CS
Muslim	n= 2,086,126 (>98%)	n= 42,464 (<2%)

Table 3.5: Number and percentage of Muslim female students by major

equal sample size from each one. As mentioned above, the total sample needed was 500, thus I randomly selected 125 students from each group. Having missing values can impact the model's quality. It is worth mentioning that there were no missing variables in the randomly selected 500 students. Thus, handling missing values was not needed for logistic regression.

3.2.3 Compare and Relate: Phase 3

The design of this study is a convergent mixed methods approach. In a convergent mixed methods approach, qualitative and quantitative data are collected concurrently, separately analyzed, and merged for analysis [Creswell et al., 2013]. A sequential exploratory method is useful, as it allows for the comparison and summary of data from two qualitative and quantitative sources, which enhances the ability to identify points of convergence and divergence, as well as problems of inconsistency or contention [Hunt and O'Leary, 2017]. When a single data source might not provide enough details for the research, the sequential exploratory method allows the two sources of information to converge to improve comprehension [Creswell and Plano Clark, 2017]. This mixed methods approach combines the benefits from collected qualitative data with the capacity of generalized information

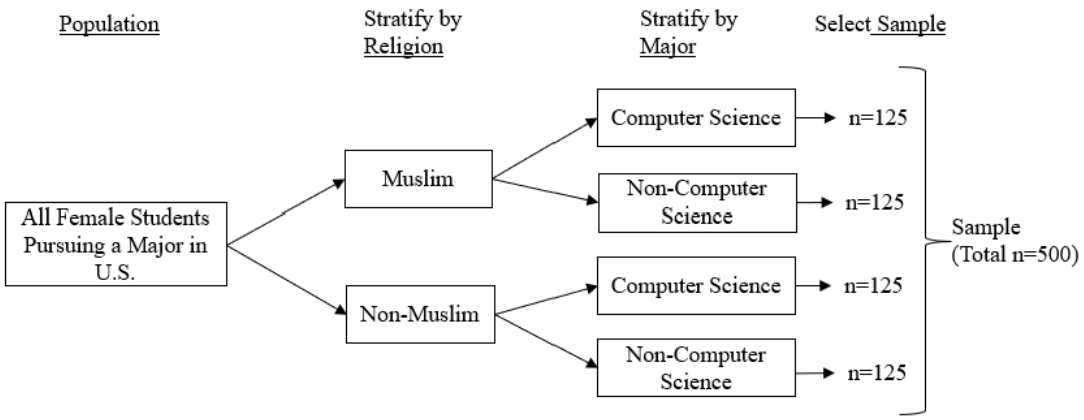

Figure 3.3: Stratified Sampling of Data

from a larger sample of quantitative data [Creswell and Plano Clark, 2017]. In other words, sequential exploratory design is intuitive, effective, and makes use of the distinctive traditions of quantitative and qualitative research. It also permits for the use of open-ended questioning (open ended interview) along with closed-ended questioning (survey) to enable more vivid storytelling and aid in the explanation of statistical measures.

As illustrated in Phase 3 of Figure 3.1, where the merged findings are interpreted, it becomes possible to identify where the data converges, diverges, is inconsistent, or where controversies may emerge. A mixed method sequential exploratory design is appropriate as it compares quantitative information about the influence of specific predictors on a woman's decision to pursue a computer science major. This is done using the qualitative findings from 9 separate interviews where participants offered their perspective in the form of storytelling that can be compared side-by-side to the quantitative data collected. The research questions identified for both the quantitative survey, as well as the qualitative interviews, aligned well with the use of a side-by-side, comparison as it related to experiential questions regarding the predictors. The goal of this research was to clarify the following two research

questions: ***RQ1****:How do micro and macro level cultural influences impact Muslim identified women's intention to pursue a computer science undergraduate degree?* and ***RQ2****: How do experiences differ in their impact on pursuing a computer science degree for Muslim as compared to non-Muslim women in the United States?*

I implemented a sequential mixed methods approach to enrich the quantitative survey data with qualitative interviews of Muslim women students. One qualitative (**RQ1)** and one quantitative (**RQ2)** question were answered by simultaneously collecting both qualitative and quantitative data. The results of the (**RQ1)** aided with selection of variables from HERI data for (**RQ2)**. In other words, themes emerged (see subsection 4.1) from the qualitative analysis used for selecting variables (see Table 3.2) from the survey.

Once both qualitative and quantitative data were analyzed, they were merged through a process of comparison and integration. It is worth mentioning the validity criteria for qualitative and quantitative data, as well as mixed methods and pilot study research, which are addressed earlier in this chapter (see CHAPTER 3 Methods, subsections 3.1 and 3.2). The selection and data collection procedures described earlier were implemented to ensure consistency with the sequential exploratory mixed methods design approach. Employing both qualitative and quantitative evidence of students' experiences is valuable, as employing both methods provide a fuller picture of women students' experiences towards pursuing a computer science major. After the independent analysis of qualitative and quantitative data, the last step was to analyze the data jointly through the examination of the relationship between the predictor and dependent variables. For this part of the study, Phase 3 I used a side-by-side comparison of the qualitative and quantitative data, searching for similarities and differences. In the next chapter (CHAPTER 4), findings from Phase 1, Phase 2, and Phase 3 are discussed.

3.2.4 Interpretation: Phase 4

For Phase 4 of the process (see Figure 3.1), I used combined data analysis to determine how these findings addressed the research questions of the study. I looked for areas of convergence, divergence, inconsistency, and dispute in the data during this process of examining the combined data in relation to the research questions put forth to help inform the study's conclusions [Creswell and Plano Clark, 2017]. I used figures and tables throughout this research study to offer visuals for areas of similarity and difference in order to provide further information to help answer the research questions.

Overall, the aim of this study is to identify which factors impact a woman's choice to pursue a computer science degree. Through a mixed method sequential exploratory design, I analyzed the results of the data collected to establish validity [Trochim et al., 2016]. I aimed to understand how cultural factors impact Muslim women and non-Muslim women students towards pursuing a computer science major. The details of the findings are discussed in the next chapter (CHAPTER 4).

CHAPTER 4

RESULTS

The goal of this study was to answer the following research questions:

RQ1: How do micro and macro level cultural influences impact Muslim identified women's intention to pursue a computer science undergraduate degree? RQ2: How do experiences differ in their impact on pursuing a computer science degree for Muslim women as compared to non-Muslim women in the United States?

Study findings were obtained from two primary sources; these include interviews of 9 Muslim female students, and 500 students from survey. The findings for the first research question will be shared by theme which emerged from the coding process. There were four important themes which emerged from the data which appear to influence female students towards pursuing computer science as a major. They related to family role, playing computing games, educational foundation and early exposure to programming, and the expectations and unspoken rules. Students opened up about how they chose to pursue a degree in the computer science field. 9 participants provided information about their families, education, and things that are important to them in life. Each theme will begin with a brief description followed by the exact captured quote from student interview data; exact captured quotes can bring a topic to life and it prevents the (mis)use of catchy phrases [Silverman, 2015]. It is critical that quotations are used in a way that respects participants and that are presented in a trustworthy manner, including maintaining participants' confidentiality [Beck and Denise F. Polit, 2017]. It is worth mentioning all students interviewed are foreign language speakers and their first language is not English. Thus, there is the appearance of grammatical inconsistencies and perceived flow disruptions in the exact captured quotes selected from the interviews from the point of view of a native English speaker.

4.1 Qualitative Findings

4.1.1 Micro Cultural Influences: Family Role

The students described their interest in the computer science field as beginning during middle school or high school from other immediate and extended family members in the field. In the interviews, students mentioned either their father, brother, uncle, and/or cousin were important people who impacted their decision towards pursuing computer science.

> **One of my cousins** she was studying computer science at the college when I was at high school and we were so close together. So **she was kind of my motivation to choose the computer science** (Sania).

> Actually, I had an **uncle studying computer science** in United States many years ago, **that was a motivation for me** [...]. (Mona)

> **My brother is basically the very reason why I started majoring in computer science**. My brother moved to the United States almost 10 years ago, when I was in high school. [...] My brother was also doing programming so he told me that this is a major that if you choose, you always would learn new things, there is no ending to this major so its a good choice for you. That's when I decided to do computer back in my country for my Bachelor's degree. (Maya)

> **I wanted to be a computer scientist like my father**, so I was looking up to be like my father. My father is a computer scientist and I wanted to be like him. (Kate)

Face-to-face interaction is the cornerstone of all social groups and organizations to which we belong, making micro level study crucial [Ballantine and Roberts, 2009]. Micro level analysis focuses on how individuals or families interact under certain circumstances [Ballantine and Roberts, 2009]. Research has demonstrated the importance of family impact on students' exposure and interest towards pursuing computer science major [Hamdan, 2005, Islam, 2019]. At the micro level orientations, and interpretations of family members can impact women's actions, and orientations [Ballantine and Roberts, 2009, Islam, 2019]. Fisher et al. demonstrated females' stories in the computer science discipline were filled with descriptions of watching their dad work at the computer, or having their older brother showed them how he programmed the machine [Fisher et al., 1997].

According to the results of this study, many students revealed that once they become interested in their immediate and extended relatives career, they will dig into the career and do more research about it. The more they know about the career, the more they are interested and want to choose computer science as a major. Additionally, the involvement, encouragement, and role modeling provided by immediate and extended family of computer science majors indicate the importance such support has for the choice of a major for many of these students. From the results of this study, it can be concluded that students at the micro level are impacted by their families towards pursuing a computer science major.

4.1.2 Micro Cultural Influences: Playing Computing Games

Most participants mentioned they started playing computer games during their childhood or teenage years. Some mentioned they still play computer games as adults. They interpreted it as a fun activity that gave them enjoyment. Students

mentioned that playing video games had an impact on them pursuing computer science as a major.

> **I was used to playing a lot of games with the computer I had at home** and because I feel **I liked it**. (Sania)

> [...] in my high school I always was a fan of computer. **I played a lot of games on my computer**. (Sara)

> I remember when I was nine or 10 years old **my father bought a computer for our family**, and I was really excited about it. And I usually **used to play games with it**. [. . .] it was rallies, race, car races and stuff like that and **I wanted to make new games**. So, it was my first experience, and I think that it was the moment that I thought that I really love computer science. (Lily)

> [...] when I was younger, like eight or nine years old, **I used to play games** with my brother and it was fun. It was the time when PCs where everywhere so everyone would buy a computer at their home and play games. [...] **I do play games**, like I play football on PS4. (Maya)

> I enjoy playing games with my computer or on my phone like play cards, play baseball. I was attracted by the design of the game like the graphics and how it look. (Ruby)

> **I love computer games**, I played Play Station growing up as a child, I played video games, I play games on my phone these days, **playing games is fun, I really enjoy**. (Kate)

According to the literature, there is a positive relationship between playing video/computing games and interest in pursuing a computer science major [Sevin and DeCamp, 2016, Fromme, 2003]. According to researchers, the logic utilized in video games and the scientific method are similar [Gee, 2003, Johnson, 2006]. They claim that playing video games teaches players how to recognize patterns, formulate hypotheses, test these hypotheses, and assess the outcomes [Gee, 2003]. According to research, science lessons frequently provide students with information about the universe in the form of facts; however, video games provide students a new world in which they can discover things on their own [Johnson, 2006]. In other words, students are taught the scientific method in the classroom, but they may apply it while playing video games. As such when a player recognizes particular patterns in one game, they can use that information in the following game because gameplay of the same genre is usually similar [Ball et al., 2018]. This contributes to the fact that experienced gamers can learn and master a new game far more quickly than beginners. Finding new patterns and developing new hypotheses is a constant requirement of playing a diverse range of games in a variety of genres. Thus, playing video/computing games has a positive relationship with problem-solving abilities.

Additionally, playing video/computing games can increase students' technological abilities. One example of this is setting up video games and handling any issues that may occur with the physical gaming hardware [Johnson, 2006]. For experienced gamers, it is more likely they have knowledge of the various game engines or the technical hardware differences between various consoles [Ball et al., 2018]. Video games are essentially a form of leisure technology, as opposed to many other types that are primarily used for practical purposes. The vast majority of players are unlikely to play video games to become technologically literate; however, in the search for entertainment they end up becoming literate [Sevin and DeCamp, 2016]. This

is true regardless of how casually people play, but it is especially true for those who are more involved with playing video/computing games.

As mentioned, players interact with a number of interfaces, patterns, logic, and potential technical problem-solving scenarios through video/computing games. Due to this experience, even if players do not utilize computers as their primary gaming device, the more they play video games, the more likely it is that they will develop an interest in other practical parts of digital technology, specifically computers [Sevin and DeCamp, 2016]. The results of this study also suggest that students who played video/computing games became more curious about how things work in computing, had a higher desire to make games, and developed enthusiasm towards graphics. Additionally, it can be interpreted that students who played games became more comfortable with technology. Thus, playing video/computing games had a positive role in attracting Muslim women into the computer science major. The important factor that needs to be considered is that students started playing video/computing games at early ages. Although "families are more or less external observers" it is the family role at the micro level (see Figure 2.1) that provides adequate gaming hardware and allocates play time for their children [Fromme, 2003, Radich, 2013, Ibtasam et al., 2019].

4.1.3 Macro Cultural Influences: Educational Foundation and Early Exposure to Programming

All the students interviewed described a strong background in math and English courses during their education. Additionally, some students indicated that early exposure to programming had a positive impact on them towards pursuing computer science as a major.

