Views of Science Teaching and Learning by Immigrant Somali Elders: Perceptions of Conflict and Acceptance

A Dissertation
SUBMITTED TO THE FACULTY OF
UNIVERSITY OF MINNESOTA
BY

Nancy Jean Albrecht

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

Bhaskar Upadhyay and Fred Finley,
Advisors

December 2015

Acknowledgements

I am grateful to all of the people who have supported me throughout this work including academic advisors and professors, teaching colleagues, students, family and friends. I wish to give special thanks to Bhaskar Upadhyay who consistently provided encouragement and support throughout the years, as well as the means to think more critically and thoughtfully as the data emerged. I also wish to give thanks to my Somali and non-Somali colleagues and peers who provided insightful conversations along the way, and allowed me to pitch new ideas to them as we worked together to provide meaningful education to our students. A special thanks goes to Kelly Mayberry, for spending many hours in local coffee shops with me as we wrote draft after draft of our respective theses, and to Ellen Fuge, for her hours of editing on the last draft. Lastly, I wish to thank my family and friends who consistently encouraged me to continue on despite the many trials and tribulations along the way.

Dedication

This work is dedicated to

Jacqueline,

Alex,

&

Sarah

who continue to provide me

with unwavering

encouragement, advice and laughter

as we navigate our respective journeys together.

Abstract

The gap between a student's home culture and that of classroom science may create challenges for students and families, especially those from recent immigrant cultures, including refugees. As a result, science learning in schools may require a form of cultural border crossing between home cultures and the culture of classroom science. Given this, as educators, how do we make these borders more porous for better science learning experiences? Using the frameworks of funds of knowledge, culturally relevant pedagogy, and socio-constructivism, this study focuses on the perspectives of Somali-American *elders and parents* about school science. Designed as an in-depth interview study, five purposefully selected participants were interviewed over a period of two years. The guiding questions for the study included: 1) *What are the perceptions of Somali elders about school science? and* 2) *How do Somali elders believe science teaching and learning can facilitate Somali students' engagement in science?*

Analysis of the interview data revealed that Somali-American adults have complicated perceptions of school science that include both conflicts and acceptance with current pedagogy and content. For example, science education was highly valued by both individuals and the Somali community, both as a way for individuals to attain economic prosperity and respect, but also as a way to lift up the Somali diaspora, both here and in their native homeland. On the other hand, science was also viewed as an abstract discipline with little connection to students' and families' everyday home lives. Moreover, due to the intrinsic role that Islam plays in traditional and contemporary Somali culture, several areas of science education, including geology, evolution and sex

education, were viewed as problematic and unresolvable. Various potential areas of funds of knowledge and culturally relevant pedagogy were discussed including nutrition, food preparation and storage, health education, and vaccinations. The study discusses several implications for science teachers of Somali-American students including the need to be aware of the intrinsic relationship between Islam, as practiced by Somali-Americans, and everyday practices, including the possibility of cultural violence resulting from the conflicts between science teaching as practiced in the United States, and Somali-American students' beliefs. The study also discusses changes in pedagogy that are experienced by Somali-American families and students, and suggests ways to mitigate these differences. Finally, the study provides suggestions for the roles of science teachers, both in everyday teaching and learning and in their professional development practices, to make science more meaningful, accessible and engaging to Somali-American students and their families.

Table of Contents

List of Tables

Views of Science Teaching and Learning by Immigrant Somali Elders: Perceptions of Conflict and Acceptance

Chapter 1: Introduction

Sometimes, being East African, Muslim, or from another culture can affect how you think about science because sometimes, science doesn't just help. You have to go for other resources. For Muslim students, I think they look back to the Holy [Koran] or what their culture says about science.

Aisha, 10th grader, 2008

Science and religion are not different at least in my religion because to us the Qur'an is the nobel science. Believe it or not a lot of the science [in] the middle ages [used] came from the Qur'an. Amazingly some of the greatest discover[ies] man has found were found in the Qur'an before the discovery even took place.

Ahmed, 10th grader, 2008

Rationale

I was into my third year of teaching at a Somali American charter school, when I read these quotes from students in my 10th grade biology class. The quotes were in response to a prompt asking students to reflect on how their culture(s) influenced their perceptions of the story of Rosalind Franklin and the discovery of the structure of DNA, and how science and religion were different. At that time, another graduate student and myself were working on a study to explore Nature of Science (NOS) issues with Somali-American immigrant students; we had incorporated several units that asked students to engage in NOS activities and reflections as part of their 10th grade biology course (Albrecht, Reese, Roehrig & Upadhyay, 2012). As the year progressed, it became clear to us that our students, although going through the motions of science in our classroom, had unique, and perhaps unexplored perspectives on the role of science in their daily lives,

and the inseparability of their religion (Islam) and science. Moreover, as we looked through student reflections, we saw that some students had difficulty reconciling their religious views with the science they were learning, and that some students questioned the very nature and purpose of school science. Although we found very little in the literature on Somali students, and Muslim students in general, we did find that our results were consistent with an emerging rich literature on minoritized students in science education that gave us a context to focus and adapt our research methods and propose future work.

I begin with this story for a couple of reasons. First, it sets the context for this study, which grew out of eight years of daily classroom science teaching with Somali American immigrant students. As I worked with students, it became clear to me that their "take" on school science was complex; complicated by their deep religious beliefs which pervaded their daily lives in many ways, but also complicated by their need to find some sort of meaning (and hence motivation) in this joint endeavor. Some students had difficulty finding meaning in science, and others just saw possibilities. Second, over time, as I tried to infuse culturally relevant pedagogy into my science instruction, it also became clear to me that I really did not know enough about my students' culture(s), social milieu, and Islam as part of the cornerstone of their everyday lives to anticipate what might be considered culturally relevant for this group of students. For example, when we started a neighborhood vegetable garden, it was my thought that we should try to grow herbs native to Somalia, or at least those used by our Somali families in their traditional cooking. As I worked with the students, it became clear that what they really

wanted to grow was a salsa garden because many of them had a fondness for chips and salsa as these foods closely resembled foods they grew up with. Over time, it became apparent to me that I really needed to start working with adults in the community to find out more about their views and reflections on Somali culture and their children's cultures, in order to make school science meaningful, accessible and more relevant and interesting to Somali students. This thesis represents the next step in this process, and focuses on the views and reflections of Somali adults on classroom science, teaching and learning of science, and the value of science within the Somali community including Somali youth. And, although this dissertation stems from my initial interest in NOS research with Somali students, and weaves in NOS issues throughout, it focuses on cultural issues relevant to the teaching and learning of school science with Somali students.

In this chapter, I introduce some of the challenges of science teaching and learning for minority students, including Somali students, and then briefly review the history of science education reform efforts in the U.S., including content standards and equity issues. Next I describe the need for research in science education with Somali students and parents and then describe the research questions and basic flow of this dissertation. Finally, I preview the relevant concepts used in this work.

Somali Students and Schools

Since the advent of the civil war in 1991, many Somali families have been forced to seek refuge in other parts of the world, including the United States, Canada, and Europe. In Minneapolis alone, it is estimated that there are currently 32,000 people of Somali descent, many of them children who have entered the public K-12 educational

system (American Community Survey, 2011). At least one recent study has found that Somali students believe that they are often tracked in low level courses; teachers have low level expectations of them; and that, in effect, the schools appear to perpetuate established social classes and contribute to the achievement gap (Basford, 2008). High poverty children score disproportionately lower on standardized tests (and on school grades) in the sciences, and fewer than half of urban students are above national achievement norms (Council of the Great City Schools, 2001). Likewise, research indicates that children attending high poverty, urban schools have reduced access to new textbooks, scientific equipment, and science-related extracurricular activities (e.g. Darling-Hammond, 2010).

With respect to Somali students, their school achievement is complicated by the fact that Somali students are most often lumped into the demographic data of African Americans in U.S. schools. Disaggregation of these data is rarely done and requires creative measures. Searching for English Language Learners (ELL) *and* African Americans, Taxis (2014) found that the math proficiency of Somali students was in the lowest 10% of students in the state of Minnesota. With respect to higher education, Mohamed (2008) found that despite the increasing number of Somali students in U.S. public schools, the number of Somali graduates with four-year degrees in 2006 was so low as to be statistically insignificant. These disparities call into question the progress the U.S. has made towards educating *all* students in science.

In addition to research on student achievement and access to resources, there is a growing body of research in science education that suggests that students of minority

cultures in U.S. schools perceive their science education to be inaccessible, and presented in ways that are not meaningful to their lives (Atwater, 1996; Fusco, 2001; Lee & Fradd, 1998; Nieto, 1994; Sleeter & Grant, 1991). Studies have indicated that the bridge between a student's home culture and that of the science culture may create difficult challenges for students and teachers (e.g., Aikenhead & Jegede, 1999; Costa, 1995). Others have suggested that science learning in mainstream schools requires a form of cultural border-crossing between the learners' cultures and the culture underlying the assumptions and practices of the scientific endeavor including school culture (Aikenhead & Jegede, 1999; Dogan & Abd-El-Khalick, 2008; Giroux, 2005).