I was at the top of the class for the math and English during high school. I **ranked first in math during my first grade in high school** in the whole city that I was living back in my country.[...] I also remember that we have some **programming course in high school and I feel like I liked the programming**, and I was doing some **DOS programming back in the middle school** so I had some experience and **that was my motivation**. (Sania)

I usually **got fullest score for my math and English**, I was **almost the top** of the class. (Sara)

I was the **top student in English courses and I had little bit lower grades in comparison with my English grades in Math courses**. So I wasn't top student in math courses but good, not bad. (Lily)

My math was always the best score in the class and my English was good. I think both of them were really good. [...] I was **starting programming when I was in the first year of high school** and then **I was really enthusiastic about this topic** so, I followed it in the university as my first selection. My first choice in the university. (Mona)

All the years before the very last year of my high school, I had the grade A in mathematics, but at the very last year of my high school, which I was preparing for college entrance, I think I would get a B. I got a B grade. My English was always grade A. (Maya)

I was a nerd a little bit, **I was A plus student my whole life**. [...] I took **summer classes in high school**, like training classes, and

I start to learn about programming and then I was fascinated about this field. I want to learn more, that's why I join it. (Ava)

My math and English were excellent, I got good grades. **I liked solving problems**, I like that feeling. [...] **We had programming in high school**. We had Visual Basic, and like basic stuff, it was very basic, **and I liked it**. (Ruby)

In math, I usually get A plus. But English, we study English when we are 14 years old and it's very simple English. So, this is why I got A plus, but it is very simple English. [...] **We had some programming in high school**, but they are very simple like programs for calculating to do the simple mathematical operation. (Mahi)

I generally had good grades in school. It was from the 100 scale version, you would be graded for each subject out of 100 at the end of the semester and I always had above 90 in all subjects, but **in math it was above 95 all the years**. (Kate)

External factors, such as school, can influence a person's learning and performance orientation levels [Gully and Phillips, 2005]. It is clear all these experiences mentioned above are happening in the organizational culture (school level) setting at the macro level (see section 2.1, and Figure 2.1). It is common to think about learning and performance orientations as traits or personality qualities [Dweck, 1986]. However, as discussed in the literature review (see section 1.2) it must be kept in mind that one's orientation might be impacted by situational factors [Farr et al., 2003]. Influence of personal and cultural values, as well as the social environment like classroom atmosphere, can contribute to an increase

in women's self-confidence in mathematics and subsequently in pursuing computer science [Mittelberg and Lev-Ari, 2010]. According to research, learning and performance orientations can be influenced by the environment [Martocchio, 1994]. Put differently, even if an individual's personality is predisposed to be low in learning orientation and moderate in performance orientation, contextual factors, such as learning environments, and motivations can be introduced to raise or lower one's learning orientation or performance orientation for a specific task [Kozlowski et al., 2001]. Thus, it is important to understand which tasks or situations can aid women students towards pursuing a computer science major.

In this study, I observed similar factors in that many students interviewed identified themselves in a good (average and above mathematics grades) academic standpoint during their education. It came to my attention how Muslim women expressed their mathematical abilities in school confidently by using terms such as "I was at the top of the class," "My math was always the best score in class," and more (see interview quotes in subsection 4.1.3). Additionally, interviewees expressed enthusiasm for mathematics logic and felt that computing fit their skills. Furthermore, they spoke about the pleasure they got from solving problems. Additionally, students described how early exposure to programming and positive experiences impacted them towards pursuing computer science. Students revealed that love of basic programming attracted them to majoring in the computer science field.

Individual actions, motives, and perceptions manifest organizational learning and performance orientations [Bowen and Ostroff, 2004]. Organizational learning and performance orientations are impacted by the workgroups and leadership of individuals, as well as organizational policies, procedures, and human resource management systems [Bowen and Ostroff, 2004]. Individual orientations within a school vary, and there are systemic contextual differences between schools. Culture is one

of the factors that have been identified as significant contributors to organizational effectiveness and performance [Ostroff et al., 2012]. Culture is an important contextual factor that has a greater impact on people's attitudes and behavior than dispositional traits do [Davis-Blake et al., 1989]. Thus, the results indicates how organizational culture (school) in Muslim majority countries is impacting Muslim women towards pursuing a computer science major.

4.1.4 Micro and Macro Cultural Influences: Expectations and Unspoken Rules

Students spoke about the cultural unspoken rules and the difficulties they had in communicating with their male colleagues during the time they were undergraduates at university in their home countries. Considering family role as a micro level influence, and unspoken rules in the society as the macro influences, I concluded that the interviewees experienced both levels of cultural influences while deciding on their majors. Cultural beliefs and values of families had a significant influence on students' decisions in choosing CS. All of the interviewees mentioned they chose CS over other engineering topics by describing limitations of other engineering topics over CS; they described either doubts of their families (micro) or they mentioned future job environment concerns (macro).

> In my country we have a national exam, which is the entrance exam for the university. After taking the exam, we need to choose the major and the city. **My family asked me to choose** some engineering major because I was in a math major to which, after the graduation, I also can find a **good environment to work on**. Because I also was interested

in electrical engineering but **my family thought** that electrical engineering, **the workplace for electrical engineers are mostly male dominated and it's not good place for a female to work with them. This one affect my decision.** (Sania)

At that time **I really cared to go to a school in my city to be with my family**, and that's why I selected that university and that university was the best in my city in computer science. (Sara)

When I wanted to choose the major I thought that this is the major that I really love, so I didn't choose electrical engineering and mechanical engineering. **But maybe I was affected by the environment** because **in our country they also say that women can't do engineering majors like electronics or mechanical engineering**. So, I loved computer science but **maybe I was affected by the environment that you're a girl and you cannot do those majors**. [...] As our major was computer science the number of girls and boys were almost equal, or maybe we had more girls than boys. **But for other majors such as electrical or mechanical engineering most of them were boys.** [...] **in my country you rarely can speak with your classmates who are male because it's not really good to speak with boys** [...] my classmates that I've told you they have a good programming skills were all boys. And when I used to ask my questions then on campus, for example, it wasn't really good. So, anybody thought, Okay. **They started backbiting you. He's her boyfriend.** Or it's not good, **Why this girl is speaking with a boy?** [...] And

these **traditional and religious things** that made anybody think not good talking to boys. (Lily)

[...] female students are limited, but I don't think it is because of the country, it's because of their families, culture, and standards. They can't select any major. The families are **not very open to mixed environments**. (Ava)

[...] **my father, my mother they told me** you have a high grade and you can apply for computer science. I booked the computer science as number one in my application [...] and I'll get the acceptance in the computer science. (Mahi)

There were majors that were not offered then. Like **electrical engineering was not offered to females then**. And **we don't have females working these jobs**. [...] **I knew by going into computer science, there are jobs for females out there**, computer science majors are hired by private and government companies. (Kate)

Muslim women explained different ways they attached to computer science and detached from other fields. Their stories were counter to the suggestion that women students wanted to please their families, and meet the expectations of society. Muslim women students' success in the computer science field was not without costs, though; they went through a arduous situations as societal constraints, and cultural restraints. Culture (see Figure 2.1), at the macro level, impacts behaviours in the society. As mentioned earlier, culture and religion (see section 2.2) that people learn as they grow up determines who does what and certainly plays a part in students' decisions towards pursuing a major [Ballantine and Roberts, 2009].

In the interviews, Muslim students indicated different factors that impacted them towards pursuing computer science. Factors included culture and religion, future job plans, playing video/computer games, parental expectations, and wanting to live near home. Findings also revealed Muslim women students do not have prejudice against the computer science field, however, they have stereotypical perceptions about other fields (ex. mechanical engineering, electronics).

The results demonstrated that Muslim women are guided by different motives and expectations regarding the subject of computer science, and in some cases evaluate their strengths and abilities in different ways. Findings stressed the importance of perceived abilities in pursuing a computer science major. Abilities for successfully studying computer science were named, including interest in computer science, motivation, and previous experience, for example with programming, or playing video/computing games. In the next chapter (CHAPTER 5) I will discuss the findings in greater detail.

4.2 Quantitative Findings

In order to answer RQ2: How do experiences differ in their impact on pursuing a computer science degree for Muslim women as compared to non-Muslim women in the United States? I used data from HERI. In total, I selected 9 questions from the survey. Six of the questions were selected based on the themes that emerged from the qualitative data analysis including family role, playing computing games, educational foundation and early exposure to programming, expectations and unspoken rules (see Table 3.2). The remaining three were students' gender, major, and religion. It is worth noting that for educational foundation, I did not study students' English ability as I did not have information on whether students' first language

was English or not. And as a researcher I did not want to make assumptions about students' language proficiency in this study.

As an initial step, I examined the relationship between factors and pursuing computer science using logistic regression for all the students selected (n=500). I considered six different factors from the survey described in Table 3.2. The results of the logistic regression revealed there is a significant ($p<0.001$) positive relationship between "Play Video/Computing Games" (Estimate= 1.12), ($p<0.05$) "Want to live near home" (Estimate= 0.59), ($p<0.05$) "Please my parents" (Estimate= 0.54), ($p<0.05$) "Average mathematics" (Estimate= 1.68), ($p<0.01$) "Above average mathematics" (Estimate= 2.11), and ($p<0.05$) "Highest 10% mathematics" (Estimate= 1.87) with pursuing computer science as a major. Conversely, there was a significant ($p<0.05$) negative relationship between pursuing a computer science field and "Father career" in CS (Estimate= -0.58). Another important factor to consider is the odds ratio of the model demonstrated in Table 4.1. "Play video/computing games", "Want to live near home", "Please my parents", "Average mathematics", "Above average mathematics", and "Highest 10% mathematics" were positive predictors with odds ratios of (3.06), (1.80), (1.71), (5.36), (8.24), and (6.48) respectively. This means that having "Play video/computing games", "Want to live near home", "Please my parents" variables will correspond to 3.06, 1.80, and 1.71, times higher odds of pursuing computer science as a major consecutively as compared to not having it. Furthermore, in comparison to baseline the odds ratios for the "Average mathematics", "Above average mathematics", and "Highest 10% mathematics" were reported as following 5.36, 8.24, and 6.48. The R^2 (McFadden) for the model is 0.11. Note that this small amount of variance explained was expected since there are many other factors that contribute to student's computer science major choice beyond the factors examined in this study.

	Estimate	SE	z-Value	Sig.	Odds Ratio
Intercept	-2.03	0.88	-2.30	*	0.13
Play video/computing games	1.12	0.23	4.79	***	3.06
Father career	-0.58	0.26	-2.24	*	0.55
Mother career	0.23	0.35	0.67	ns	1.25
Want to live near home	0.59	0.23	2.51	*	1.80
Please my parents	0.54	0.21	2.57	*	1.71
Below average mathematics	0.65	0.86	0.76	ns	1.91
Average mathematics	1.68	0.82	2.04	*	5.36
Above average mathematics	2.11	0.81	2.58	**	8.24
Highest 10% mathematics	1.87	0.84	2.23	*	6.48

Table 4.1: Logistic regression analysis on five different factors and pursuing computer science
ns: not significant; ***p<0.001; **p<0.01; *p<0.05

I used two methods (logistic regression and Wilcoxon rank sum tests) to answer **RQ2**, and to examine how a student's religion impacted their interest in pursuing computer science as a major. First, I used Wilcoxon rank sum tests to compare if the impact of factors differed by religion. In particular, Wilcoxon rank-sum tests was utilized to compare variables from two groups (Muslim, and non-Muslim) in the population, and to determine if there were significant differences (see Table 4.2).

There was no significant difference by the "Father career". However, there were significant differences between the rest of the factors from table 4.1 impacting students towards pursuing computer science by religion. According to the analysis, on average non-Muslim students reported playing video/computing games 0.32% of the time, as compared to 0.24% Muslim students. However, Muslim students, on average, reported wanting to live near home 0.32%, pleasing their parents 2.42%, and mathematical ability 3.66% as compared to 0.23%, 2.25%, and 3.41% non-Muslim students respectively.

Additionally, in order to compare the different factors impacting Muslim and non-Muslim students I used two different logistic regressions. I divided my dataset

Factor	p-value	Non-Muslim	Muslim.
Play video/computing games	*	0.32	0.24
Want to live near home	*	0.23	0.32
Please my parents	**	2.25	2.42
Mathematical ability	***	3.41	3.66

Table 4.2: Wilcoxon rank sum test on factors for Muslim and non-Muslim students $p<0.05$

	Estimate	SE	z-Value	Sig.	Odds Ratio
Intercept	-1.81	1.37	-1.32	ns	0.16
Play video/computing games	0.85	0.34	2.45	*	2.33
Father career	-0.11	0.36	-0.31	ns	0.89
Mother career	0.44	0.49	0.90	ns	1.55
Want to live near home	0.43	0.31	1.36	ns	1.53
Please my parents	0.79	0.29	2.74	**	2.20
Below average mathematics	-0.47	1.40	-0.33	ns	0.62
Average mathematics	0.95	1.30	0.73	ns	2.58
Above average mathematics	1.28	1.29	0.99	ns	3.59
Highest 10% mathematics	0.79	1.31	0.59	ns	2.20

Table 4.3: Logistic regression analysis on five different factors and pursuing computer science for Muslim women students
**$p<0.001$; *$p<0.05$

to Muslim and non-Muslim students. Next, I used the same factors from 3.2 and conducted two different analysis. The logistic regression for Muslim students revealed there is a positive significant ($p<0.05$) relationship between "Play video/computer games" (Estimate=0.85) and ($p<0.01$) "Please parents" (Estimate=0.79) with the odds ratio of (2.33) and (2.20) respectively. It is worth mentioning that "Father career" had a negative impact on Muslim students towards pursuing computer science as a major. The R^2 (McFadden) for the model is 0.10. As mentioned before, this small amount of variance explained was expected since there are many other factors that contribute to students' computer science major choice beyond the factors examined in this study.