Some scholars have suggested that teaching science from a traditional Baconian view (using an empirical methodology in science) to students of Islamic cultures (as opposed to other views including more recent constructivist or even traditional Islamic views), in particular, may create a situation of "symbolic violence" for Muslim students (Tobin, 1996; Haidar, 1999). Symbolic violence, as defined by Tobin (1996), is unintentional in that an individual, who feels misplaced within a community, feels a sense of devalue for his/her cultural artifacts. The possible consequences of symbolic violence include the feeling of not belonging and marginalization, creating the possibility of opting out of science all together. This juxtaposition of western science and Islam is also noted by Taskin (2014) as he reviewed the changing Islamization of science as part of current Muslim students' cultural milieu.

Science Education Reform Efforts: Moving towards Science for All?

To address these inequities, as well as a perceived lack of science content and rigor, science education in the U.S. has undergone significant reform efforts. As noted by historians of American education, curriculum and pedagogy in U.S. schools have become "contested terrains" in our society wherein factions vie for "official sanctification" of their deeply held beliefs (DeBoer, 1991; Kliebard, 2004). In other words, different groups of people (with differing values and beliefs) have competed with others for inclusion of their perspectives into the American curriculum. As part of this educational history, the history of science education reflects these tensions. The question of "why teach science?" has been posed and answered differently since the establishment of public schools in the late 1800s and has often been embedded in the national discourse of educational thought and practice at any given time. Most recently, the visions and goals for science education have evolved as part of the national discourse on improving K-12 education vis-à-vis the social progressivism of the 1960s and 1970s. Following the 1983 publication of *A Nation at Risk* and *Educating Americans for the 21st Century* (National Commission on Excellence in Education, 1983; Commission on Pre-College Education in Mathematics, Science & Technology, 1983), a vision emerged that (re)focused on intellectual rigor and a common core of scientific knowledge as a means to securing a society of knowledgeable and competent citizens. The American Association for the Advancement of Science's (AAAS) (1989) *Project 2061*, for example, focused on defining and promoting scientific literacy for American adults, and resulted in the publication of *Science for All Americans* (AAAS, 1989) and *Benchmarks for Science Literacy* (AAAS,

1993). Following *Benchmarks*, the National Research Council (NRC) (1996) produced the *National Science Education Standards*, and were recently revised and as the *Next Generation Science Standards* (NGSS) (2013). Throughout these years, the gradual translation of national standards and guidelines to state science standards and curriculum has occurred state-by-state.

The goals of these reform efforts as they appear in the standards documents, as stated by DeBoer (1991), are laudable, and include (1) decreased content coverage to increase student understanding of the ideas being taught, (2) science for all students, (3) the integration of ideas within subject areas and across subject areas to increase meaning and aid in retention, (4) knowledge that is useful for personal growth and development, and (5) content that takes into account both the products of science and the way that knowledge was developed. Yet, as these standards were developed and used for No Child Left Behind (NCLB) testing, critics have noted that their implementation has resulted in many unintended results that preclude science for all. For example, Mutegi (2009, 2013) argues that the prevailing curricular approach to science education in the U.S. is not likely to meet the social needs of African American students, and argues for a "socially transformative curriculum". This approach includes content mastery, but also includes critical awareness, racial awareness, conscientization, and praxis aimed at ameliorating the historical and current structures of colonialism under which African American students and their families live. In other words, science for and with African American students needs to provide the means for changing the status quo in these students' lives,

and for empowering them, through both content and critical thinking skills, to transform their communities and society at large.

Equity in Education

Given these historical and on-going standards-based reform efforts, the case can be made that less attention has been given to educational equity for all students, especially those from minority backgrounds. And although the recent research in science education has provided a substantial knowledge base for high standards in curriculum, instruction and assessment, the attainment of educational equity is still in its infancy (Lee & Buxton, 2010; Lee & Fradd, 1998). The implementation of high-stakes state standards itself may be questioned as science education in the U.S. institutionalizes a form of "official knowledge", meaning that those who benefit from these standards are those already part of the culture of power. In effect, standards may only exacerbate educational inequities by holding all students to the perspectives and ways of knowing of the dominant culture, or culture in power in any given setting or context; those students with more diverse experiences, languages and ways of knowing may be further marginalized by this process as schools teach science in academic English only, and disregard students' knowledge based on myths, cultural stories, and home experiences (Turner, 2003).

Other specific concerns include the fact that science curriculum materials seldom incorporate the cultural experiences, analogies, or representations from specific cultural groups, or even larger areas of the world outside of Europe and the U.S (Lee & Buxton, 2010; Lee & Luykx, 2006). In addition, science teachers are often under-prepared to understand and work with students who are unlike themselves, and are often reluctant to

see diversity and equity as part of their mission (Lee & Buxton, 2010). Assessment practices of non-mainstream students often provide a poor window into what they know, because the assessments are not given in the students' home languages, and are written in unfamiliar academic languages. Moreover, these assessments often include examples and questions from contexts that are unfamiliar to non-mainstream students (e.g. lawn maintenance as part of a writing prompt for high poverty, urban students[1]). As high stakes assessments under No Child Left Behind have emerged, the research has also shown a narrowing of the curriculum in high poverty schools, such that science classes are being squeezed out of the curriculum in lieu of more basic reading, writing and mathematics course (Lee & Buxton, 2010).

Equity and Standards

As noted by Fusco (2001), recent reforms in science education, with the laudable goal of science literacy for all, have moved science education from the acquisition of facts and figures to a more constructivist approach wherein students learn science as active constructors of their own knowledge. Critical thinking skills are emphasized, with a concomitant decrease in memorization skills. Yet, as many have noted, this might not be enough for non-mainstream students, if the nature of science itself is not questioned, because their ways of knowing about the world may be devalued in the process. For example, school science has typically not included the diversity of achievements, perspectives and ways of knowing for many groups of students (Atwater, 1996;

[1] Observed while I proctored a state-mandated writing test.

Rodriguez, 1998). More recent research into students' funds of knowledge[2] has clearly illustrated that students bring valuable experiences and cultural knowledge into the classroom, if researchers and teachers are willing to acknowledge and validate that knowledge (Calabrese Barton & Tan, 2009; Gonzalez, Moll, & Amanti, 2005; Upadhyay, 2006, 2010). Although this research is in its infancy in science education, its implications are powerful for school science. Moreover, as Fusco (2001) elegantly articulates, students must not only actively participate in the culture of science, they must have opportunities to be producers of science and culture—to explore multiple methods of talking, thinking, and doing science.

Despite the fact that science education in the U.S. has seen a number of reform efforts, particularly in the last 30 years, the emphasis has been on adopting content standards and institutionalizing those standards through the development of standardized curriculum. And, although the most recent versions of the standards and guidelines include equity as a goal (Next Generation Science Standards (NGSS), for example; 2013), there is still a need for science educators to move beyond these standards to justly address the needs of all students and nature of inequity or inequitable experiences in science learning.

Crossing Borders: Physical to Metaphorical

As noted by Calabrese Barton (2003), although science educators believe that science education should be essentially egalitarian in its nature, students may have a

[2] Funds of knowledge refers to the historically accumulated and culturally developed bodies of knowledge and skills essential for household or individual functioning and well-being (see "Relevant Concepts", p 17).

different experience, especially those living and learning in poverty like many minority students in this country. From their perspective, it is they, the students, who must make changes to truly understand the science we, the teachers and researchers, teach (Calabrese Barton & Roth, 2004). These border crossings may be physical, as exemplified by Somali students who have immigrated from war-torn countries to refugee camps and then to other parts of the world, or they may be based on perceived pedagogical, language, content, religious or spiritual barriers. In other words, schooling in this country is not a neutral enterprise---languages, traditions and curricula enable opportunities to some students, and not to others.

Science teachers can also be thought about as border crossers (Aikenhead & Otsiji, 2000). Teachers play a pivotal role in enhancing the learning opportunities for these (and all) students. As Giroux (2005) notes, by being able to listen critically to the voices of their students, teachers become border-crossers through their ability to not only make a different narrative available to themselves and other students but also by legitimizing that difference as a basic condition for understanding the limits of one's own voice. By viewing schooling as a form of cultural politics, educators can bring the concepts of culture, voice, and difference together to create a borderland where multiple subjectivities and identities can exist as part of a pedagogical practice that provides the potential to expand the politics of a democratic community and solidarity.

Moreover, border crossing into science could be made smoothly for many minority students by incorporating their lived experiences. These lived experiences could be used by teachers as assets, or funds of knowledge (Gonzalez et al., 2005). These funds,

once brought into the classroom can be used to create culturally relevant curricula and instruction for students of minority cultures and also for students from any other groups. As such, it is dynamic, emergent and interactional; and focuses on validating the experiences of students and their families, both in school and out of school.

A Special Note on Religious and Spiritual Borders

In working with Somali students all these years, it has become very clear that their religious beliefs, practices and traditions permeate every aspect of their lives, both inside and outside of school. The potential for some sort of cultural or symbolic violence when confronted with Western Science has always appeared to be high, and exhibited in different ways depending on the student. As noted in the opening student quotes, the relationship between science and religion is complicated for Somali students. Some find science to be in conflict with their beliefs, and others not. In all cases, it appears as if their traditional spiritual beliefs, based on the Qur'an or holy Islamic texts, are their ultimate source of truth. As noted by Taskin (2014), contemporary Muslim scientists believe that there is one truth regarding the real world and that all truth can only be found in Holy Qur'an. This philosophy/belief means that all problems found in life can be understood in the context of the Qur'an. These potential conflicting ideologies for Muslim students need to be considered by educators. I agree with Giroux when he suggests that we need to not only acknowledge the differing cultural borders that our students experience, we also need to analyze how these varying ideologies are actually taken-up in the voices and lived experiences of students as they give meaning to dreams, desires, and the subject positions they inhabit.