	Estimate	SE	z-Value	Sig.	Odds Ratio
Intercept	-1.96	1.25	-1.56	ns	0.14
Play video/computing games	1.29	0.32	3.97	***	3.63
Father career	-1.02	0.38	-2.64	**	0.36
Mother career	-0.02	0.54	-0.04	ns	0.98
Want to live near home	0.84	0.37	2.24	*	2.31
Please my parents	0.26	0.32	0.82	ns	1.29
Below average mathematics	1.32	1.19	1.11	ns	3.74
Average mathematics	2.14	1.15	1.86	ns	8.49
Above average mathematics	2.68	1.15	2.33	*	14.58
Highest 10% mathematics	2.71	1.19	2.27	*	15.02

Table 4.4: Logistic regression analysis on five different factors and pursuing computer science for non-Muslim women students
**p<0.001; *p<0.05

Furthermore, the logistic regression for non-Muslim students revealed that there is a significant negative relationship between (p<0.01) "Father career" (Estimate=-1.02) and pursuing computer science for non-Muslim students with the odds ratio of (0.36) indicating that if a student had a father who had a career in computer science they were 64% less likely to pursue a computer science major. The results also indicated a positive significant relationship (p<0.001) between "Play video/computing games" (Estimate=1.29), (p<0.05) "want to live near home" (Estimate=0.84), (p<0.05) "Above average mathematics" (Estimate=2.68), and (p<0.05) "Highest 10% mathematics" (Estimate=2.71) with odds ratio of (3.63), (2.31), (14.58), (15.02). This means that 1-point increase in the "Play video/computing games", "want to live near home", "Above average mathematics", and "Highest 10% mathematics" will correspond to 3.63, 2.31, 14.58, and 15.02 times higher odds of pursuing computer science as a major respectively. The high odds of ratio indicates a strong association between mathematical ability and pursuing a computer science major for non-Muslim students. The R^2 (McFadden) for the model is 0.15, which is better than for the model for Muslim students.

In this chapter I discussed the results of qualitative (Phase 1) and quantitative (Phase 2) findings. The Phase 3 (Compare and Relate) and Phase 4 (Interpretation) will be discussed in the next chapter.

CHAPTER 5

DISCUSSION AND CONCLUSION

In this final chapter, I restate the research problem and review the findings of this study. The sections of this chapter include discussion of the findings and their relationship to prior research and the study's framework, limitations and my future research, as well as the implications for practice.

5.1 Summary of Study

This research study was designed to examine the underrepresentation of women in the computer science field by presenting the pathways of those achieving or exceeding parity outside of the United States. This research was guided by two research questions to better understand why and how different cultures, religions, and experiences impact female students' educational outcomes and interest towards pursuing a computer science degree.

Research Questions:

RQ1: How do micro and macro level cultural influences impact Muslim identified women's intention to pursue a computer science undergraduate degree? RQ2: How do experiences differ in their impact on pursuing a computer science degree for Muslim women as compared to non-Muslim women in the United States?

This study was established and executed as a sequential exploratory mixed methods inquiry that was guided by multi-level cultural theory. This approach allowed me to combine both the strength of qualitative and quantitative approaches, and gain insight into cultural factors, which have an impact on students' education.

This study was developed with clear research questions and with a strong theoretical foundation. The capacity to connect the themes that arose from the interviews to the research questions in the study's conclusion demonstrates the study's strength.

The sequential exploratory mixed methods study included 9 one-on-one interviews with graduate Muslim women in the computer science field; it is worth mentioning that for the qualitative part of this study and in the interview protocol, I regard the students as expert witnesses in their own world, and tried to ask the questions that enabled them to best elucidate their thoughts about computer science. For the quantitative part of this study, I used data from the HERI freshman online survey, which was completed by students between 2000 and 2010. The results of this study identified areas of convergence and divergence from past studies as it relates to factors that impact students towards pursuing a computer science major.

Based on the interview data, three themes emerged: micro cultural influences, macro cultural influences, as well as micro and macro cultural influences. Muslim female students interpreted and negotiated their experiences in various ways. Participants considered their existence in the computer science field in reference to different factors, including their family, playing computer/video games, early exposure to programming, cultural influences and unspoken rules. As discussed earlier quantitative factors for analysis were selected with regards to the theoretical framing of the study as well as the results of these qualitative findings.

5.2 Results and Answers

In this section I compare and relate (Phase 3) the results from each qualitative theme and quantitative factor, along with the literature, accordingly (See table 5.1). It is worth mentioning that there is at least one quantitative factor for each qualitative

Convergence and Divergence	Qualitative Themes	Quantitative Factors
Family	Micro cultural influences: Family role	Father career in the computer science field
Family	Micro cultural influences: Family role	Mother Career in the computer science field
Gaming	Micro cultural influences: Playing computing games	Play video/computing games
Exposure	Macro cultural influences: Educational foundation and early exposure to programming	Mathematical ability
Expectations	Micro and Macro cultural influences: Expectations and unspoken rules	Want to live near home
Expectations	Micro and Macro cultural influences: Expectations and unspoken rules	Please my parents

Table 5.1: Qualitative Theme and Quantitative Factor

theme in this study. However, as I am comparing both qualitative themes and quantitative factors next to each other, there are instances when themes that emerged from the qualitative findings do not have the exact same variable in the quantitative data (see table 5.1). Thus, for example, in **Family**, although I wanted to explore more about the relationship between siblings and extended family members with students pursuing computer science field, I did not have quantitative data to explore it. As in the HERI data, there was not enough information around siblings' majors or extended families' majors and their relation with students to compare and draw convergent conclusions related to this theme. Similarly, when students were introduced to programming in **Exposure**, I did not have data regarding when students were introduced to programming. This can be a topic for further exploration in a future study, as it needs deep exploration with a larger amount of quantitative data and it was out of the scope of this study both financially and time-wise.

5.2.1 Family:

Qualitative Theme: Micro cultural influences - Family role

Quantitative Factor: Father's career in the computer science field, and Mother's career in the computer science field

Students' lack of information about majors prevents students from making wise decisions [Bogenschneider and Johnson, 2004]. One way that students become aware about fields of study is through their family [Bresnihan et al., 2021, Bogenschneider and Johnson, 2004]. Thus, students who have more knowledge about their relatives' careers tend to be affected by them [Calderon and Marken, 2020, Bresnihan et al., 2021]. The findings of the qualitative part of this study suggests students who became familiar with computer science contexts at an early age became more informed about the field. Qualitative results revealed Muslim women become interested in the computer science field from their immediate and extended family members including father, brother, uncle, and cousin. It is worth mentioning, as opposed to Western culture, the traditional Muslim family is extended to three or more generations in one household [Anwar, 1994]. The importance of extended family from different points, including students academic success, has been discussed in the literature [Ferguson, 2006, Coleman, 1981]. Studies found that the risk that children will drop out of school was decreased by high levels of social support from their extended family [Ferguson, 2006]. According to research, factors such as number of extended family members who reside in the home, the amount of interactions the child has with these family members, and the frequency with which the youngster travels to see extended family members, are among the important factors predicting the amount of support students can get from their extended family members [Ferguson, 2006]. Although the importance of immediate family members, and more specifically par-

ents, in a student's major choice, has been discussed widely by prior researchers [Calderon and Marken, 2020, Muenks et al., 2020, Kargarmoakhar et al., 2019], to date there is limited literature around the importance of extended family members and pursuing a computer science major.

Studies demonstrated that parents place a high importance on education in the computer science field, globally [Bresnihan et al., 2021, Šimunović et al., 2018]. According to the available research, students who are supported by their parents perform better academically, perform better on standardized tests, maintain better attendance records, drop out less frequently, have higher expectations, and have more favorable attitudes toward learning [Bogenschneider and Johnson, 2004]. It is worth mentioning that extended families continue to exist in countries where children settle near their parents, but in modern urban societies, both the sense of community and the connection to the extended family are greatly diminished. This suggest that Muslim women have higher chances of getting impacted by their extended family members, than students in more modern countries such as United States, as discussed in the literature review.

The other important factor to mention is the effect of parents on their children's choice of major [Bogenschneider and Johnson, 2004]. There are students who follow in the steps of their parents because they feel more comfortable, secure, or had no other option [Tillman and Engel, 2015]. According to the available research, intentional and unintentional parental influence on children's professional choices can have both positive and negative effects [Contributor, 2020]. When students are treated as if their opinions are valued, they are more receptive to their parents' ideas, which may lead to them pursuing careers in the same fields as their parents [Tillman and Engel, 2015]. However, it is important to note that parents who put pressure on their children to pursue specific high-profile jobs, be-

lieving they are pushing their children to aim high, can negatively impact students [Contributor, 2020, Tillman and Engel, 2015]. In other words, parental pressure tactics might backfire and raise opposition to parental counsel. Students who are influenced by their parents negatively are less likely to choose the same career field of their parents. According to Dietrich and Kracke (2009) "if adolescents perceive their parents as putting through their own wishes for the child's future career rather than collaborating with the child in preparing for a career this may be interpreted as disinterest in the child's plans..." (p. 116) [Dietrich and Kracke, 2009]. Thus, too much pressure from families can cause disengagement from a field. The quantitative results of this study highlighted that students experienced a negative impact towards pursuing the computer science field if they have parents in the computer science field. The effect of having a father in the computer science field for non-Muslim students was significant. This may mean that non-Muslim women students experienced pressure from their fathers in the field towards pursuing a computer science major; and this pressure backfired in the students selecting their major.

In the qualitative data, students had the opportunity to explain their path towards computer science and the impact they received from their family members. One Muslim female student specifically spoke about her relation to her father and him being her role model for pursuing a career in the computer science field. Thus I selected this theme to explore more in the quantitative data. Results showed that non-Muslim students were negatively ($p<0.01$) impacted by their fathers towards pursuing a computer science major. When I explored the literature, I found that the students who experience pressure from their parents towards pursuing a major they have less interest in pursuing that particular (in this case computer science) major. As discussed in the literature review, non-Muslim women have biases that computer science is a masculine field. Adding a father (masculine) role in the computer science

field can have an additional negative impact on students towards pursuing computer science. Thus, it suggest that both Muslim women and non-Muslim women experience pressure towards pursuing a computer science degree from their parents, which can cause less interest towards pursuing a computer science major.

5.2.2 Gaming:

Qualitative Theme: Micro cultural influences - Playing computing games

Quantitative Factor: Play video/computing games

For a long time, researchers have examined the relationship between playing video/computing games and pursuing a computer science major [Denner et al., 2015, DiSalvo and Bruckman, 2009, Sweedyk et al., 2005]. Researchers cited a positive relationship between playing video/computing games and majoring in the computer science field [DiSalvo and Bruckman, 2009, Tillberg et al., 2005, Kersteen et al., 1988]. Students' motives in gaming reported as competition, challenge, design, graphics, passing time, skill construction, peer pressure, and emotional support for marginalized groups [Gabriela T. Richard and Kishonna L. Gray, 2018]. It is reported that women benefit from playing video/computing games via improving their cognitive, social, and physical skills [Lopez-Fernandez et al., 2019]. As discussed in the literature review, many Muslim women face systematic marginalization in society (Muslim majority couturiers) [Gabriela T. Richard and Kishonna L. Gray, 2018, Schell et al., 2016]. Previous research shows that the religious paradigm and many cultural factors have an impact on Muslim women's recreational and leisure activities. Some families believe playing video/computing games can impact students faith and result in students disobedience [Aziz, 2019]. As Islam condemns worthless and pointless entertainment that has no worldly or religious value, many families

restrict students in the kind of games they can play [Umair, 2022]. Scholars reported gaming activity as one way Muslim women feel freedom in their society [Hussain et al., 2021]. According to the literature, Muslim women reported playing video games as a "vehicle for an oppositional agency and personal freedom from the patriarchal system" in the Muslim country [Hussain et al., 2021]. In the qualitative part of this research, students opened up about their experiences with playing video/computing games. The findings illustrated (see 4.1.2) that almost all of the students had experience playing video/computing games. The majority of those students revealed that playing video/computing games positively impacted them towards pursuing a computer science major. The students mentioned they enjoyed playing video/computing games, found them fun, enjoyed the graphics, and aspired each student towards making new games themselves. Thus one way it can be interpreted is that students who play video/computing games can escape their life problems via gaming which Muslim students found it a fun activity. This fun activity results in positive outcomes such as students becoming interested in pursuing a computer science major [Stenseng et al., 2012] .

In the context of the United States, previous research focused on playing video/computing games was reported as a masculine activity. In other words, video/computing games are typically connected with stereotypical male characteristics, such as being extremely aggressive and feature sexualized elements [Lopez-Fernandez et al., 2019]. This masculine imagery within gaming prevents the majority of women students from playing it [Lopez-Fernandez et al., 2019]. Therefore, women in the United States are less encouraged to play video/computing games.

In the quantitative part of this study, I further analyzed the relationship between playing video/computing games for both Muslim women and non-Muslim women,

and pursuing a computer science major. The results revealed that there is a significant relationship between playing video/computing games and pursuing a computer science major for both Muslim women and non-Muslim women (see table 4.1, 4.3, and 4.4). Additionally, it is worth mentioning that on average non-Muslim women reported playing video/computing games more than Muslim women students (see table 4.2).

As discussed, although there is a significant relationship between playing video/computing games and pursuing computer science for both Muslim and non-Muslim students, the intentions behind it are very different for Muslim women as compared to non-Muslim women. Muslim women play video/computing games as a fun activity which allow them to feel freedom [Hussain et al., 2021] and that feeling elevates their interest towards pursuing a computer science major. On the other hand, it may be sufficient to interpret non-Muslim women who play video/computing games as being the ones who overcome the idea that playing video/computing games is a masculine activity. Additionally, results revealed that non-Muslim women play more video and computer games compared to Muslim women students. From the literature, it may be the case that Muslim women face more limitations towards playing video/computing games than their non-Muslim counterparts.

5.2.3 Exposure:

Qualitative Theme: Macro cultural influences - Educational foundation and early exposure to programming

Quantitative Factor: Mathematical ability

Mathematics, English, and previous computer programming experiences are reported among the possible contributing factors for women students pursuing a computer science major [Cantwell Wilson, 2002, Fabros-Tyler, 2014]. For non-English native students, English language proficiency has a positive relationship with students' overall academic achievement [Fakeye et al., 2009]. Thus, in the qualitative part of this study I asked Muslim students whose native language was not English about their English grades during their school years (see APPENDIX A). Almost all of the participants responded they got the top grades of their class during their education (see 4.1.3). From the interviews, it can be understood that although students reported they had good grades in English, they were not at a native level. Thus, for the quantitative part, as the majority of the students were native in English, I did not use English proficiency as one factor to measure its relation to pursuing a computer science major.

According to the literature, mathematics is a very important topic that serves as a tool for many disciplines, including computer science [Fabros-Tyler, 2014, Cantwell Wilson, 2002]. As computer science is identified as a math-related major, performance accomplishment in mathematics may have an impact on how people perceive their own self-efficacy [Cantwell Wilson, 2002]. Thus, students perceived self-efficacy increases if their mathematical experiences provide positive information about the computer science major [Cantwell Wilson, 2002]. A large body of literature demonstrates that self-efficacy and confidence in mathematics are key factors in choosing computer science as a major for women students [Hawke et al., 2009, Dijkstra et al., 2016, Rittmayer and Beier, 2008]. Thus, students who have better mathematics experiences are more interested in pursuing a computer science major. It is important to note that according to the previous research, countries with gender based disparities do not necessarily have parity in

males' and females' interest related to mathematics [Reilly, 2012]. Muslim majority counties including Oman, Iran, Bahrain, Kuwait, Morocco and Saudi Arabia are some examples of women's increased self-confidence and interest in mathematics over men's [Ghasemi and Burley, 2019]. In the interviews, almost all of the students mentioned they got good grades in mathematics, and identified themselves among the top ten percent of their classes. This factor demonstrated how Muslim women were confident in their mathematical abilities.

In general, women in the United States are not very confident in their mathematical abilities [Miura, 1987, Ghasemi and Burley, 2019]. Research revealed that, despite having the same math grades and test results as their women counterparts, men rate their own mathematical proficiency higher than women do in the United States [Voyer and Voyer Susan D., 2014, Correll, 2001]. Thus, women in the United States believe math related topics are more appropriate for males. On the other hand, an important factor that I noticed in the interviews was that none of the Muslim women identified mathematics as a masculine topic. According to the literature, in Muslim majority countries, the number of women students who pursue math related topics is equal or sometimes exceed the number of males [UIS, , Hyde et al., 1990]. To conclude we can interpret that mathematics and math-related topics are not considered masculine in Muslim majority countries as opposed to the United States [Hyde et al., 1990, Hyde and Mertz, 2009, Kargarmoakhar and Ross, 2019].

Quantitative results demonstrated that there was a significant positive relationship between rating mathematical ability above average and pursuing a computer science major for non-Muslim students (see Table 4.4). However, there was not a significant relationship between mathematical ability and pursuing a computer science major for Muslim students (see Table 4.3). According to previous literature, we can understand that non-Muslim women who rate their mathematical abilities higher

than average experience a higher self-efficacy in comparison to students who rate themselves lower than average [Miura, 1987]. Thus, self-efficacy in mathematical ability is impacting non-Muslim women's choice of major in the computer science field more than Muslim students.

Researchers have discovered one factor that has a major influence on women towards pursuing computer science is having programming experience [Beyer, 2014, He and Freeman, 2010]. In the United States, women are exposed to computers at older ages and have less programming experience in comparison to their male colleagues [Beyer et al., 2003, Varma, 2009]. Less experience is often tied to less interest and less self-efficacy for women [He and Freeman, 2010]. Researchers found programming experience during school years is one of the top predictors of success, in addition to being a statistically significant predictor for performance in a college computer science major [Chen et al., 2018]. Many students in the interviews revealed they were exposed to programming at around the high school and middle school years. Although students mentioned the programming courses had simple content such as a basic arithmetic calculator (see 4.1.3), they were fascinated with their programming classes and felt enthusiastic about the topic. Although, I did not have quantitative data with regards to students' first programming experience, with the help of previous literature it can be interpreted that both Muslim and non-Muslim women became interested in computing programming when they were introduced to it at early ages and before their college years [Kargarmoakhar et al., 2020, Beyer, 2014, He and Freeman, 2010, Varma, 2009, Beyer et al., 2003]. This finding demonstrates how school at the macro level can impact Muslim women and non-Muslim women students towards pursuing a computer science major.

5.2.4 Expectations:

Qualitative Theme: Expectations and unspoken rules

Quantitative Factor: Want to live near home - and please my parents

When students reach adolescence, they begin to actively explore their futures, frequently looking to their parents as role models or for professional advice [Paulu, 2005]. A parent's approach to this can either stimulate youngsters to explore a wide range of potential jobs, or lead them onto a route that they believe their parents will approve or accept [Williams, 2016]. In these cases, students might feel obligated to select a major to please their parents. In addition to parental expectations, cultural factors contribute to women's choice of major [Sax et al., 2017, Reilly, 2012]. Religion is the primary foundation of the Muslim country's political, social, and legal structures [Khalaf, 2021]. Cultural barriers and gender based discrimination, in many Muslim majority countries, inhibits women's access and participation in some fields [Hassan, 2000]. In Muslim majority countries, mathematics and mathematic-related fields, like computer science, are not considered among specific gender categories [Mellström, 2009, Kargarmoakhar and Ross, 2019]. In fact, computer science is among one of the fields that Muslim women can pursue without worrying about familial or cultural restrictions and consequences.

It is worth mentioning that there are different groups, races, religions, and cultures that are living in the United States. Although each group can practice their own cultural values, everyone living in the United States is governed by the rules of the country. At the macro level, the United States prohibits discrimination on the basis of race, gender, color, or religion [U.S. Department of Justice Civil Rights, 1964]. Thus, for students who live in the United States, there are no written gender-based restrictions on the major(s) they can pursue [U.S. Department of Education, 2021, U.S. Department of Justice Civil Rights, 1964]. However, there is an unconscious

bias that men are better than women in math-related topics, including computer science, both at the micro level (parents), and macro level (school, society) (see Figure 2.1) which impacts a student's choice of major [Dee and Gershenson, 2017]. Additionally, parental income, parental financial ability, tuition costs, students' financial motives, financial aid availability at school, as well as the distance of the school from home are among important factors that impact students towards pursuing a major [Denner et al., 2015, Chapman and Jackson, 1987, Bowers et al., , Stage et al., , Blaney, 2020, Sewell and Shah, 1968]. Thus, this suggest that students' socioeconomic status and financial motives impact students towards pursuing a computer science major in the United States.

In the interviews, a majority of the Muslim women students mentioned they chose computer science over other topics to please their parents (see 4.1.4). In fact, some students mentioned their parents asked them to choose majors such as math, computer science, and engineering. Some students also mentioned they attended schools in their city as requested by their parents. Few students mentioned they had to participate in a national exam in their country for university entrance, and they chose the most prestigious university possible with their achieved points in the exam, regardless of which city the school was located. One important factor was none of the Muslim students in the interviews mentioned educational cost as a limitation. In fact, in many Muslim majority countries, including Iran and Saudi Arabia, public schools offer students free education [WES, 2017, The Embassy of The Kingdom of Saudi Arabia, 2022]. However, free Universities are for high-achieving students. For example, in Iran, high school graduates take a national exam called Konkour for university entrance [Wikipedia, 2022]. Konkour is a standardized multiple-choice test that lasts about 4 hours and 30 minutes which covers all subjects taught during high school

[Broadbent, 2021, Khodi et al., 2021]. Konkour was implemented as a mechanism of getting access to higher education in Iran [Kamyab, 2008]. Majors with higher demand required higher points [Khodi et al., 2021]. Thus, for high achieving students, educational costs are not considered as a limitation in many Muslim majority countries.

For the quantitative part of this study, I selected two variables to study including wanting to live near home and pleasing their parents (see Table 5.1). The results revealed that there was a positive significant ($p<0.01$) relationship between pleasing parents and pursuing computer a science major for Muslim students (see Table 4.3). However, for non-Muslim students there was a positive significant ($p<0.05$) relationship between living near home and pursuing a computer science major (see table 4.4). On average, Muslim women reported higher levels of pleasing their parents and wanting to live near home as compared to non-Muslim women students (see Table 4.2).

The qualitative and quantitative results, along with the literature, demonstrates that Muslim and non-Muslim women's intentions and interests towards pursuing a computer science major are different. It is demonstrated that Muslim women are highly influenced by their parents, as well as cultural values and limitations. Muslim women tend to find the computer science field as a feminine field they can major in without being worried about cultural restrictions and parental rules and regulations. However, non-Muslim women tend to get influenced by the cultural stigma identifying computer science as a masculine field [Papastergiou, 2008]. Additionally, it was suggested from the study that non-Muslim students' financial status had an impact towards pursuing a computer science major.

In investigating women's underrepresentation and limited participation in the computer science field in the United States, I compared their experiences to well

represented women from Muslim majority countries. Ultimately, and as discussed in my research study, this thesis is not about finding the solution to the problem. Instead, my intent was to connect different aspects of the historical and current cultural experiences of students who participated in the interviews detailing how their lived experiences shaped their path towards pursuing a computer science major, as well as the quantitative responses on the survey.

Taking together the four themes emerged (see 4.1), this suggest that although factors such as family, playing video/computing games, and mathematical abilities may seem to have similar impacts on Muslim and non-Muslim women towards pursuing a computer science major, there were inherently different factors as well (as discussed earlier see 5.2.1, 5.2.2, and 5.2.3). The most interesting factor identified that influenced students was cultural expectations and unspoken rules at the macro level (see 5.2.4). It demonstrated how Muslim women, with limited options and the necessity to respect cultural values, are finding their independence and freedom through pursuing a computer science major. Although both Muslim and non-Muslim students wanted to live near their (parents') home, their intentions were very different. As Muslim women wanted to meet cultural expectations, non-Muslim women wanted less expenses during their education [Pew Research Center, 2011]. In other words, financial motives (such as being able to live near home and have less expenses during their education) was very important for non-Muslim students [Remington, 2012]. Another important factor to mention is that the borders of femininity and masculinity are different in Muslim majority countries and the United States. In the United States, women believe math related topics including computer science are masculine. However, Muslim women believe computer science is a feminine field since it requires less interaction with men in addition to be an indoor job that doesn't necessitate field work or distant commuting. As discussed earlier, women in the United States

perform as well as men in mathematics [Hargreaves et al., 2008]. However, it may be safe to say that opposed to women in Muslim majority countries, these long held masculinity beliefs are among the most important factors distancing women in the United States from pursuing the computer science field.

5.3 Limitations and Future Work

While my research addresses an evident gap in literature on women's pursuit in the computer science field, there are limitations to this study. When I was designing this study, I had concerns about being representative of the many experiences of women in Muslim majority countries towards pursuing a computer science field, as there are more than 50 Muslim majority countries in the world. The qualitative size of this study (9 Muslim women) did not allow for such expansion, nor did the methodology I use require it. The nature of the study was not expansive or representative of the population rather the main idea was to get rich and detailed data by paying attention to each individual participant. The themes that emerged provided glimpses into Muslim women's experiences in the computer science field. This study was designed to better understand how Muslim majority countries, which are presumed to be gender unequal (in rights and liberties), reached parity in the computer science fields, while the United States, as a presumed more gender equal country, did not reach that equality.

More than half of the interviews were conducted over the phone due to the restrictions caused by the COVID-19 virus. Even though none of the participants said that they did not want to be interviewed by phone, some of them were not very comfortable at the start of the interview. In face-to-face interviews, students felt more comfortable and opened up about their experiences more quickly. However, it

is worth noting not having face-to-face interviews did not impact the quality of the results.

There were some limitations with the quantitative part of this study as well. It should be noted that the students who completed the survey are in the United States. Thus, the Muslim women we are referring to have different experiences and backgrounds from students who completed their undergraduate degrees in the Muslim majority countries. Additionally, the online survey was completed solely by students, and some questions were open for interpretation; for example, questions asking students to rate their abilities in mathematics. As there is no one rule or one grade, the question is open to students self-perception.

As mentioned earlier (see Table 5.1), although I had at least one representative quantitative variable for each qualitative theme, there were instances when each qualitative theme did not have a direct quantitative variables. These variables include information around students' immediate and extended families; for example, if students had an immediate or extended family member who pursued a computer science degree and/or other related field and how their gender and occupation impacted students towards pursuing said major. Another variable was how the students were first introduced to the computer science field; for example information about their first programming experience, first class, first topic, and first teacher. This information can aid which type of experiences are helping to attract students towards pursuing a computer science major. Furthermore, as discussed earlier, I did not study students' English ability in the quantitative part of this study. However, further analysis on students' English ability and their interest towards pursuing computer science could be beneficial. Thus, further analysis with a new validated survey would be of assistance, yet was beyond the scope of time and budget of this project.

In the future, I would like to conduct a qualitative study with a more diverse population of Muslim women. As mentioned, there are about 50 Muslim majority countries, and in this study I only had Muslim women from two Muslim majority countries including Iran and Saudi Arabia [Pew Research Center, 2009]. My plan is to interview Muslim women from all these other Muslim majority countries (both developed and emerging) to better understand women's experiences and expectations. I would like to conduct the quantitative study in both Muslim majority countries and in the United States to better compare Muslim students experiences and find out more about which aspect of the cultural level, micro or macro, has the most impact on students pursuing a computer science major. In the future, I am planning to develop a new survey which contains the variables mentioned. Then, I will be able to better situate the study and have a more in depth comparison between Muslim and non-Muslim women experiences. With understanding which cultural layer has the most important impact we can take measures to implement new rules or regulations on that level and attract more women to the computer science field in the United States.

It is worth mentioning, with the help of guiding research questions, theoretical frame work, both qualitative and quantitative methods, as well as the previous literature, I ensured this study had strong and detailed information for which the limitations mentioned above do not diminish the quality of the findings.