Need for Research

Although there is the recognition that the endeavor of science is socially and culturally based (Atwater, 1996), there is a greater need for new studies that focus on specific ethnicities or cultural experiences of students, parents and/or teachers and their implications for interventions in the science classroom. Likewise, more studies need to address how the unique cultures of those students influence their knowledge and perceptions of science. As the first step towards developing culturally relevant science units and instructional strategies with Somali and Somali-American students, this study focuses on the perspectives of Somali parents and/or elders of U.S.-based Somali students. Designed as a multiple case study, the guiding questions include:

1) *What are the perceptions of Somali elders about school science?*

2) *How do Somali elders believe science teaching and learning can facilitate Somali students' engagement in science?*

Outline of Dissertation

Following the introduction and justification in this chapter (Chapter 1), the remainder of this dissertation focuses on more specifics. In Chapter 2, I introduce the Somali diaspora and review what's known about the school experiences of Somali immigrants and their challenges and their academic achievement. In Chapter 3, I review the relevant science education literature, drawing upon theories of culturally relevant pedagogy and funds of knowledge, to develop a conceptual framework for both parents and students of Somali American communities. In Chapter 4, I describe the

methodological details of this qualitative interview study. I begin by justifying the methodological orientation for this study, and then detail the methods of generating and analyzing data that I employed to make sense of parents' and/or elders' views. In Chapter 5, I report findings of the study's two research questions. This chapter draws on the stories of the interviewees: their journeys (and hence their children's journeys) to American science classrooms, and their perceptions of pedagogical changes and content. In the first part of Chapter 5, I present the stories and findings within the cases; in the second part of Chapter 5, I present the findings across the cases. In Chapter 6, I focus on the implications of this study for science classroom teaching and learning, its limitations, and my suggestions for future research.

Relevant Concepts

As the research in science education has emerged over time, so too has our discourse about it. In order to be clearer about the science education frameworks, paradigms and concepts used throughout this document, this section identifies and defines the significant concepts relevant to this research.

Constructivism

Constructivism is a cognitive theory of learning that posits that learning is an active, constructive process wherein students actively create new ideas and concepts from prior (current and past) ideas and concepts; new information is linked to prior knowledge. Recognized contributors to this paradigm include Piaget, Bruner, and Vygotsky, for example.

Culture

I am choosing to use the definition provided by Gonzalez, Moll and Amanti (2005) which essentially views culture as the lived experiences of students. As such, it is dynamic, emergent and interactional; and focuses on validating the experiences of students and their families, both in school and out of school. Culture includes the traditions, languages, beliefs, religions and other experiences of students and their families.

Culturally Relevant Pedagogy (CRP)

Culturally relevant science was first introduced by Ladson-Billings (1995) and supports the idea that science education should be linked to the cultures (and needs) of the students. Ladson-Billings suggested that culturally relevant science should encompass three facets**:** 1) Students must experience academic success; 2) students must develop and/or maintain cultural competence (in their own respective cultures); and 3) students must develop a critical consciousness through which they challenge the status quo of the current social model (Ladson-Billings, 1995, p. 160).

Culturally Responsive Pedagogy

Also sometimes known as culturally sensitive pedagogy, culturally responsive pedagogy postulates that discontinuities between school and low-income students and students of color is an important factor in their low academic achievement. Gay (2000) suggests that culturally responsive pedagogy, although called by many different names (including culturally relevant, reflective, mediated, contextualized…) represents a compilation of ideas and thoughts from many scholars, all focusing on making the

cultural knowledge, prior experiences, frames of reference and performance styles of ethnically diverse students part of the learning process. Gay suggests that culturally responsive teaching is validating (to the learner), comprehensive, multidimensional, empowering, transformative, and emancipatory.

In this study, especially in the literature review, I have tried to use the term (culturally relevant pedagogy or culturally responsive pedagogy) that was originally used in the respective studies. In my analysis, I view them as essentially interchangeable.

Funds of Knowledge

Funds of knowledge are defined as the historically accumulated and culturally developed bodies of knowledge and skills essential for household or individual functioning and well-being (Gonzalez et al., 2005). Using a funds of knowledge approach, teachers and researchers come to view students (and families) as experts in their own lives and having rich cultural and cognitive resources that can be used in the classroom to enhance learning.

Inquiry Science

Inquiry science is defined as "the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Scientific inquiry also refers to the activities through which students develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world." (NRC, 1996, p. 23)

Symbolic Violence

Symbolic violence, as first described by Tobin (1996) and Haidar (1999), is a

form of psychological violence, that although unintentional, creates the feeling of being misplaced within a community and/or devalued. For example, when science is taught in a way that conflicts with the cultural and/or religious beliefs or philosophies of a student, the student may feel that he or she does not belong in science, creating the possibility of opting out of science all together.

Chapter 2: An Introduction to the Somali Diaspora

> The desire for us to get education was so high that she sent us to school every morning when we were at the refugee camps. She used to wake up and prepare breakfast for us. She used to cook with firewood, not even with a stove. She even got an eye surgery due to excessive smoke that damaged both her eyes when she arrived at the United States. Gaining knowledge was her first priority for us to do. She worked hard and burned the midnight oil to lighten the burden of illiteracy in our hearts. She used to say, "You need to learn, because the learners of today are the leaders of tomorrow."
>
> Teaching her kids and shaping them for a better future was the hardest and the most prominent thing she ever wanted, because in Somalia, we never had the facilities to do that. She never quit taking us to school and enforcing learning in our house. We used to travel a long distance just to take an English or math class that was taught under an acacia tree with no chairs, tables or even sometimes a board. (M. Ali, personal communication, 2008)

As Ali, a former 10th grade biology student, explains in his statement of special circumstances[3], education in a refugee camp was his mother's first priority for him; it was a commodity that was purposefully and painfully sought. After living at Kakuma in Kenya for several years, and then Nairobi for several more, Ali and his family eventually made their way to the United States, where he and his siblings enrolled in public schools. Although he does not write of these school experiences here, thoughtful practitioners, policy makers and researchers might ask how he or his mother would speak of these later experiences. How were they received once he became a student in U.S. schools? What special issues did they have to negotiate due to their background, culture and life history? How did they perceive classroom science in his U.S. schools? And, did Ali succeed---if so, for whom and for what purposes? The answers to these questions in a research context

[3] Written as part of a college admissions program; used with permission.

are important for they have many implications for Somali students, parents and communities as well as for their host communities and schools. One might assert that how we treat the newest of our students is a reflection of what we value and who we are as a global community.

In this chapter, I introduce the global Somali diaspora, including the Somali community of the large metropolitan area where I conducted this study. In order to give a broader context, I first explore the school experiences of Somali immigrants as noted in various published literature sources. These include the intersections between various issues that have direct links to the school success of Somali immigrants, the first of which is the integral part played by religious beliefs and practices that influence the schooling of Somali students (including how schools might accommodate their needs for academic success). Second, I explore Somali learning styles as noted by elders and the few sources I could find. Finally I discuss immigration with respect to school choice, school experiences and achievement in mathematics and science.

The Somali Diaspora

"When elephants fight, the grass dies."
Somali saying

Diaspora is from the Greek *diaspora'* which means a dispersion. According to Random House (2008), diaspora initially referred to the scattering of the Jews to countries outside of Palestine, but more generically refers to any group that has migrated or fled from its country of origin or traditional homeland. The Somali diaspora, as it is termed, usually refers to the forced exodus of Somali people from their homeland, the

country of Somalia, starting in the late 1980s[4]. Since the start of the civil war in 1991, hundreds of thousands, if not millions, of Somalis have made their way to other countries near the horn of Africa, to the Middle East, or to their former colonial governments such as the United Kingdom, France, and Italy (Kusow & Bjork, 2007). Significant Somali communities also exist in the Netherlands, Norway, Denmark and Sweden (Bigelow, 2008). Additionally, Somalis have immigrated to Canada, the United States, Australia, and New Zealand (Kusow & Bjork, 2007). Significantly, hundreds of thousands of Somalis still remain in refugee camps in nearby Ethiopia, Yemen, Djibouti and Kenya. As of March 2008, the Dadaab Refuge camp alone in northeastern Kenya, for example, was serving over 300,000 men, women and children (Huisman, 2011).

As noted by Bigelow (2010), the word diaspora is a useful construct in this case because the essence of being *Somali* still matters to those who left the country of Somalia, no matter where they currently reside and, in fact, the notion of *somaliness* is greatly valued and purposefully sought in diasporic communities in the U.S. and elsewhere. Inherent in this concept is the notion that diasporic communities retain a common history, values and traditions, yet change as they adapt to their specific national and local contexts. Hence, with the Somali diaspora, there is a strong desire to maintain the central (innate) foundation of the Somali culture; yet, pressures to change to meet the needs of changing local contexts and traditions are changing the culture. This tension plays out in many ways as Somali students negotiate their religious, linguistic, racial and gendered identities in classrooms around the world.