5.4 Implications

The results of this study add to other scholarly research and will inform policy and decision making activities for families, schools, universities, institutions, and gov-

ernments interested in increasing the participation rates of females in the computer science field.

From a practical standpoint, offering early computing exposure will improve students' interest and awareness around the computer science field. As mentioned earlier, some of this exposure comes from immediate or extended family members who have had experiences in the field. Additionally, students can become aware about the computer science field by simply playing video/computing games or gaining some basic programming experience at home or in classes offered in middle school and high school. The study demonstrated that each of these experiences had a positive impact on students; in fact, many students became interested in knowing more about the computer science field with this small but important exposure at a young age. Thus, parents can provide opportunities for gaming, while schools can prepare courses to teach very basic programming concepts and its implementation for students.

One important factor here is to address that both men and women have the same capabilities in math related topics including programming and computer science taught by their teachers [Hyde et al., 1990, Hargreaves et al., 2008]. Unfortunately, teachers' unconscious biases around men being better in math related topics have negative impacts on women in the United States. The adoption of an asset-based approached to programming should be adopted by educators before they start teaching programming classes for their students. Additionally, families in the United States have to be educated by the schools on the fact that their children (both men and women) have the same capacities in math related topics, so they should not expect lower grades or performance from their daughters in comparison to their sons. Although, we need leaders who can fundamentally alter the learning cultures of schools and the teaching profession itself in order to achieve

long-lasting reform, cultural shifts can happen through communication strategies as well [Fullan, 2002, Tonso, 1996]. For example, forums are a space where participants (parents, teachers, principals, institutional leaders) can communicate about the ways cultural norms impact women students [Tonso, 1996]. Additionally, principals can invite experts to schools to share their knowledge with teachers and parents [Leithwood and Jantzi, 1990].

Another finding was the importance of finances in students' educational paths in the United States. Many students in the United States want to live near their parents because of economic challenges. For example, students who live with their parents can save money on rent for a new place, food, travel and commute expenses, as well as tuition fees, and much more [Turley, 2006]. Additionally, students who have less economic opportunities have less computer ownership, which ties back to having less exposure and ultimately less experience with computers [Norris et al., 2003]. Thus, these disadvantaged students have less information about computer science education, as well as future employment and income levels related to the field in comparison to more affluent students. Measures that can be taken include the U.S. government providing technology and computer access for students, as well as promoting and demonstrating available career opportunities and income levels of people in the computer science field to students. These initiatives may result in more interest towards pursuing computer science by students in the United States.

This study adds to other scholarly research and prior work regarding examining motives for women to pursue a computer science major. When considering tactics to encourage students to consider a computer science major, I proposed that educational institutions should investigate ways to actively involve parents and teachers in order to oppose stereotyped gendered conceptions of computer science in the schools. Additionally, institutions and schools, with the help of policy makers in the gov-

ernment, should propose plans to make initiatives in eliminating the boundaries of masculinity and femininity in education, precisely math related topics and computer science. According to the literature, one way to achieve gender equality and gender parity in education is gender equity. Gender equity is defined as a policy concept that emphasizes "redistribution of resources between women and men in a way that addresses gender based asymmetries in investment and capacities of women and men" [Subrahmanian, 2005]. Furthermore, with the new Biden-Harris administration the coalition for feminist foreign policy is under review [Graham and Corrado, 2021]. The United States is developing a vision to promote values and good practices to achieve the highest standards for gender equality and inclusion around the globe [Thompson, 2020].

The most important finding was that many Muslim women selected the computer science field between the limited number of fields that were accepted by families, governments, as well as cultural values and expectations. Thus, when comparing Muslim women to non-Muslim women, it should be considered that Muslim women face some restrictions deciding on their major as opposed to non-Muslim women. It should be noted that Muslim women select computer science as one major to pursue between a limited number of options available; as opposed to non-Muslim women who pursue computer science as one of many options for their education. Thus, there can always be a drastic percentage difference between the participation of Muslim versus non-Muslim students in the computer science field.

LIST OF REFERENCES

[UIS,] UIS Statistics.

[Al Alhareth, 2013] Al Alhareth, Y. (2013). E-learning contribution to the enhancement of higher education opportunities for women in Saudi Arabia (Pilot study). *US-China Education Review A& B, USA*, 3(9):637–648.

[Alghamdi, 2017] Alghamdi, F. (2017). Why do female students choose to study CS in the Kingdom of Saudi Arabia?

[Alhashmi, 2018] Alhashmi, T. (2018). AGSIW — Cracking the Glass Ceiling: Arab Women in Technology.

[Alkassim et al., 2016] Alkassim, R. S., Tran, X., Rivera, J. D., Etikan, I., Abubakar Musa, S., and Sunusi Alkassim, R. (2016). Comparison of Convenience Sampling and Purposive Sampling. *American Journal of Theoretical and Applied Statistics*, 5(1):1–4.

[Allen Smith, 2022] Allen Smith, J. (2022). Out-of-State Remote Workers Are Increasing Legal Risks for Employers.

[Altheide and Johnson, 2011] Altheide, D. L. and Johnson, J. M. (2011). Reflections on interpretive adequacy in qualitative research. *SAGE handbook of qualitative research*, 4:581–594.

[Anwar, 1994] Anwar, M. (1994). *Young Muslims in Britain : attitudes, educational needs and policy implications*. Islamic Foundation.

[Aquil, 2011] Aquil, R. (2011). Change and Muslim Women. *International Journal of Humanities and Social Science*, 1(21).

[Arthur et al., 2012] Arthur, J., Waring, M., Coe, R., and Hedges, L. V. (2012). Research methods and methodologies in education. page 456.

[Austin et al., 2017] Austin, P., medical, E. S. S. m. i., and 2017, u. (2017). Events per variable (EPV) and the relative performance of different strategies for estimating the out-of-sample validity of logistic regression models. *journals.sagepub.com*, 26(2):796–808.

[Aziz, 2019] Aziz, M. (2019). Influence of Video Games on the Faith of Toddler Muslims. *Exploration of Father's Perception and Practices Regarding Child Care and Development in Balochistan, Pakistan*, page 64.

[Ball et al., 2018] Ball, C., Huang, K.-T., Cotten, S. R., and Rikard, R. V. (2018). Gaming the SySTEM: The Relationship Between Video Games and the Digital and STEM Divides:. *https://doi.org/10.1177/1555412018812513*, 15(5):501–528.

[Ballantine and Roberts, 2009] Ballantine, J. H. and Roberts, K. A. (2009). Our social world : introduction to sociology.

[Beck and Denise F. Polit, 2017] Beck, c. T. and Denise F. Polit (2017). NURSING RESEARCH:GENERATING AND ASSESSING EVIDENCE FOR NURSING PRATICE. pages 68–70.

[Beehner, 2007] Beehner, L. (2007). Religious Conversion and Sharia Law — Council on Foreign Relations.

[Belkin, 2021] Belkin, D. (2021). A Generation of American Men Give Up on College: 'I Just Feel Lost'.

[Beyer, 2014] Beyer, S. (2014). Why are women underrepresented in Computer Science? Gender differences in stereotypes, self-efficacy, values, and interests and predictors of future CS course-taking and grades. *Computer Science Education*, 24(2-3):153–192.

[Beyer et al., 2003] Beyer, S., Rynes, K., Perrault, J., Hay, K., Haller, S., Beyer, S., Rynes, K., Perrault, J., Hay, K., and Haller, S. (2003). Gender differences in computer science students. In *Proceedings of the 34th SIGCSE technical symposium on Computer science education - SIGCSE '03*, volume 35, page 49, New York, New York, USA. ACM Press.

[Blaney, 2020] Blaney, J. M. (2020). Broadening Participation in Computing: !e Role of Upward Transfer. *Proceedings of the 51st ACM Technical Symposium on Computer Science Education*.

[Bogenschneider and Johnson, 2004] Bogenschneider, K. and Johnson, C. (2004). Family Involvement in Education: How Important Is It? What Can Legislators Do. *A policymaker's guide to school finance: Approaches to use and questions to ask*, pages 19–29.

[Bourner, 2003] Bourner, T. (2003). Reflective Learning Key to Learning from Experience.PDF.

[Bowen and Ostroff, 2004] Bowen, D. E. and Ostroff, C. (2004). Understanding HRM-firm performance linkages: The role of the "strength" of the HRM system. *Academy of Management Review*, 29(2):203–221.

[Bowers et al.,] Bowers, T., Personnel, R. P. J. o. C. S., and 1973, u. Factors underlying college choice by students and parents. *psycnet.apa.org*.

[Boyatzis, 1998] Boyatzis, R. E. (1998). Thematic Analysis and Code Development The Search for the Codable Moment. *Transforming Qualitative Information*, (800):9774.

[Braun and Clarke, 2011] Braun, V. and Clarke, V. (2011). Thematic analysis. In *APA handbook of research methods in psychology, Vol 2: Research designs: Quantitative, qualitative, neuropsychological, and biological.*, pages 57–71. American Psychological Association, Washington.

[Bresnihan et al., 2021] Bresnihan, N., Bray, A., Fisher, L., Strong, G., Millwood, R., and Tangney, B. (2021). Parental Involvement in Computer Science Education and Computing Attitudes and Behaviours in the Home: Model and Scale Development. *ACM Transactions on Computing Education*, 21(3):1–24.

[Broadbent, 2021] Broadbent, S. (2021). Update on the Iranian Konkur .

[Brownlee, 2020] Brownlee, J. (2020). Imbalanced Classification with the Fraudulent Credit Card Transactions Dataset.

[Bujang et al., 2018] Bujang, M. A., Sa'At, N., Tg Abu Bakar Sidik, T. M. I., and Lim, C. J. (2018). Sample Size Guidelines for Logistic Regression from Observational Studies with Large Population: Emphasis on the Accuracy Between Statistics and Parameters Based on Real Life Clinical Data. *The Malaysian Journal of Medical Sciences : MJMS*, 25(4):122.

[Calderon and Marken, 2020] Calderon, V. J. and Marken, S. (2020). Parents Think Computer Science Education Is Important.

[Cantwell Wilson, 2002] Cantwell Wilson, B. (2002). A Study of Factors Promoting Success in Computer Science Including Gender Differences. *Computer Science Education*, 12:1–2.

[Cao and Shen, 2022] Cao, L. and Shen, H. (2022). CSS: Handling imbalanced data by improved clustering with stratified sampling. *Concurrency and Computation: Practice and Experience*, 34(2):e6071.

[Castillo-Montoya, 2016] Castillo-Montoya, M. (2016). Preparing for Interview Research: The Interview Protocol Refinement Framework Refinement Framework. *The qualitative report*, 21(5):811–831.

[Chapman and Jackson, 1987] Chapman, R. G. and Jackson, R. (1987). *College Choices of Academically Able Students: The Influence of No-Need Financial Aid and Other Factors. Research Monograph No. 10.*

[Chen et al., 2018] Chen, C., Haduong, P., Brennan, K., Sonnert, G., and Sadler, P. (2018). The effects of first programming language on college students' computing attitude and achievement: a comparison of graphical and textual languages. *https://doi.org/10.1080/08993408.2018.1547564*, 29(1):23–48.

[Chiseri-Strater, 1996] Chiseri-Strater, E. (1996). and Reflexivity in Case Study and Ethnographic. *Ethics and Representation in Qualitative Studies*, 1:115–133.

[Cislaghi and Heise, 2020] Cislaghi, B. and Heise, L. (2020). Gender norms and social norms: differences, similarities and why they matter in prevention science. *Sociology of Health and Illness*, 42(2):407–422.

[Cohen, 2011] Cohen, A. B. (2011). Religion and Culture.

[Cohen and Crabtree, 2006] Cohen, D. and Crabtree, B. (2006). Qualitative research guidelines project.

[Coleman, 1981] Coleman, J. S. (1981). *Public and private schools*, volume 3. ERIC Document Reproduction Service.

[Commission On Technology and Education, 2000] Commission On Technology, G. and Education, T. (2000). Tech-Savvy: Educating Girls in the New Computer Age. *Education*, pages 1–86.

[Contributor, 2020] Contributor, C. (2020). The Effect of Parents on an Adolescent's Choice of Career.

[Correll, 2001] Correll, S. (2001). Gender and the Career Choice Process: The Role of Biased Self-Assessments. *American Journal of Sociology*, 106(6):1691–1730.

[Cox, 1958] Cox, D. R. (1958). The Regression Analysis of Binary Sequences. *Journal of the Royal Statistical Society: Series B (Methodological)*, 20(2):215–232.

[Creswell and Poth, 2016] Creswell, J. and Poth, C. (2016). Designining a Qualitative Study: Choosing Among Five Approaches. *Qualitative Inquiry and Research Design: Choosing Among Five Approaches*.

[Creswell, 2012] Creswell, J. W. (2012). *Educational Research Planning, Conducting, and Evaluating Quantitative and Qualitative Research Creswell 4th Edition*.

[Creswell and Creswell, 2017] Creswell, J. W. and Creswell, J. D. (2017). *Research Design : Qualitative, Quantitative, and Mixed Methods Approaches*. SAGE Publications.

[Creswell et al., 2013] Creswell, J. W., Klassen, A. C., Clark, V. L. P., and Smith, K. C. (2013). Best practices for mixed methods research in the health sciences. *National Institute of Health*, pages 541–545.

[Creswell and Plano Clark, 2017] Creswell, J. W. and Plano Clark, V. L. (2017). *Designing and Conducting Mixed Methods Research: Edition 3 by John W. Creswell, Vicki L. Plano Clark - Books on Google Play*.

[Curry et al., 2009] Curry, L. A., Nembhard, I. M., and Bradley, E. H. (2009). Qualitative and Mixed Methods Provide Unique Contributions to Outcomes Research. *Circulation*, 119(10):1442–1452.

[Damaskinidis, 2017] Damaskinidis, G. (2017). Qualitative Research and Subjective Impressions in Educational Contexts. *American Journal of Educational Research, Vol. 5, 2017, Pages 1228-1233*, 5(12):1228–1233.

[Daniel, 2014] Daniel, J. (2014). Choosing the Type of Probability Sampling. *Sampling Essentials: Practical Guidelines for Making Sampling Choices*, pages 125–174.

[Davis-Blake et al., 1989] Davis-Blake, A., review, J. P. A. o. m., and 1989, u. (1989). Just a mirage: The search for dispositional effects in organizational research. *journals.aom.org*, 14(3):385–400.

[Dee and Gershenson, 2017] Dee, T. and Gershenson, S. (2017). Unconscious Bias in the Classroom: Evidence and Opportunities, 2017. *Stanford Center for Education Policy Analysis*.

[Denner et al., 2015] Denner, J., O'Connor, L., and Werner, L. (2015). Women in community college: Factors related to intentions to pursue computer science. *NASPA Journal About Women in Higher Education*, 8(2):156–171.

[Dey, 2003] Dey, I. (2003). *Qualitative Data Analysis: A user friendly guide for social scintists*. Routledge.

[Dickson-Swift et al., 2016] Dickson-Swift, V., James, E. L., Kippen, S., and Liamputtong, P. (2016). Doing sensitive research: what challenges do qualitative researchers face?:. *http://dx.doi.org/10.1177/1468794107078515*, 7(3):327–353.

[Dietrich and Kracke, 2009] Dietrich, J. and Kracke, B. (2009). Career-specific parental behaviors in adolescents' development. *Journal of vocational behavior*, 75(2):109–119.

[Dijkstra et al., 2016] Dijkstra, A., economics, L. H. F., and 2000, u. (2016). Measuring socio-economic gender inequality: Toward an alternative to the UNDP gender-related development index. *Taylor & Francis*, 6(2):41–75.

[DiSalvo and Bruckman, 2009] DiSalvo, B. J. and Bruckman, A. (2009). Questioning video games' influence on CS interest. *FDG 2009 - 4th International Conference on the Foundations of Digital Games, Proceedings*, pages 272–278.

[Dweck, 1986] Dweck, C. S. (1986). Motivational processes affecting learning. *American Psychologist*, 41(10):1040.

[Easton et al., 2016] Easton, K. L., McComish, J. F., and Greenberg, R. (2016). Avoiding Common Pitfalls in Qualitative Data Collection and Transcription:. *http://dx.doi.org/10.1177/104973200129118651*, 10(5):703–707.

[Edgar and Manz, 2017] Edgar, T. W. and Manz, D. O. (2017). Exploratory Study. *Research Methods for Cyber Security*, pages 95–130.

[Elkjer, 1992] Elkjer, B. (1992). Girls and information technology in denmark—an account of a socially constructed problem. *Gender and Education*, 4(1-2):25–40.

[Ensmenger, 2010] Ensmenger, N. (2010). Making programming masculine. *homes.luddy.indiana.edu*.

[Erez and Gati, 2004] Erez, M. and Gati, E. (2004). A Dynamic, Multi-Level Model of Culture: From the Micro Level of the Individual to the Macro Level of a Global Culture. *Applied Psychology*, 53(4):583–598.

[Fabros-Tyler, 2014] Fabros-Tyler, G. (2014). English, Mathematics, and Programming grades in the secondary level as predictors of academic performance in the college level. *IISA 2014 - 5th International Conference on Information, Intelligence, Systems and Applications*, pages 427–431.

[Fakeye et al., 2009] Fakeye, D., Research, Y. O. E. J. o. S., and 2009, u. (2009). English language proficiency as a predictor of academic achievement among EFL students in Nigeria. *unn.edu.ng*, 37(3):490–495.

[Farr et al., 2003] Farr, J. L., Sin, H. P., and Tesluk, P. E. (2003). Knowledge Management Processes and Work Group Innovation. *The International Handbook on Innovation*, pages 574–586.

[Faulkner, 2001] Faulkner, W. (2001). The technology question in feminism: A view from feminist technology studies. *Women's Studies International Forum*, 24(1):79–95.

[Fereday et al., 2016] Fereday, J., Adelaide, N., Australia, S., and Eimear Muir-Cochrane, A. (2016). Demonstrating Rigor Using Thematic Analysis: A Hybrid Approach of Inductive and Deductive Coding and Theme Development:. *http://dx.doi.org/10.1177/160940690600500107*, 5(1):80–92.

[Ferguson, 2006] Ferguson, K. M. (2006). Social capital and children's wellbeing: A critical synthesis of the international social capital literature. *International Journal of Social Welfare*, 15(1):2–18.

[Findlow, 2008] Findlow, S. (2008). Islam, modernity and education in the Arab States. *Intercultural Education*, 19(4):337–352.

[Fisher et al., 1997] Fisher, A., Margolis, J., and Miller, F. (1997). Undergraduate women in computer science. *ACM SIGCSE Bulletin*, 29(1):106–110.

[Fossey et al., 2002] Fossey, E., Harvey, C., McDermott, F., and Davidson, L. (2002). Understanding and evaluating qualitative research. *Australian and New Zealand Journal of Psychiatry*, 36(6):717–732.

[Frehill, 2016] Frehill, L. M. (2016). The Gendered Construction of the Engineering Profession in the United States, 1893–1920:. *http://dx.doi.org/10.1177/1097184X03260963*, 6(4):383–403.

[Fromme, 2003] Fromme, J. (2003). Computer games as a part of children's culture. *Gaming studies*, 3(1):49–62.

[Fullan, 2002] Fullan, M. (2002). The change. *Education Leadership*, 59(8):16–20.

[Gabriela T. Richard and Kishonna L. Gray, 2018] Gabriela T. Richard and Kishonna L. Gray (2018). Gendered Play, Racialized Reality: Black Cyberfeminism, Inclusive Communities of Practice, and the Intersections of Learning, Socialization, and Resilience in Online Gaming. *Frontiers: A Journal of Women Studies*, 39(1):112.

[Garcia and Quek, 1997] Garcia, L. and Quek, F. (1997). Qualitative Research in Information Systems: Time to be Subjective? *Information Systems and Qualitative Research*, pages 444–465.

[Gary and Holmes, 2020] Gary, A. and Holmes, D. (2020). Researcher Positionality-A Consideration of Its Influence and Place in Qualitative Research-A New Researcher Guide. *International Journal of Education*, 8(4):1–10.

[Gee, 2003] Gee, J. P. (2003). What video games have to teach us about learning and literacy. *Computers in Entertainment*, 1(1):20–20.

[Ghasemi and Burley, 2019] Ghasemi, E. and Burley, H. (2019). Gender, affect, and math: a cross-national meta-analysis of Trends in International Mathematics and Science Study 2015 outcomes. *Large-Scale Assessments in Education*, 7(1):1–25.

[Good and Brophy, 1995] Good, T. L. and Brophy, J. E. (1995). *Contemporary educational psychology, 5th ed.*

[Graham and Corrado, 2021] Graham, S. and Corrado, M. E. (2021). How to Advance a Feminist U.S. Foreign Policy.

[Guest et al., 2012] Guest, G., M. MacQueen, K., and E. Namey, E. (2012). Applied Thematic Analysis - Google Books.

[Gully and Phillips, 2005] Gully, S. M. and Phillips, J. M. (2005). A Multilevel Application of Learning and Performance Orientations to Individual, Group, and

Organizational Outcomes. *Research in Personnel and Human Resources Management*, 24:1–51.

[Hamdan, 2005] Hamdan, A. (2005). Women and education in Saudi Arabia: Challenges and achievements. *International Education Journal*, 6(1):42–64.

[Hamdani, 2004] Hamdani, D. (2004). Muslim women: Beyond perceptions. *Toronto: Canadian Council of Muslim Women*.

[Hansen, 2021] Hansen, M. (2021). The U.S. Education System Isn't Giving Students What Employers Need.

[Hargreaves et al., 2008] Hargreaves, M., Homer, M., and Swinnerton, B. (2008). A comparison of performance and attitudes in mathematics amongst the 'gifted'. Are boys better at mathematics or do they just think they are? *http://dx.doi.org/10.1080/09695940701876037*, 15(1):19–38.

[Harvil, 2015] Harvil, A. K. (2015). Improving intercultural competence of female university students in EFL within Saudi Arabia. *Procedia-Social and Behavioral Sciences*, 192:544–566.

[Hassan, 2000] Hassan, F. (2000). Islamic women in science. *Science*, 290(5489):55–56.

[Hawke et al., 2009] Hawke, J. L., Olson, R. K., Willcut, E. G., Wadsworth, S. J., and DeFries, J. C. (2009). Gender ratios for reading difficulties. *Dyslexia*, 15(3):239–242.

[He and Freeman, 2010] He, J. and Freeman, L. A. (2010). Are men more technology-oriented than women? The role of gender on the development of general computer self-efficacy of college students. *Journal of Information Systems Education*, 21(2):3–212.

[HERI, 2022] HERI (2022). HERI – Higher Education Research Institute and home of Cooperative Institutional Research Program.

[Herrera, 2007] Herrera, L. (2007). Higher Education in the Arab World. *International Handbook of Higher Education*, pages 409–421.

[Hilal and Alabri, 2013] Hilal, A. H. and Alabri, S. S. (2013). Using Nvivo for Data Analysis in Qualitative Research. *International Interdisciplinary Journal of Education*, 2(2):181–186.

[Hunt and O'Leary, 2017] Hunt, J. and O'Leary, Z. (2017). *The essential guide to doing your research project*. SAGE Publications.

[Hussain et al., 2021] Hussain, U., Yu, B., Cunningham, G. B., and Bennett, G. (2021). "I Can be Who I Am When I Play Tekken 7": E-sports Women Participants from the Islamic Republic of Pakistan. *Games and Culture*, 16(8):978–1000.

[Hutchinson, 2021] Hutchinson, A. (2021). Taking Arkansas's Computer Science Education Initiative to the Nation.

[Hyde et al., 1990] Hyde, J. S., Fennema, E., and Lamon, S. J. (1990). Gender Differences in Mathematics Performance : A Meta-Analysis. 107(2).

[Hyde and Mertz, 2009] Hyde, J. S. and Mertz, J. E. (2009). Gender, culture, and mathematics performance. *Proceedings of the National Academy of Sciences of the United States of America*, 106(22):8801–8807.

[IBM, 2021] IBM (2021). What is Logistic regression? — IBM.

[Ibrahim, 2012] Ibrahim, M. (2012). THEMATIC ANALYSIS: A CRITICAL REVIEW OF ITS PROCESS AND EVALUATION. *West East Journal of Social Sciences-December*, 1(1).

[Ibtasam et al., 2019] Ibtasam, S., Razaq, L., Ayub, M., Webster, J. R., Ahmed, S. I., and Anderson, R. (2019). "My cousin bought the phone for me. I never go to mobile shops.". *Proceedings of the ACM on Human-Computer Interaction*, 3(CSCW):1–33.

[Iliyasu and Etikan, 2021] Iliyasu, R. and Etikan, I. (2021). Comparison of quota sampling and stratified random sampling . *Biometrics & Biostatistics International Journal*, 10(1):24–27.

[Imenda, 2014] Imenda, S. (2014). Is There a Conceptual Difference between Theoretical and Conceptual Frameworks? Technical Report 2.

[Islam, 2017] Islam, S. I. (2017). Arab Women in Science, Technology, Engineering and Mathematics Fields: The Way Forward. *World Journal Education*, 7(6):12–20.

[Islam, 2019] Islam, S. I. (2019). Science, Technology, Engineering and Mathematics (STEM): Liberating Women in the Middle East. *World Journal of Education*, 9(3):94–104.

[Johnson, 2006] Johnson, S. (2006). *Everything bad is good for you: How today's popular culture is actually making us smarter*.

[Kamyab, 2008] Kamyab, S. (2008). The university entrance exam crisis in Iran. *International Higher Education*.

[Kargarmoakhar et al., 2021] Kargarmoakhar, M., Lunn, S. J., Ross, M. S., Hazari, Z., Weiss, M. A., Georgiopoulos, M., Christensen, K., and Solis, T. (2021). Impact of Social and Programmatic Experiences on Students' Interest in Pursuing a Graduate Degree in a Computing Field.

[Kargarmoakhar and Ross, 2019] Kargarmoakhar, M. and Ross, M. (2019). How Cultural Messages Through Experiences Influence Occupational Pursuit of Muslim Female Computer Science Students. In *2019 ASEE Annual Conference & Exposition Proceedings*, Tampa, Florida. ASEE Conferences.

[Kargarmoakhar et al., 2019] Kargarmoakhar, M., Ross, M., Hazari, Z., Weiss, M., Georgiopoulos, M., and Christensen, K. (2019). Influences of Friends and Family on Women ' S Pursuit of Computing ; a Sequential Explanatory Design.

[Kargarmoakhar et al., 2020] Kargarmoakhar, M., Ross, M. S., Hazari, Z., Weiss, M. A., Georgiopoulos, M., Christensen, K., and Solis, T. (2020). Computing pathways: A quantitative inquiry into the dynamic pathways of students in computing with gender comparisons. *ASEE Annual Conference and Exposition, Conference Proceedings*.

[Kegler et al., 2018] Kegler, M. C., Raskind, I. G., Comeau, D. L., Griffith, D. M., Cooper, H. L. F., and Shelton, R. C. (2018). Study Design and Use of Inquiry Frameworks in Qualitative Research Published in Health Education & Behavior:. *https://doi.org/10.1177/1090198118795018*, 46(1):24–31.

[Kersteen et al., 1988] Kersteen, Z., Linn, M., ..., M. C. J. o. E., and 1988, u. (1988). Previous experience and the learning of computer programming: The computer helps those who help themselves. *journals.sagepub.com*, 4(3):321–333.