---

[4] as opposed to the voluntary emigration of Somalis into various societies prior to the civil war (for education, businesses and other purposes).

Somali Diaspora and Culture

Before colonization by the European countries of England, Italy and France, the Somali people had a long and rich tradition of nomadic herding, trading and agriculture, all of which contributed to the culture over time. The nomadic tradition explains the namesake of Somalia, *Somaale,* meaning "go milk for yourself" or "help yourself to the milk." This comes from the historical reality that many Somali herders could not carry a lot of supplies while herding animals and therefore, had to rely on the generosity of others (Mayberry, 2015; Yusuf, 2012).[5] In contrast, the sea coast of Somalia afforded more urban residents with the opportunities to trade while in the southern portions of the country a more agrarian society developed. Despite these regional differences in land use traditions, the Somali people are often described as one of the most homogeneous cultures of Africa. Central to this was the introduction of Islam in the 10th century by Arab Muslim traders; the Somali people often describe their shared culture as having a language, an ethnicity and a commitment to Islam. For virtually all of the Somali people, it is impossible to separate religion and culture. As noted by Farid and McMahan (2004), Islamic teaching is so integrated into the fabric of Somali society that it is often difficult to see where religious influences end and where local culture begins.

Research on the School Experiences of Somali Immigrants

Research on the school experiences of Somali immigrants is emerging, as the Somali people move to different areas of the world. In the early 1980s, for example, there

[5] This nomadic culture may include an unspoken understanding of what community members need, and a subsequent offering of assistance without needing to ask. Contrast this to the U.S., and particularly the Midwest where one needs to ask for help. This cultural gap may create problems in schools for students and teachers, and may impede communication between parents and schools.

were few Somalis in Toronto, yet by 1995, there were 30,000. Likewise, there were few Somalis in London prior to the late 1980s, but by 1995 there were 40,000 (McGown, 1999). The Somali population of Minneapolis, called the "Mogadishu of North America", for example, was estimated to be approximately 50,000-100,000 in 2008 (Roble & Rutledge, 2008). As the Somali people have migrated to new homes, their children, of course, have made their way to K-12 educational institutions, both public and private. The experiences of the Somali students and their parents in these school institutions can be said to be specific to context and are therefore intrinsically varied; yet some important themes emerge in the literature: Islam and schools (Zine, 2000, 2001, 2006); accommodation and assimilation (McGowan, 1999); and academic and language challenges in new settings (Basford, 2008; Mohammed, 2008). In the following pages, I will discuss each of these areas in turn, in the context of science education in particular, and at times, education in general.

Religion and schools: Islam in a Judeo Christian context

> "I'm from a family who wants you to believe no matter what the world says about you still u are who u are."
>
> S. Hashi, 10th grade biology student (Megarry, 2006)[6]

As Zine (2000) so eloquently states, for Muslim students[7], "religious identification adds another marker to the racialized, classed and gendered identities they must bring to and negotiate within the contexts of their educational experiences." Being Muslim in a secular Eurocentric world where the predominant culture is primarily Judeo-

[6] This student quote mirrors the general philosophy in the Somali community (as I have observed it) that the Somali identity, or Somaliness, is about being a good Muslim, despite what others may think. This Somaliness is exhibited by both adults and children.

[7] 99% of Somali immigrants consider themselves Muslim (Roble & Rutledge, 2008);

Christian presents a special set of challenges for Somali youth in K-12 schools, no matter where the schools are located. Several recent studies have addressed this issue, most of them focusing on immigrant Muslim youth in western European countries, Canada, or the United States (Bigelow, 2008; Zine, 2000, 2001, 2006).

In three studies that focus on Muslim youth in Canadian schools, Zine found that students who practice Islam encounter significant pressure from peers, teachers and administrators as they enter the public schools (Zine, 2000, 2001, 2006)[8]. Pressure from peers can be positive if the students are able to connect with other Muslim students through social networks or Muslim Student Organizations. On the other hand, pressure from peers can be perceived as negative, from both Muslim friends and from non-Muslim friends. Moreover, at the same time students are negotiating their way through the culture of mainstream schools, their parents are pressuring them to maintain an Islamic lifestyle. Mainstream cultural practices such as dating, attending dances, participating in music and art events, using alcohol and attending pubs and parties presented special difficulties for Canadian Muslim students.

In her work with Somali students in the Minneapolis area, Bigelow (2008) found that Somalis and other Muslims experienced religious and racial discrimination, hostile attitudes toward their religion and cultural practices, and Islamophobia, fueled by, as she stated, "a powerful public discourse that depicts all Muslims as extremists and

---

[8] Zine's studies included Muslims from South Asian, Caribbean, Arab and Somali backgrounds. Although her research does not focus exclusively on Somali students and parents, I believe the findings are relevant to Somali students. Moreover, due to the paucity of research on the educational experiences of Somali students vis-a-vis their religious beliefs and practices, I have included larger works on Muslim students in this chapter.

fundamentalists" (p.27). Like Zine, Bigelow found that it is very difficult to be a practicing Muslim in public schools. Muslim students experience value conflicts with a number of common high school activities and discourses including, for example, dating, dancing and mixed-gender athletic events. Moreover, Muslim students who choose to be open about their religion or culture by wearing a veil, for example, are frequently misunderstood and caught between their parents' or communities' requirements and the larger U.S. society's view of them as "*terrorists"*. Hence, many Muslim students have to make the choice of isolation versus loss of culture or alternatively, they may lack a sense of choice or agency, when the parents and community expect one thing and the dominant society characterizes them as something they are not. This conundrum between the host countries' cultural norms and the Somali students' cultural norms creates a false choice, if indeed there is one. The sense of loss of agency to influence or to adjust to both cultural demands is quite understandable. However, many schools and teachers who encounter these discrepancies are generally at a loss in terms of formulating policies and actions. When students are deprived of their agency in school settings, they become disinterested in learning or become passive in their classroom interactions with teachers, peers, and the content they are learning (Bigelow, 2008). Giddens (1984) argues that without agency, individuals tend to be reluctant to see themselves learning any content or actively interacting with the community that has very little value for their knowledge or ways of learning. Bigelow (2008, p. 32) provides a number of suggestions for educators and administrators who wish to improve the educational climate for Somali youth in public schools focusing on race and Somali youth:

1. Students could be engaged in learning about and researching their own identities and those of their classmates. Teachers could promote deep reflection on the meaning of symbols that adolescent culture in the United States adopts.

2. All students should learn about how racialization occurs at schools and in communities. Students can engage in their own inquiry about racialization practices.

3. At the school level, teachers should be required to foster productive inter- and intra-ethnic understanding, rather than animosity. This may require examining longstanding school practices such as tracking students racially and academically. Regarding Islam and Somali youth, Bigelow further recommends:

1. Teachers should work with Muslim parents and the school administrators to accommodate the obligatory religious practices that some Muslim students may wish to observe (e.g., wearing a hijab, not eating pork, prayer times, single gender physical education and health classes). Educators can find experts on Islam who can engage in thoughtful conversations with adolescents and their families.

2. Non-Muslim classmates should know more about Islam in general. One place to begin may be an exploration of the reasons for wearing a hijab. Are there opportunities where teachers can facilitate a conversation about what the hijab means and why Muslim girls may wish to wear it? Could teachers help answer questions about the hijab such as: What styles of clothes are worn under the hijab? Why are some veils more stylish than others and how do veils differ across cultures?

3. Besides demystifying the hijab, teachers can work against Islamophobia through the curriculum. Local and national media that engenders fear could be analyzed

(Haque, 2004). Islamic arts, history, and politics could be explored across a number of subject areas in ways that would deepen the curriculum and offer a forum for learning how dramatically different Islamic societies are.

4. Students and teachers can learn to recognize anti-Islamic (and other) bias in textbooks and other course materials. For example, most science textbooks do not include images of Muslim scientists or students, especially females who are veiled. Moreover, the educational community should actively seek the removal of materials that stereotype or marginalize members of the school or larger community.

In a case study situated in a Somali Charter School in the upper Midwest, Basford (2008) interviewed teachers, students and parents and community members about the school's accommodation of Muslim students. In this geographic area, hostility toward Muslim students in the district schools had been so significant that the Somali community chose to start a public charter school for their students. In their former schools, the students and parents struggled with a lack of culturally responsive teaching and learning as well as the dominant (white) pedagogical methods of instruction that were focused on participation through asking questions rather than listening to a teacher and focusing on the text. This new school made several provisions for the accommodation of Islamic practices such as allowances for daily prayers and Friday mosque service, halal meals in the cafeteria, separation by gender in the school's physical education classes, and a dress code that allowed for the wearing of the hijabs, camises, and kofias as students chose. The school also attempted to be culturally responsive by offering Arabic as a second language; by training teachers and staff in culturally relevant pedagogy; and by

incorporating methods to serve English Language Learners in mainstream classes. A number of bilingual Somali staff members were employed at the school as administrators, teachers, paraprofessionals and community liaisons. As a result of these changes in school culture and practices, Somali students came to view their school as a refuge where they were offered a second chance to succeed (Basford, 2008; Basford, Hick & Bigelow, 2007).