[Khalaf, 2021] Khalaf, S. (2021). *Cultural Resistance: Global and Local Encounters in the Middle East*. Saqi books edition.

[Khodi et al., 2021] Khodi, A., Alavi, S. M., and Karami, H. (2021). Test review of Iranian university entrance exam: English Konkur examination. *Language Testing in Asia*, 11(1):1–10.

[King, 2004] King, N. (2004). Essential guide to qualitative methods in organizational research. chapter 21, page 408.

[Klein and Kozlowski, 2016] Klein, K. J. and Kozlowski, S. W. J. (2016). From Micro to Meso: Critical Steps in Conceptualizing and Conducting Multilevel Research:. *https://doi.org/10.1177/109442810033001*, 3(3):211–236.

[Klein et al., 1999] Klein, K. J., Tosi, H., and Albert A. Cannella, J. (1999). Multilevel Theory Building: Benefits, Barriers, and New Developments. *https://doi.org/10.5465/amr.1999.1893934*, 24(2):248–253.

[Kozlowski et al., 2001] Kozlowski, S. W., Gully, S. M., Brown, K. G., Salas, E., Smith, E. M., and Nason, E. R. (2001). Effects of training goals and goal orientation traits on multidimensional training outcomes and performance adaptability. *Organizational Behavior and human decision Processes*, 85(1):1–31.

[Kranov et al., 2015] Kranov, A. A., Deboer, J., and Abu-Lail, N. (2015). Factors affecting the educational and occupational trajectories of women in engineering in five comparative national settings. *Proceedings of 2014 International Conference on Interactive Collaborative Learning, ICL 2014*, (December):21–28.

[Kunkle et al., 2016] Kunkle, S., Christie, G., Yach, D., and El-Sayed, A. M. (2016). The Importance of Computer Science for Public Health Training: An Opportunity and Call to Action. *JMIR Public Health and Surveillance*, 2(1).

[Lacey and Luff, 2009] Lacey, A. and Luff, D. (2009). Qualitative Data Analysis The NIHR Research Design Service for Yorkshire and the Humber. *National Institute for Health Research*.

[Lederman and Lederman, 2015] Lederman, N. G. and Lederman, J. S. (2015). What Is A Theoretical Framework? A Practical Answer. *Journal of Science Teacher Education*, 26(7):593–597.

[Leithwood and Jantzi, 1990] Leithwood, K. and Jantzi, D. (1990). Transformational Leadership: How Principals Can Help Reform School Cultures. *School Effectiveness and School Improvement*, 1(4):249–280.

[Lopez-Fernandez et al., 2019] Lopez-Fernandez, O., Jess Williams, A., Griffiths, M. D., and Kuss, D. J. (2019). Female gaming, gaming addiction, and the role of women within gaming culture: A narrative literature review. *Frontiers in Psychiatry*, 10(JULY):454.

[Mangiafico, 2016] Mangiafico, S. S. (2016). *Summary and analysis of extension program evaluation in R*. New Brunswick: Rutgers Cooperative Extension.

[Marcus, 2019] Marcus, J. (2019). Why Saudi Arabia and Iran are bitter rivals .

[Margolis and Fisher, 2002] Margolis, J. and Fisher, A. (2002). *Unlocking the clubhouse: Women in computing*.

[Marsh and Furlong, 2002] Marsh, D. and Furlong, P. (2002). A Skin, not a Sweater: Ontology and Epistemology in Political Science. *Theory and Methods in Political Science*, 2(1):17–41.

[Martocchio, 1994] Martocchio, J. J. (1994). Effects of conceptions of ability on anxiety, self-efficacy, and learning in training. *Journal of Applied Psychology*, 79(6):819.

[McCusker and Gunaydin, 2015] McCusker, K. and Gunaydin, S. (2015). Research using qualitative, quantitative or mixed methods and choice based on the research. *Perfusion (United Kingdom)*, 30(7):537–542.

[Mee Thien and Abd Razak, 2012] Mee Thien, L. and Abd Razak, N. (2012). A Proposed Framework of School Organization from Open System and Multilevel Organization Theories. *World Applied Sciences Journal*, 20(6):889–899.

[Mellström, 2009] Mellström, U. (2009). The Intersection of Gender, Race and Cultural Boundaries, or Why is Computer Science in Malaysia Dominated by Women? *http://dx.doi.org/10.1177/0306312709334636*, 39(6):885–907.

[Miles and Huberman, 1994] Miles, M. and Huberman, A. (1994). *Qualitative data analysis: An expanded sourcebook*.

[Ministry of Education, 2022] Ministry of Education (2022). Ministry of Education.

[Mittelberg and Lev-Ari, 2010] Mittelberg, D. and Lev-Ari, L. (2010). Confidence in Mathematics and its Consequences: Gender differences among Israeli Jewish and Arab youth. *http://dx.doi.org/10.1080/09540259920771*, 11(1):75–92.

[Miura, 1987] Miura, I. T. (1987). The relationship of computer self-efficacy expectations to computer interest and course enrollment in college. *Sex Roles*, 16(5-6):303–311.

[Montgomery, 2016] Montgomery, D. W. (2016). *Practicing Islam Knowledge, Experience, and Social Navigation in Kyrgyztan*.

[Moshfeghyeganeh and Hazari, 2021] Moshfeghyeganeh, S. and Hazari, Z. (2021). Effect of culture on women physicists' career choice: A comparison of Muslim majority countries and the West. *Physical Review Physics Education Research*, 17(1):010114.

[Muenks et al., 2020] Muenks, K., Peterson, E. G., Green, A. E., Kolvoord, R. A., and Uttal, D. H. (2020). Parents' Beliefs about High School Students' Spatial Abilities: Gender Differences and Associations with Parent Encouragement to Pursue a STEM Career and Students' STEM Career Intentions. *Sex Roles*, 82(9-10):570–583.

[Mynatt et al., 2020] Mynatt, E., Watts, D., Bliss, N., Nelson, A., Pearson, W., and Rutenbar, R. (2020). Harnessing the Computational and Social Sciences to Solve Critical Societal Problems.

[Norris et al., 2003] Norris, C., Sullivan, T., Poirot, J., and Soloway, E. (2003). No access, no use, no impact: Snapshot surveys of educational technology in K-12. *Journal of Research on Technology in Education*, 36(1):15–27.

[Nowell et al., 2017] Nowell, L. S., Norris, J. M., White, D. E., and Moules, N. J. (2017). Thematic Analysis: Striving to Meet the Trustworthiness Criteria. *https://doi.org/10.1177/1609406917733847*, 16(1).

[Ong et al., 2011] Ong, M., Wright, C., Espinosa, L., and Orfield, G. (2011). Inside the double bind: A synthesis of empirical research on undergraduate and graduate women of color in science, technology, engineering, and mathematics. *Harvard Educational Review*, 81(2):172–209.

[Ostroff et al., 2012] Ostroff, C., Kinicki, A. J., and Muhammad, R. S. (2012). Organizational Culture and Climate. *Handbook of Psychology, Second Edition*.

[Panchanathan, 2022] Panchanathan, S. (2022). Building stronger bridges between discovery, innovation, and prosperity.

[Papastergiou, 2008] Papastergiou, M. (2008). Are Computer Science and Information Technology still masculine fields? High school students' perceptions and career choices. *Computers & Education*, 51(2):594–608.

[Pariona, 2017] Pariona, A. (2017). The Major Branches Of Islam.

[Park, 2014] Park, C. (2014). Handbook of the Psychology of Religion and Spirituality, Second Edition - Google Books.

[Parsons, 2017] Parsons, V. L. (2017). Stratified Sampling. *Wiley StatsRef: Statistics Reference Online*, pages 1–11.

[Paulu, 2005] Paulu, N. (2005). Helping Your Child through Early Adolescence. Revised. *US Department of Education*.

[Peckham et al., 2007] Peckham, J., Harlow, L. L., Stuart, D. A., Silver, B., Mederer, H., and Stephenson, P. D. (2007). Broadening participation in computing. *ACM SIGCSE Bulletin*, 39(3):9–13.

[Peters and Daly, 2013] Peters, D. L. and Daly, S. R. (2013). Returning to graduate school: Expectations of success, values of the degree, and managing the costs. *Journal of Engineering Education*, 102(2):244–268.

[Pew Research Center, 2009] Pew Research Center (2009). MAPPING THE GLOBAL MUSLIM POPULATION A Report on the Size and Distribution of the World's Muslim Population. Technical report, Pew Research Center.

[Pew Research Center, 2011] Pew Research Center (2011). Is College Worth It? . Technical report.

[Phillippi and Lauderdale, 2018] Phillippi, J. and Lauderdale, J. (2018). A Guide to Field Notes for Qualitative Research: Context and Conversation. *Qualitative Health Research*, 28(3):381–388.

[Quraishi-Landes, 2016] Quraishi-Landes, A. (2016). Five myths about sharia - The Washington Post.

[Radich, 2013] Radich, J. (2013). Technology and interactive media as tools in early childhood programs serving children from birth through age 8. *Every Child*, 19(4):18–19.

[Reilly, 2012] Reilly, D. (2012). Gender, culture, and sex-typed cognitive abilities. *PLoS ONE*, 7(7).

[Remington, 2012] Remington, A. (2012). Women see value and benefits of college, while men lag on both fronts - The Journalist's Resource.

[Rich et al., 2004] Rich, L., Perry, H., and Guzdial, M. (2004). A CS1 course designed to address interests of women. *SIGCSE Bulletin (Association for Computing Machinery, Special Interest Group on Computer Science Education)*, 36(1):190–194.

[Ritchie et al., 2013] Ritchie, J., Lewis, J., Nicholls, C., and Ormston, R. (2013). *Qualitative research practice: A guide for social science students and researchers*, volume 29.

[Rittmayer and Beier, 2008] Rittmayer, A. D. and Beier, M. E. (2008). Overview: Self-Efficacy in STEM.

[Roberts, 2003] Roberts, E. (2003). Keynote address. *ACM SIGCSE Bulletin*, 35(1).

[Rogelberg, 2004] Rogelberg, S. G. (2004). Handbook of research methods in industrial and organizational psychology. page 536.

[Rousseau and House, 1994] Rousseau, D. M. and House, R. J. (1994). Meso organizational behavior: Avoiding three fundamental biases. *Trends in organizational behavior, Vol. 1*, pages 13–30.

[Ruiz and Krogstad, 2018] Ruiz, N. G. and Krogstad, J. M. (2018). Where most H-1B visa workers are located in the U.S. — Pew Research Center.

[Sadan, 2014] Sadan, V. (2014). Mixed Methods Research: A New Approach. *International Journal of Nursing Education*, 6(1):254.

[Sadker, 1986] Sadker, M. (1986). Sexism in the classroom: From grade school to graduate school. *JSTOR*.

[Saeed, 2018] Saeed, A. (2018). Islam and religious freedom. In *Human Rights and Islam*, pages 192–214. Edward Elgar Publishing.

[Salmona et al., 2019] Salmona, M., Lieber, E., and Kaczynski, D. (2019). *Qualitative and mixed methods data analysis using Dedoose: A practical approach for research across the social sciences*. SAGE Publications.

[Saroglou and Cohen, 2011] Saroglou, V. and Cohen, A. B. (2011). Psychology of culture and religion: Introduction to the JCCP special issue. *Journal of Cross-Cultural Psychology*, 42(8):1309–1319.

[Savin-Baden and Essential, 2013] Savin-Baden, M. and Essential, C. H.-M. (2013). Qualititative research: The essential guide to theory and practice. *The Essential Guide to Theory and Practice. Routledge*.

[Sax et al., 2017] Sax, L. J., Lehman, K. J., Jacobs, J. A., Kanny, M. A., and Lim, G. (2017). Anatomy of an Enduring Gender Gap : The Evolution of Women ' s Participation in Computer Science. 88(2):258–293.

[Schell et al., 2016] Schell, R., Hausknecht, S., . . . , F. Z. G., , and 2016, u. (2016). Social benefits of playing Wii Bowling for older adults. *journals.sagepub.com*, 11(1-2):81–103.

[Schwab, 2016] Schwab, K. (2016). The Fourth Industrial Revolution: what it means and how to respond.

[Scott et al., 2017] Scott, A., Martin, A., McAlear, F., and Koshy, S. (2017). Broadening participation in computing: Examining experiences of girls of color. *Annual Conference on Innovation and Technology in Computer Science Education, ITiCSE*, Part F128680:252–256.

[Scott et al., 2016] Scott, A., Martin, A., McAlear, F., and Madkins, T. C. (2016). Broadening participation in computer science: Existing out-of-school initiatives and a case study. *ACM Inroads*, 7(4):84–90.

[Secules et al., 2021] Secules, S., McCall, C., Mejia, J. A., Beebe, C., Masters, A. S., L. Sánchez-Peña, M., and Svyantek, M. (2021). Positionality practices and dimensions of impact on equity research: A collaborative inquiry and call to the community. *Journal of Engineering Education*, 110(1):19–43.

[Seifi, 2021] Seifi, F. (2021). Iranian and Saudi women: Overcoming comparative suffering? — Middle East Institute.

[Sergon, 2022] Sergon, V. (2022). The education system in Saudi Arabia — Expatica.

[Sevin and DeCamp, 2016] Sevin, R. and DeCamp, W. (2016). From playing to programming: The effect of video game play on confidence with computers and an interest in computer science. *Sociological Research Online*, 21(3):16.

[Sewell and Shah, 1968] Sewell, W. H. and Shah, V. P. (1968). Social class, parental encouragement, and educational aspirations. *American Journal of Sociology*, 73(5):559–572.

[Shahrokni, 2020] Shahrokni, N. (2020). *Women in place : the politics of gender segregation in Iran*. University of California Press.

[Silverman, 2015] Silverman, D. (2015). *Interpreting qualitative data*.

[Šimunović et al., 2018] Šimunović, M., Reić Ercegovac, I., and Burušić, J. (2018). How important is it to my parents? Transmission of STEM academic values: the role of parents' values and practices and children's perceptions of parental influences. *https://doi.org/10.1080/09500693.2018.1460696*, 40(9):977–995.

[Smith and Firth, 2011] Smith, J. and Firth, J. (2011). Qualitative data analysis: the framework approach. *Nurse researcher*, 18(2):52–62.

[Snyder, 2012] Snyder, Thomas D.—Dillow, S. A. (2012). Digest of Education Statistics, 2011. NCES 2012-001. *National Center for Education Statistics*.

[Stage et al.,] Stage, F., Development, P. R. J. o. C. S., and 1993, u. A combined model of student predisposition to college and persistence in college. *psycnet.apa.org*.

[Steckler et al., 1992] Steckler, A., Kenneth McLeroy, D. R., Goodman, R. M., Sheryl Bird, M. T., Lauri McCormick, M., Allan Steckler, M., Bird, S. T., McCormick, L., and Hill Kenneth McLeroy, C. R. (1992). Toward Integrating Qualitative and Quantitative Methods: An Introduction. *Health Education & Behavior*, 19(1):1–8.

[Stenseng et al., 2012] Stenseng, F., Rise, J., and Kraft, P. (2012). Activity Engagement as Escape from Self: The Role of Self-Suppression and Self-Expansion. *Leisure Sciences*, 34(1):19–38.

[Stokols, 2016] Stokols, D. (2016). Translating Social Ecological Theory into Guidelines for Community Health Promotion:. *http://dx.doi.org/10.4278/0890-1171-10.4.282*, 10(4):282–298.

[Strauss and Corbin, 1990] Strauss, A. and Corbin, J. (1990). *Basics of qualitative research*.

[Subrahmanian, 2005] Subrahmanian, R. (2005). Gender equality in education: Definitions and measurements. *International Journal of Educational Development*, 25(4):395–407.

[Sweedyk et al., 2005] Sweedyk, E., deLaet, M., Slattery, M. C., and Kuffner, J. (2005). Computer games and CS education. page 256.

[Tashakkori and Teddlie, 1998] Tashakkori, A. and Teddlie, C. (1998). Mixed methodology : combining qualitative and quantitative approaches. page 185.

[The Embassy of The Kingdom of Saudi Arabia, 2022] The Embassy of The Kingdom of Saudi Arabia (2022). Education .

[Thompson, 2020] Thompson, L. (2020). Feminist Foreign Policy: A Framework. *International Center for Research on Women*.

[Tillberg et al., 2005] Tillberg, H., studies, J. C. F. a. j. o. w., and 2005, u. (2005). Attracting women to the CS major. *JSTOR*, 26(1):126–140.

[Tillman and Engel, 2015] Tillman, K. and Engel, S. (2015). Parental Influence on College Students' Career Aspirations.

[Tobin et al., 2004] Tobin, G. A., Rmn, R., Rnt, R., Begley, C. M., Rm, R., Ffnrcsi, R., and Tobin, G. (2004). Methodological rigour within a qualitative framework. *Journal of Advanced Nursing*, 48(4):388–396.

[Tonso, 1996] Tonso, K. L. (1996). The impact of cultural norms on women. *Journal of Engineering Education*, 85(3):217–225.

[Trochim et al., 2016] Trochim, W. M. K., Donnelly, J. P., and Arora, K. (2016). Research methods : the essential knowledge base. page 422.

[Turley, 2006] Turley, R. N. (2006). When parents want children to stay home for college. *Research in Higher Education*, 47(7):823–846.

[Turner, 2010] Turner, D. W. (2010). Qualitative Interview Design: A Practical Guide for Novice Investigators. *The Qualitative Report*, 15(3):754–760.

[Ulloa et al., 2016] Ulloa, R., Kacperski, C., and Sancho, F. (2016). Institutions and Cultural Diversity: Effects of Democratic and Propaganda Processes on Local Convergence and Global Diversity. *PLOS ONE*, 11(4):e0153334.

[Umair, 2022] Umair, A. (2022). Entertainment and Islam.

[UNESCO, 2021] UNESCO (2021). UIS Statistics.

[United States Census Bureau, 2022] United States Census Bureau (2022). U.S. and World Population Clock.

[Universities UK, 2022] Universities UK (2022). Universities UK.

[University of Cambridge, 2020] University of Cambridge (2020). The Middle East: Saudi Arabia and Iran compared .

[U.S. Department of Education, 2021] U.S. Department of Education (2021). U.S. Department of Education Confirms Title IX Protects Students from Discrimination Based on Sexual Orientation and Gender Identity — U.S. Department of Education.

[U.S. Department of Justice Civil Rights, 1964] U.S. Department of Justice Civil Rights (1964). Nondiscrimination On The Basis Of Race, Color, National Origin, Sex, Religion, Or Age In Law Enforcement Programs, Services, And Activities Receiving Assistance From The United States Department Of Justice.

[Van Buren Iii et al., 2020] Van Buren Iii, H. J., Syed, J., Mir, R., Van, H. J., and Iii, B. (2020). Religion as a Macro Social Force Affecting Business: Concepts, Questions, and Future Research. *Business & Society*, 59(5):799–822.

[van Smeden et al., 2019] van Smeden, M., Moons, K. G., de Groot, J. A., Collins, G. S., Altman, D. G., Eijkemans, M. J., and Reitsma, J. B. (2019). Sample size for binary logistic prediction models: Beyond events per variable criteria. *Statistical Methods in Medical Research*, 28(8):2455–2474.

[Varma, 2009] Varma, R. (2009). Gender differences in factors influencing students towards computing. *http://dx.doi.org/10.1080/08993400902819006*, 19(1):37–49.

[Voyer and Voyer Susan D., 2014] Voyer, D. and Voyer Susan D., D. (2014). Gender differences in scholastic achievement: A meta-analysis. *Psychological Bulletin*, 140(4):1174–1204.

[W.Creswell, 2013] W.Creswell, J. (2013). *Qualitative Inquiry Research Design*. SAGE, Thousand Oaks, 3rd edition.

[Wellington et al., 2005] Wellington, J., Bathmaker, A., Hunt, C., and McCulloch, G. (2005). *Succeeding with your Doctorate*.

[WES, 2017] WES (2017). Education in Iran.

[West et al., 1987] West, C., society, D. Z. G. ., and 1987, u. (1987). Doing gender. *journals.sagepub.com*, 1(2):125–151.

[Wikipedia, 2022] Wikipedia (2022). Iranian University Entrance Exam .

[Williams, 2016] Williams, E. (2016). The Effect of Parents on an Adolescent's Choice of Career.

[World Bank, 2022] World Bank, W. D. I. (2022). World Bank Open Data.

[World Economic Forum, 2021] World Economic Forum (2021). Global Gender Gap Report 2021 . Technical report.

[World Politics Review, 2019] World Politics Review (2019). Iran and Saudi Arabia Battle for Supremacy in the Middle East .

APPENDICES

Interview Questions

1- What is your name and your major?

2- Where were you born and raise?

3- How do you identify yourself? (Gender, Race, Ethnicity)

4- Do you come from a small or large family? How do you define small or large family?

5- What types of things are important to you (in general not just education)?

6- What do you think Computer Science is?

7- What was your major in undergrad?

8- How were your grades in Math and English during high school?

9- Who encouraged you to choose CS?

10- Describe how living in a Muslim majority country affected your decision to do major in CS?

11- Have you had any one in your family or friends that doing CS? If so, who?

12- Describe how you came to know about CS?

13- Tell me about your first programming class, the professor, students

14- Did you have any friends in that class? Describe these friends.

15- Did you participate in any after school clubs or anything that had any computing during your undergraduate school? If yes, please describe it for me.

16- Tell me about your undergrad experience university wise (why did you select that university)

17- Tell me about your journey to grad school (why did you choose to come to USA)

18- Did you have any research experience in undergrad? How was it?

19- Do you think it (research experience in undergraduate school) triggered you to start graduate school?

20- Did you have any work experience between your undergrad school and your graduate school? Tell me about your experience.

21- Tell me what year are you now

22- Do you participate in any campus organizations (WICS, UPE...)?

23- Did you have any internships from the time you entered graduate school?

24- How was your experience (how many female interns were with you)

25- Have you attended conferences? Tell me about your experiences

26- How do you see yourself in CS? Do you see yourself as a CS person?

27- Do you think others see you as a CS person (like will people come to you to ask questions about a course or project...)? How?

IRB Protocol

The consent form that was used in the study is shown below. It was approved by the FIU IRB prior to dissemination. All the interviewees signed and dated the consent form.

FLORIDA INTERNATIONAL UNIVERSITY

ADULT CONSENT TO PARTICIPATE IN A RESEARCH STUDY
Exploration of women in computing

PURPOSE OF THE STUDY
You are being asked to be in a research study. The purpose of this study is to explore the experiences of women in computing

NUMBER OF STUDY PARTICIPANTS
If you decide to be in this study, you will be one of ten people in this research study.

DURATION OF THE STUDY
Your participation will require your enrollment in a computing discipline.

PROCEDURES
If you agree to be in the study, we will ask you to do the following things:
1. Particpate in no more than 3 sixty-minute interviews. All interviews will be audio-recorded for accuracy.

RISKS AND/OR DISCOMFORTS
The risks of participating in this research are minimal, and comparable to the risks in a normal classroom. If you are uncomfortable with any questions, you do not have to answer them.

BENEFITS
It is unlikely that you will benefit from this research, but your participation will help improve the computer science program and contribute to research in education.

ALTERNATIVES
There are no known alternatives available to you other than not taking part in this study. However, any significant new findings developed during the course of the research, which may relate to your willingness to continue participation will be provided to you.

CONFIDENTIALITY
The records of this study will be kept private and will be protected to the fullest extent provided by law. In any sort of report we might publish, we will not include any information that will make it possible to identify you. Research records will be stored securely and only the researcher team will have access to the records. However, your records may be reviewed for audit purposes by authorized University or other agents who will be bound by the same provisions of confidentiality.

All identifiable data will be removed and a number or pseudoym will be used.

COMPENSATION & COSTS
You will not be responsible for any costs to participate in this study. You will also be compensated $25 for every interview.

RIGHT TO DECLINE OR WITHDRAW
Your participation in this study is voluntary. You are free to participate in the study or withdraw your consent at any time during the study. Your withdrawal or lack of participation will not affect any benefits to which you are otherwise entitled. The investigator reserves the right to remove you without your consent at such time that they feel it is in the best interest.

RESEARCHER CONTACT INFORMATION
If you have any questions about the purpose, procedures, or any other issues relating to this research study you may contact Monique Ross at ECS-342B, 305-348-8036, moross@fiu.edu.

IRB CONTACT INFORMATION
If you would like to talk with someone about your rights of being a subject in this research study or about ethical issues with this research study, you may contact the FIU Office of Research Integrity by phone at 305-348-2494 or by email at ori@fiu.edu.

PARTICIPANT AGREEMENT
I have read the information in this consent form and agree to participate in this study. I have had a chance to ask any questions I have about this study, and they have been answered for me. I understand that I will be given a copy of this form for my records.

_____ _____
Signature of Participant Date

_____
Printed Name of Participant

_____ _____
Signature of Person Obtaining Consent Date

VITA

MARAL KARGARMOAKHAR

2015	B.S., Computer Engineering Islamic Azad University Central Tehran Branch Tehran, Iran
2016	M.S., Computer Science Florida International University Miami, Florida

PUBLICATIONS AND PRESENTATIONS

Kargarmoakhar, M., Ross, M., Hazari, Secules, S., Z., Weiss, M., Georgiopoulos, M., Christensen, K. "How explicitly designed communities of practice can affect computing identity: The case of an S-STEM program across three metropolitan universities" Submitted to ACM-TOCE.

Kargarmoakhar, M., Ross, M. S. A quantitative approach: Computer science path for Muslim vs non-Muslim female students. (Under Review- In Proceedings of the 2023 FIE Annual Conference).

Kargarmoakhar, M., Lunn, S. J., Ross, M. S., Hazari, Z., Weiss, M. A., Georgiopoulos, M., ... Solis, T. (2021, July). Impact of social and programmatic experiences on students' interest in pursuing a graduate degree in a computing field. In 2021 ASEE Virtual Annual Conference Content Access.

McGill, M. M., Peterfreund, A., Sexton, S., Zarch, R., Kargarmoakhar, M.(2021). Exploring research practice partnerships for use in K–12 computer science education. ACM Inroads, 12(3), 24-31.

Kargarmoakhar, M., Lunn, S., Zahedi, L., Ross, M., Hazari, Z., Weiss, M. A., ... Solis, T. (2020, October). Understanding the experiences that contribute to the inclusion of underrepresented groups in computing. In 2020 IEEE Frontiers in Education Conference (FIE) (pp. 1-9). IEEE.

Kargarmoakhar, M., Ross, M., Hazari, Z., Weiss, M., Georgiopoulos, M., Christensen, K., Solis, T. (2020, June). Computing Pathways: A quantitative inquiry into the dynamic pathways of students in computing with gender comparisons. In 2020 ASEE Virtual Annual Conference.

Kargarmoakhar, M., Ross, M., Hazari, Z., Weiss, M., Georgiopoulos, M., Christensen, K. Influences of friends and family on women's pursuit of computing; A

sequential explanatory design. (2019, June). Poster presented at the Science, Technology, Engineering, Arts, Mathematics Education (STEM/STEAM Education) International Conference, Hawaii University.

Kargarmoakhar, M., Ross, M. S. (2019, June). How cultural messages through experiences influence occupational pursuit of Muslim female computer science students. In 2019 ASEE Annual Conference Exposition.

Kargarmoakhar, M., Taheri, M., Sadjadi, S. M. (2017). Implementing and Evaluating Scrum in Computer Science Senior Projects. In Software Engineering Knowledge Engineering (SEKE) (pp. 628-630).