Traditional Somali Education: Islam as a Factor

Good (1999) succinctly summarized the history of education in Somalia as one that transitioned from traditional education to Islamic education, and then from colonial education (imposed by the British and Italian governments) to education after independence and the military revolution of the 1960s (designed by the newly formed Somali government). Early on, traditional education was linked to agriculture and livestock for young nomadic Somali boys; and to childcare, and the provision of water duties (fetching water from distant water sources for all household purposes) and food for young Somali girls. In addition, both boys and girls were expected to observe and listen at councils led by elders resulting in the learning of decision-making processes in their communities, the traditional laws and management of community affairs. With the early introduction of Islam to Somalia, Qur'anic schools were established as the first structured educational systems. Islamic education also introduced reading, writing and arithmetic for the first time. Qur'anic schools were started as community-based schools and enrolled students at the ages of four or five.

Following colonization by the British in the north and the Italians in the south in the late 1800s, two separate formal education systems were introduced between 1905 and 1959. According to Good (1999), these systems were largely mistrusted by Somali parents and religious leaders and were never very successful in attracting and maintaining Somali students. Following independence, the new Somali government inherited two distinctly different educational systems---the British and Italian schools used different structures, languages (English, French, Italian and Arabic) and content. In 1969, the military government brought about several educational reforms including the adoption of a Latin script for the Somali language. Following this, Somalia instituted a nationwide literacy campaign that included an estimated 1.2 million people. In 1975, the government declared free and compulsory primary education for all Somali children, and the Somali language became the medium of instruction for the first time in history (Good, 1999). Despite this, education in Somalia suffered from a lack of educational resources, including qualified teachers, and increasing political instability that eventually culminated in the civil war in 1991. From that time until fairly recently, formal education in Somalia ceased to exist for all intents and purposes.

Learning Styles: Didactic Learning vs. Inquiry Science

Given the preference for Islamic education by Somali parents and adults, it is important to recognize the learning styles associated with it. As with many Eastern religions, in Islam children grow up learning Qur'anic verses directly from the text through memorization. One of the reasons for that is to ensure that young children learn exact verses so as not to distort God's words, which are believed to be very sacred, and to

have supernatural powers to bestow good luck, good health, and wealth, if recited verbatim as written in the religious text, the Qur'an. Similarly, it is likely that almost all indigenous cultures pass on valuable knowledge through repetition of the same tasks over time. Furthermore, knowledge is always passed on from the older and wiser generation to the younger generation. The responsibility of learning is on the young but also on elders for accuracy and based on the cultural norms. Therefore the practices of learning are more didactic compared to constructivist learning as advocated by science educators and researchers in U.S. schools (Upadhyay, personal communication, August, 2015). Also, in many indigenous communities learning is generally done through apprenticeship. In the apprenticeship model of teaching and learning, the rate of early failures is immense. Children learn through constant practicing of and engagement with the same task until mastery is gained. The teacher, who is always an elder of the community, is respected and never questioned (Rogoff, 2003). This is somewhat contrary to the current advocated method of learning in science education in the United States. In inquiry-based science instruction, for example, questioning the teacher is an important component, which does not fit with many Somali students' experiences at home. Therefore misunderstandings about the methods of teaching and learning can create challenges to students and also their teachers. In constructivist approaches to science learning, students show understanding through creating their own meanings of science content or ideas – this is in fact opposite to how they learn Qur'anic verses. Similarly, in an apprenticeship model the learning is evaluated based on how well a learner can replicate a task that the teacher showed. This requires very close attention to the steps as well as paying close attention to

the teacher and doing exactly what the teacher did. Therefore science teaching and learning, as advocated by Next Generation Science Standards, the American Association for the Advancement of Science, the National Science Teachers Association and many science education documents and research, may create barriers to learning for Somali students and their parents.

Accommodation, Assimilation or Participation?

"Home, my home is what I desperately desire.
I don't consider this land my home, but a fire
That consumes my life as a human.
My life is always in a cycle.
One thing over and over again
driving you insane;
I wish to go back to my home if I can,
To where the gentle streams flow
Placidly through the land like a snake,
To where the pleasant soft breezes blow.

F. Basam, 10th grade English student (Megarry, 2006)

The themes of accommodation and assimilation (wherein assimilation is traditionally viewed as the process of immigrants' language and culture becoming like that of another group, and wherein accommodation is viewed as the process of immigrants' language and culture accepting some portions of another group) for Muslim students in western schools should be viewed as part of the larger conversation about the integration of minority Muslim cultures into mainstream cultures. Much has been written about the latter. In this specific case, a couple of studies stand out. McGown (1999) interviewed eighty Somali men, women and teenagers in Toronto and London as part of a qualitative study to compare the integration of Somalis between the two countries. Although her study looked at issues broader than school experiences, it provides an

interesting lens with which to view Somali integration. In effect, she concluded that a "country's political culture is a critical determinant of the nature of the integration of immigrants and minorities into its society" (McGown, 1999. p. 6). In a country like the United Kingdom, for example, where there is a long history of shared *British* values and culture, Somali immigrants repeatedly expressed frustration with being viewed as outsiders, even though Somalis, in small numbers, had been part of London since the 1950s. On the other hand, Somalis in Toronto, expressed more satisfaction with the tolerance of Canadians towards Somali immigrants. McGown attributed the latter to the observation that multiculturalism appeared to be an established part of the Canadian national psyche. McGown's observations are substantiated by other studies of Muslims in British schools (cf. Haw, 1994).

Regarding the question of accommodation or assimilation, McGown preferred to use the term *integration* which she defined as "the inexorable process in which both the host community and the ethnic immigrant communities undergo change and some degree of convergence" (McGown, 1999. p. 43). She further described *external integration* as the ability of the minority group to access and use the political, economic and social institutions (including schools); and *internal integration* as the process by which the minority group members are able to combine elements of their host culture with their own.

In their photographic study of Somali immigration, Roble and Rutledge (2008) used photographs and stories to document the Somali diaspora in America. These authors question whether what is sometimes referred to as assimilation is really just the Somali

way of redefining a foreign situation and making it one's own. Instead, they refer to three phases of Somali immigrant life---dependence, preparation, and participation. Dependence is defined as the initial phase of immigration when Somalis are not ready to work and are dependent on social services. Preparation is defined as the stage when Somalis have language and job skills and are adjusting to American culture. Participation is defined as something different from assimilation in that Somalis are able to choose which aspects of American culture that fit their Somaliness, but not those aspects that conflict with who they are. Hence, participation is viewed as the ultimate goal from a Somali perspective. When the Board Chair of a Somali charter school was asked about the American melting pot, for example, he responded, "America may be a melting pot, but I don't want to melt"(Roble and Rutledge, 2008, p. 8).

Measuring the Academic Achievement, Challenges and Success of Muslim Immigrants[9]

Although there is a vast literature base on the academic challenges of minority students, there appears to be a dearth of quantitative information on the academic progress of some specific student groups, including Muslim students such as Somali immigrants. Scholars who have addressed this issue include Covington Clarkson (2008), Schleicher (2006), and Lee and Luykx (2006). Few studies have included information on the perceived achievement and challenges of Muslim immigrants (e.g., Basford, 2008; Basford et al., 2007; Bigelow, 2008; Merry, 2005; Zine, 2001). Rarely has research focused on the science learning of Somali or East African immigrant students. To date,

[9] The words" Achievement, Challenges and Success" are borrowed from Covington Clarkson (2008) because this author (Albrecht) believes they may promote a more positive discourse about immigrant students (as opposed to achievement gaps, achievement failures, challenges…).

searching most journal host sites such as ERIC, I could find no published quantitative research on the achievement of Somali immigrants with the exception of a brief analysis of Somali students in higher education in the U.S. As stated earlier, according to Mohamed (2008), despite the staggering number of Somali students in U.S. public schools, the number of Somali graduates with four-year degrees in 2006 was so low as to be statistically insignificant.

There are some qualitative studies in the literature that apply to Muslim immigrants in particular. In their interviews with Somali Muslims in an upper Midwest charter school, Basford and colleagues found that the students viewed themselves as "misjudged academically" (in mainstream district schools) and frequently were referred to the "safe harbor" of ELL classes (Basford et al., 2007). On the flip side of this, they believed they were often trapped in lower level high school classes, with teachers who had low expectations of them. Basford (2008) summarized that these schools appeared to perpetuate established social classes and contributed to the so-called achievement gap. As a result of this study, the authors observed that even in a charter school established for Somali Muslim immigrants, for a variety of reasons[10], refugee students were often not able to complete a college preparatory curriculum, and at the same time, were not provided any life skills for supporting themselves once they left high school (Basford et al., 2007).

In her interviews with teachers, parents and students, Zine (2001) noted that teachers and guidance counselors of Muslim immigrant students often held low

[10] One such reason noted by McGown (1999) is that immigrant students are most often initially placed in secondary schools by their age, not by their educational backgrounds or abilities.

expectations for these students; they were often subjected to "color-coded streaming" (tracking by race); they were discouraged from taking mathematics and science courses; and there were especially low expectations for Muslim female students. Discontinuities in communication styles between students and teachers, and between teachers and parents, contributed to this dilemma. Similarly, in his study of Muslim immigrants in Belgian schools, Merry (2005) found that these schools appeared to be reproducing the social class divisions---students of low social class were subjected to teachers with lower expectations and discriminatory attitudes, as well as incompatible pedagogical styles. In a broader sense, the schools suffered from differential, or possibly discriminatory funding. In a curricular sense, Muslim students were tracked into less rigorous courses; and language courses such as Arabic and Turkish were not offered (while courses in Spanish and Italian were). He also noted that Muslim immigrants were disproportionately represented in special education classes and that grade retention rates were higher with this group of students. De facto segregation appeared to be in place, with most Muslim students attending immigrant concentration schools. Limage (2000), in her study of Muslim students in France, also makes the case that the national curriculum and assimilation policies do not benefit the achievement of French Muslim students.

In their synthesis of the research on student diversity and science outcomes, Lee and Luykx (2006) describe the ideological and methodological limitations that contribute to our lack of knowledge about the science outcomes of students from various racial/ethnic and socio-economic status (SES) groups. In essence, current practices do not allow for disaggregation of achievement data (i.e., test scores) on national and international science

assessments.[11] [12] Therefore, data cannot be analyzed by SES groups within racial/ethnic groups for example, nor can test data be analyzed by specific subgroups with racial/ethnic categories. This is a salient point with reference to Somali immigrants because their scores cannot be differentiated from those of African Americans in general, or from those of ELL students in general. Clarkson (2008) makes this point specific to the disaggregation of all test data required by the U.S. No Child Left Behind Act (NCLB). She states that although we analyze data according to ethnicity, SES, gender, and home language, we do not analyze data based on immigrant status. This lack of *fine* differentiation contributes to the lack of knowledge about the achievement, challenges and successes of specific immigrant groups of students.

Gaps in the Research, Critique

Lack of data in general.

Perhaps the most obvious conclusion one might reach when delving into the school experiences of Somali immigrants is that there is a paucity of published data on this topic. As noted above, we have very little quantitative data for specific immigrant subgroups, especially as it relates to achievement. Moreover, the data we have are usually limited to test data. More work is needed in this area within both policy and research so that researchers and practitioners can have a better understanding of the many facets of achievement with racial/ethnic subgroups. These data might include graduation rates,

---

[11] In fact, Lee and Luykx (2006) note that the 2000 National Assessment of Educational Progress (NAEP) report card was the first to analyze assessment accommodations in science, yet it did not separate ELL students from students with disabilities (O'Sullivan et al., 2003, as cited in Lee and Luykx, 2006).

[12] The International Association for the Evaluation of Educational Achievement (IEA) science test could do this, but it depends on the will of the national teams to collect data by ethnicity or race, and when they do, the sample size is very low as they are seeking random samples.

attitudes towards academics, enrollment in specific courses such as science and mathematics, college degree completion and entrance into various occupational fields. As noted earlier, the data on achievement for Somali students in the U.S are usually lumped into the African American category or the English Language Learner category. Neither of these categories alone will assist us with understanding the unique needs and progress of recent Somali immigrants (as well as the larger group into which they are lumped).

Moreover, a case can be made that this lack of data impedes our ability to address the achievement gap between mainstream students and minority students in U.S. schools. Alternatively, Rodriguez (1998) makes the point that achievement gaps are related to larger social justice issues (such as the "meritocracy myth")[13]. Using a critical perspective, one might conclude that how we measure achievement is directly related to the needs of those in power as opposed to those of *the other,* meaning those not in power such as minority students and families. But perhaps the most injurious effect of this lack of data is that it may contribute to inaccurate stereotypes of immigrant groups, and may confound the progress, needs and achievements of various subgroups. Ngo and Lee (2007), in their review of South East Asian refugee education, noted that Asian Americans are often stereotyped as motivated, high achieving students, and are also often stereotyped as low achieving drop outs. A careful analysis of the educational needs and successes of the various subgroups of South East Asians led to different achievement outcomes for the groups based on ethnicity (Laotian, Cambodian, Vietnamese or Hmong) and generation (first generation vs. second generation). This type of analysis has not been

[13] The "meritocracy myth" suggests that the American belief that success is solely related to hard work, merit and virtue is false and structural inequities play a large role in the success or failure of individuals (McNamee & Miller, 2009).

done with immigrant groups from East Africa yet. Given the fact that earlier Somalis left the country voluntarily (before the civil war), it is likely that a careful analysis of achievement over time might lead to interesting results. Negative stereotyping of Muslim youth, Somali or not, appears to be very real, and these perceptions cannot be but noticed and internalized by the youths themselves.[14]

Academic achievement and influencing factors.

As mentioned previously, quantitative data on Somali students are difficult to obtain for a variety of reasons. Searching for Somali-specific data is an inexact process, requiring creative measures. As mentioned earlier, searching for English Language Learner *and* African American, Taxis (2014) found that the mathematics proficiency of Somali students was in the lowest 10% of Minnesota students statewide. Confounding this search, however, is the fact that not all Somali students consider themselves English Language Learners or are labeled as such by their respective school districts and not all English language learners who are identified as African American are of Somali descent. Using another approach, I used data from the Minnesota Department of Education's *Minnesota Report Card* (MDE, 2014), to gauge proficiency on the Minnesota Comprehensive Assessment for Science (MCA Science Test), a high-stakes assessment. Using the data for charter and alternative schools with primarily Somali students I found that proficiency ranged from 1.8% to 18.5%. This compared to a range of 29.5% to 32.2% for district schools in Minneapolis, including those in the inner city with a variety

[14] See Carlyle, 2008 for an example of a local publication that covers Somali youth issues; at that time there were numerous negative articles in local newspapers regarding Somali violence, mosques, and community issues.

of ethnicities.[15] Moreover, a brief look at American College Testing (ACT) composite scores for these same relatively homogeneous Somali charter/alternative schools indicates similar results: ranges of 15.5 to 17.6 compared to 20.6 in Minneapolis district schools, for example. Compounding this is the difficulty of sorting out the subtleties of school choice. It is not known whether or not families that chose alternative or homogeneous charter schools did so because their students did not succeed in regular district schools or whether they were looking for more culturally sensitive settings for their children. And, given the lack of data on Somali students in general, generational differences cannot be examined nor can the SES status of these families and other important factors.

School factors that contribute to success.

Huisman (2011) presents a discussion of the "internal" and "external" barriers that Somali students face in the postsecondary context. He noted that parents often have little or no formal education prior to immigration, and therefore face significant financial, academic and social challenges when negotiating U.S. schools (in other words they are missing financial and cultural capital). In addition, they often face language barriers, social isolation in their new cities, and discrimination based on race and religion. In general, they resist the cultural "melting pot". Internally, Somali families are often experiencing generational conflicts, fractured families and identities, and cross-cultural misunderstandings. Significantly, female parents and students are often face additional

[15] 2011-2013

challenges due to their cultural roles as caretakers of children and the elderly along with their regular home responsibilities that typically include cooking and cleaning.

Despite these challenges, Huisman (2011) noted that Somali parents and students often maintain a strong sense of communal identity and pride. Family is everything; and all members are expected to contribute to the common good. And, as he also noted, despite the racism that appears to be inherent in public schools in the U.S., Somali families have maintained a general resistance to it and a positive attitude towards modern education. In essence, this resistance, or "soomaalinimo", is viewed as an asset that mitigates other negative influences they experience.

Conclusion

Following the eruption of the Somali Civil War in 1991, hundreds of thousands of Somalis immigrated to distant countries, including the U.S., bringing with them their children of school age. The school experiences of Somali students and parents are varied, depending on the host country. However, the processes of accommodation and assimilation (or participation) have been fraught with perceived racism and Islamophobia. Somali parents and students have sought to mitigate these negative experiences by maintaining the essence of their culture, including a strict adherence to Islam.

Data on the experiences of Somali parents and students in schools has slowly been accumulating; much of it is qualitative and focuses on the students themselves. Due to lack of more specific data gathering practices in public schools, it is extremely

challenging to disaggregate school data to get a look at the achievement of Somali students in public schools, much less in science classrooms.

Chapter 3:

Theoretical Framework

The theoretical framework for this study on the perspectives of Somali-American elders and parents primarily draws on the current research that focuses on culturally relevant pedagogy (CRP) (Ladson-Billings, 1995, 1994), and funds of knowledge (Moll, Amanti, Neff & Gonzalez, 1992; Gonzalez et al., 2005). I start out this chapter by making the case that Somali-American youth and adults are immigrants, but more importantly refugee immigrants, who face significant challenges in their new homes, communities and schools due to a variety of factors related to their status as involuntary immigrants (Ogbu & Simons, 1998). I then briefly summarize why "culture" matters in education, and more specifically, science education. Using this premise, I outline how theories of funds of knowledge, and culturally relevant pedagogy can be helpful in thinking about the teaching and learning of science education for Somali students, especially in the context of a socio-constructivist perspective (Vygotsky, 1978). Throughout this chapter, I argue that although culture is an intrinsic component of the science education of all students, it is particularly cogent to the science education of immigrant refugee students.

Refugee Immigrants

The majority of current Somali-Americans are refugee immigrants who were forcibly displaced from their homeland because of political unrest. As involuntary immigrants, Somali refugees face significant challenges when entering U.S. school

systems[16]. These challenges are complicated further because local Somali communities often have unique views and experiences that influence their thinking about what sort of science Somali students should learn and engage in. The United Nations High Commission on Refugees (UNHCR) reported that Somalis were the third largest refugee group in the world in 2013, numbering 1.2 million individuals. Among industrialized nations, the U.S. was the second largest country in hosting refugees (and the second most popular country for new refugee asylum seekers (47,500) (UNHCR, 2013). In 2014, the U.S. Department of State reported that 70,000 refugees from 65 different countries entered into the U.S. and settled (United States Department of State, 2014). According to the same report, more than 15,000 refugees came from the continent of Africa alone.

Immigration of all kinds has brought tremendous change in the cultural, linguistic, and social diversity of the U.S. One key factor related to the success of immigrant families is their level of English language proficiency. For example, the percentage of public school students in the U.S. who were English Language Learners in 2012-2013 was 9.2% or an estimated 4.4 million students (National Center for Educational Statistics, 2015). It is likely that this is yet another hurdle that students have to manage in order to succeed in their new respective communities. In many cases, immigrants' native languages may not provide them with the tools to participate in everyday activities in their new communities and schools. For students from these families, language may be the single most important barrier to overcome in their new school systems.

---

[16] Involuntary immigrants, as defined by Ogbu (1992), undergo forced migrations and are more likely to view accommodation and assimilation of the host country's values and traditions as negative influences on their own culture.

Children from immigrant families make up 25% of students under the age of 18 in the U.S. (Migration Policy Institute, 2014). Therefore, teachers across the country encounter students from refugee groups and other immigrant families in their classrooms on a daily basis. Even though refugees are often viewed as additions to the diversity of schools, they are also viewed as the most needy among immigrant children because they have previously gone through many traumatic life experiences (Hernandez, Denton, & Macartney, 2009). Moreover, it is likely that this trauma does not disappear in their newly adopted countries, making teaching and learning even more complex.

As communities admit refugees and their children into their school systems, school systems and teachers find themselves having to learn new social, cultural, and linguistic norms and values which impact teaching and learning. Similarly, refugee adults and students also have to engage in new social, cultural, and linguistic norms and values. Therefore, there are various trade-offs that refugee families have to make in order to realize educational and economic gains, as well as social and economic mobility. Many scholars have argued that acknowledging and valuing students' historical experiences, languages, and social and cultural values improves students' learning and participation in science (eg. Gay, 2000; Ladson-Billings, 1994; Ogbu, 1992). The myriad connections between home experiences and school science are even more essential if refugee students are to like and to succeed in science.

Culture in Science Education

The connection between culture and education is not a new one, and has been explored extensively in education research for the last two decades. As noted in Durdan

(2008), sociocultural theorists view learning as a culturally-mediated phenomenon. In other words, as described by Vygotsky, how children think is largely governed by culture. Research wherein culture is viewed as an asset (i.e., cultural capital) has shown to accelerate, enhance and affirm the educational experiences for diverse student populations (Bell, 2001; Ladson-Billings 1994, 1995; Schmoker, 1999; Sizemore 1985; Trawick-Smith, 2000; Truscott & Watts-Taffe, 2003). Research wherein culture is viewed as a deficit has shown to negatively impact the educational experiences of diverse student populations (Valenzuela, 1999).

Research and subsequent discussions of the relevance of culture to science education have ranged from philosophical, focusing on epistemological questions (e.g., Lee & Buxton, 2010), to more practical, focusing on students' worldviews, including beliefs and practices, and communication/learning styles (e.g. Allen & Crawley, 1998; Costa, 1995). The relationship between religion and science, when viewed as a subset of culture, has started to be explored with some cultural groups including those from primarily Muslim cultures (BouJaoude, Asghar, Wiles, Jaber, Sarieddine, & Alters, 2010; Taskin, 2014).

Epistemological questions related to science and science education tend to focus on the questions of what science should be taught (What counts as science? What questions should be asked? How do we go about answering those questions? and Who gets to determine the answers to these questions?). In essence, arguments have centered on a more "universalist" view of science vs. a more "multiculturalist" view of science. Universalist views of science suggests that science is primarily a western European

endeavor that uses a specific set of rules to explore the universe that operates on specific set of rules (Lee & Buxton, 2010). Implicit in this view is the notion that culture (including race, ethnicity, traditions, language and other factors) is largely irrelevant to the process of science and science education. On the other hand, there has been a growing body of research that contradicts this view, arguing essentially that although the universe may operate by a set of rules (and hence be relatively objective), we, as humans, do not. Our culture (language, traditions, ethnicities, genders, and worldviews, for example) implicitly or explicitly determines what we choose to study, how we go about it, and how we interpret our results (Aikenhead & Jegede, 1999). In this view, other ways of knowing, including indigenous science and other non-Western traditions are recognized as part of the scientific endeavor, and hence, have become part of the discourse related to science education.

Research on worldview, as part of culture, in science education has clearly shown that science education for non-mainstream students may be more complicated when students' various ways of viewing science are taken into consideration (e.g. Lee, 1999; Jegede and Okebukola, 1991). For many cultures, natural phenomena may be attributed to spiritual or mystical beliefs, in addition to, or instead of, more western explanations. For example, in a frequently cited study of students' perceptions on the causes of hurricanes, Lee (1999) found that students' interpretations differed by ethnicity and socioeconomic status (SES). Some groups of students (African American and Hispanic, especially those of low SES) were more likely to view the causes of hurricanes to be related to non-natural phenomenon like social ills (racism, crime, violence), personal or

family wrongdoings, or supernatural or mystical factors. On the other hand, White students were more likely to attribute the cause of the hurricanes to natural phenomena. When ethnicity, gender and SES were taken into consideration together, white male students of moderate SES were most likely to give explanations based on Western scientific knowledge and thinking. In a similar vein, Jegede and Okebukola (1991) found that Nigerian high school students who held strong beliefs in traditional African cosmology were less likely to make correct observations about natural scientific phenomena. However, after participating in an inquiry-based culturally relevant science program that connected their beliefs to Western science instruction, these same students achieved higher than those students who had not participated in a similar program. The authors concluded that when students were allowed to make connections between their traditional ways of knowing and Western science they were able to use both (and not replace one with the other). Additional research in the area of worldview indicates that students from cultures that are traditionally more authoritarian may have more difficulty with inquiry science than others. The process of evaluating evidence and critical questioning may be new for many students who have been taught not to question communally held knowledge and beliefs (Lee and Buxton, 2010).

Although the definition of culture or cultural capital varies, recent definitions essentially focus on the reality and experiences of the learner. For the purposes of this thesis, I am choosing to use the definition provided by Gonzalez, Moll and Amanti (2005) which essentially views culture as the lived experiences of students. As such, it is dynamic, emergent and interactional; and focuses on validating the experiences of

students and their families, both in school and out of school. Moreover, building on the premise that culture matters, it is appropriate to explore how it matters in education, and more specifically, how it matters in the science education of refugee children of Somali descent.

Pedagogy of Engagement and Learning in Science for Refugee Immigrants

It can be said that a refugee is in search of a place and people who will support his/her ways of learning, knowledge, language, culture and social habits and practices. Since a refugee family, by definition, has lived through trauma, violence, and discrimination (DeCapua, Smathers, & Tang, 2007), they are often in need of psychological, academic, and developmental support both at home and in school (Boyson & Short, 2003). However, many schools in U.S. lack a systematic way to provide these support systems to make learning happen. For many refugee families and students, the barriers to success in U.S. schools include not only a lack of English language proficiency, but also unresolved trauma and stress, and lack of academic support. Such an acute demand in multiple areas creates huge pressures on the teachers as it is they who are the first line of contact in school classrooms. Hence, I believe that the science learning of refugee students (and the adults who care for them at home) can be significantly improved when we recognize the value of different kinds of social, cultural, linguistic, religious, and psychological experiences and then utilize these values as resources in the science classroom.

Socio-constructivist Perspective and Science Teaching and Learning

Knowledge, skills, and habits grounded in homes will help refugees towards positively influencing learning through "intent participation" (Rogoff et al., 2003, p.176) situated in-home experiences. Rogoff's socio-constructivist perspective argues that people learn from intentional participation with adults in the home environment. In this type of learning, the less knowledgeable and the less experienced children and youth work as apprentices to learn new skills, knowledge, and the appropriateness of various interactions. Without direct experiential experiences in a given context, youth and children will not learn relevant knowledge and skills. Hence, learning in the home context is happening in a socially and culturally mediated environment. Turning to science education, one can posit that similar learning happens in the context of learning science as students are observing and following adult teachers to learn about science knowledge, skills, and practices so that they can function in a science environment. For example, in a study of Haitian students, Roseberry, Warren, Constant, and Hudicourt-Barnes (1992) showed that Haitian refugee students understood the relationship between slope and speed of an object travelling down the slope based on their own experiences in the hills of Haiti. In this case, they described the science more from their own Haitian experiences than from the scientific terms or concepts learned in their science classes. The learning from one experience was transferred to a new experience as they constructed science knowledge.

Theoretical Framework

In order to further build a more nuanced framework to understand Somali adults' perceptions of science teaching and learning this study builds on Rogoff's socio-constructivist perspective (1990) with the notions of *funds of knowledge* (Moll et al. 1992) and *culturally relevant pedagogy* (CRP) (Ladson-Billings, 1994; 1995). Notions of funds of knowledge and CRP form a powerful theoretical framework as these theories help us foreground socio-cultural experiences at home as the fundamental basis for understanding Somali adults' perceptions of science teaching and learning. Funds of knowledge and culturally responsive pedagogy draw from the idea that any learning that occurs in an individual is mediated by knowledge and skills gained during household activities, or the socio-cultural context of home and community.

Funds of Knowledge and Science Teaching and Learning

Based on a similar premise, funds of knowledge (Moll et al. 1992; Gonzalez et al. 2005) provides a positive argument for connecting school and home in teaching and learning. The framework of funds of knowledge argues that the knowledge and skills gained at home by participating in cultural, social, economic, historical, and political activities are the foundation for future learning. González et al. (2005) describe household activities and routines such as "car repair, gardening, home improvement, child-care, working in a family business or hobby … music practices, sports, shopping with coupons, and other aspects of life" (p.18) as the basis for future learning growth. Based on this research, I believe that the utilization of these experiences through direct participation (or by observation of the more experienced adults) is crucial for Somali

adults and students in science. Furthermore, these experiences help create funds (or banks) of knowledge from which individuals draw from to engage in and learn from new contexts.

Riojas-Cortez (2001) further extended previously accepted home-based funds of knowledge activities (e.g., farming practices, religion) to include activities such as parents' languages, values and beliefs, types of discipline, and beliefs about the value of education. Hughes and Pollard's (2006) work showed that funds of knowledge could be useful in changing teachers' perceptions and how families are positioned in the new context.

Therefore, in this study I build from the works of these aforementioned scholars to define "funds of knowledge" as all of the knowledge and skills gained by students at home from their cultural, social, historical, linguistic, and political engagement that forms a base for further learning and that aids in active engagement in activities that are worthwhile in the community. These funds of knowledge are developed over time and have strategic value as children look forward to future growth in science and science-related fields (Calabrese Barton & Tan, 2009; Moll et al., 1992; Upadhyay, 2006). For example, in Somalia, a child will learn how to survive in an arid and hot environment based on what she or he experienced with adults in the family. This knowledge is then utilized strategically for future professions such as farming, healthcare, and animal husbandry. Teachers in science classrooms in U.S. could leverage this knowledge to engage Somali students in various aspects of doing and learning science. For example, over the years as a biology teacher of Somali students, I often replaced the regional

biomes and climate with those found in East Africa (e.g., arid desert ecology). I believe that in making this simple switch, while still maintaining fidelity to state standards, we allowed Somali students and parents to be more engaged in environmental science. In this way, students more easily found relevance to who they are and what they were learning.

Numerous other studies have included funds of knowledge as a useful framework in science education. In their qualitative study of inner city mothers' perceptions of school science, Calabrese Barton, Hinden, Contento, Trudo, Yang, Hagiwara and Koch (2001) found that although mothers' perceptions of science were not static, they could be loosely grouped into four categories including schoolwork/knowledge, fun projects, a tool for maintaining home and family, and an untouchable domain. In essence, those mothers who spent time doing science with their children were more likely to have a more personal and dynamic view of science, and those mothers who spoke about contexts that were familiar to them such as nutrition, food and childcare saw science as more dynamic and inquiry-based. Implications for science education reform included the need to acknowledge (and work with) mother's perceptions of science (wherever they fell) as well as to involve mothers in their children's science education, especially as it is relevant to their everyday activities. In addition, the authors noted that context appeared to be very important to these parents in their understandings of school science and their potential contributions. For example, science activities that included the daily experiences of these mothers (nutrition, food/cooking, for example) appeared to allow them to cross borders into the domain of school science with their children more easily.

Another example of the importance of including the knowledge and perspectives

of parents in science education is the Chicago River Project, initiated in the late 1990s at a Chicago public elementary school. The goal of this multidisciplinary project was to co-create “connected science," in which real-world problems and school-community partnerships were used as contextual scaffolds for bridging students' community-based knowledge and school-based knowledge, as a way to provide all students opportunities for meaningful and intellectually challenging science learning (Bouillion & Gomez, 2001). In this case study, researchers were able to demonstrate that including the community perspectives and funds of knowledge, including those of parents, allowed for more meaningful science education:

> We see little of nature in this cemented neighborhood, yet our immigrant parents from Mexico have extensive knowledge of the earth. Many of our children travel back to their homeland to visit family, bringing to us stories of life in rural Mexico. In order for our children to succeed, it is paramount that we as educators assist our students in maintaining a sense of where they came from so they can successfully construct knowledge. (Buollion and Gomez, 2001, p.886)

Hammond (2001) explored the use of a collaborative science project wherein students, parents and the community designed and created community books and a Mien-American garden house using participants’ funds of knowledge. In this ethnographic study, parents were used as experts in order to make a link between the deep knowledge of the Hmong community and school science. As the author noted, this was an interesting case because the contrasts between Mien knowledge of the natural world and classroom science were significant. For example, Mien knowledge could be characterized as animistic and spiritual wherein oral culture prevails; and the knowledge of elders cannot be questioned. In contrast, school science knowledge is often viewed as more mechanistic and empirical; written records are essential; and academic success depends on

questioning. Despite these differences, the school community (parents, teachers, preservice Mien teachers, students) was able to negotiate compromises and build the structure using Mien knowledge, resources and skills.

Hagiwara et al. (2007) explored the role of immigrant (Dominican) mothers as both teachers and learners in an inner city middle school science program using the LiFE program (Linking in Food and the Environment). Using the framework of culture, language and identity, this study explored how immigrant mothers could create a hybrid "third" space at school by incorporating knowledge and skills from their homes ("first space") into their children's school spaces ("second space") by assuming the role of "teacher". Again, context appeared to be important. In this case, mothers were able to negotiate hybrid identities as insiders in school science through the use of their knowledge of food and nutrition (e.g. plant science, cooking, food preservation).

In a study of urban middle school students, Calabrese Barton & Tan (2009) showed that students brought their experiences from home to practice science as well as to make very strategic decisions about what they would like to be when they grew up. Their experiences, or their funds of knowledge, allowed them to create spaces for doing science. In another study of an elementary teacher in a Texas school, Upadhyay (2006) showed that the concept of funds of knowledge was an empowering tool for students from immigrant and underrepresented groups as they figured out how science was being practiced at home and how it could increase their classroom performance in science. Thus, for this study, funds of knowledge was an important and natural lens that provided a means to understanding how and why adults and students found space for engagement

in science teaching and learning. Limited work, such Upadhyay (2010, 2009), has focused on refugee adults, parents, and/or students. I believe refugees are distinctly different from other immigrants in that they are forced out of their homes – as noted by Ogbu (1992); they are unwilling immigrants with unique hardships and experiences, all of which can be brought into the science classroom.

Culturally Relevent Pedagogy (CRP) and Science Teaching and Learning

> Being Hmong, if people did not know about our culture and our ways of living, they would probably call us one of the most illiterate people in America because we come from a place where pencils and papers don't even exist. But what I discovered from my grandmother and other old people is that their minds are filled with their own experiences and knowledge that you can never find in a book or a television show. I do not remember a time when the science teacher ever asked for ideas related to our cultural background. I was very hesitant to share my ideas about gardening because teachers did not seem interested. This is probably why I did not like science very much because I always thought it was just facts and computations. (a Hmong preservice teacher, Hammond 2001, p. 983.)

Science teachers who understand that refugee adults and students need to connect school science to familiar things are likely to be more successful in assisting refugee students as they transition into U.S. educational system. In addition to curriculum transitions, transitions in pedagogy are likely a source of conflict for both adults and students. Due to their experiences with previous colonial education, Somali refugee adults and students are more familiar with teacher-centered instruction than the student-centered instruction in science in U.S. classrooms. The novelty of an inquiry approach to learning science likely does not fit well culturally into the psyche of Somali adults or students. Furthermore, it is likely that a good deal of scientific vocabulary, concepts, and ways of thinking are alien to many Somalis who had limited formal education in their

home country or refugee camps. I believe that one of the most effective ways to bridge this gap could be through the use of culturally responsive pedagogy[17].

Culturally relevant pedagogy (CRP), as framed by Ladson-Billings (1994), is about the need for a new way to rethink multicultural teaching and learning. For those researchers and practitioners who have explored the relationship between culture and science education, culturally relevant science is one area of research that seeks to bridge the gap between students' home lives and their school science. Although CRP itself is relatively new, it is rooted in research traditions that have been extensively explored including multicultural and inclusive science stemming from feminist perspectives on science education and research (e.g. Capobianco, 2007), language and culture in science education (e.g. Lee, 2001), scientific literacy (e.g. Roth & Calabrese Barton, 2004), equity and diversity issues related to student learning and access to science (Lee & Buxton, 2010), and critical pedagogy (e.g. Mutegi, 2011). Despite their seemingly disparate foci, all of these areas raise epistemological questions such as what counts as science, which questions get to be asked, and which tools get to be used to answer the questions. Moreover, these research traditions assert that science is enriched by the diverse cultures, languages and ways of knowing that people bring to science (Lee & Buxton, 2010).

Likewise, CRP is historically rooted in the cognitive and constructive approaches to teaching and learning that emerged in the last three decades. These approaches suggest that students are active constructors of knowledge, as opposed to passive recipients, and

[17] Culturally responsive and culturally relevant pedagogy are viewed as equivalent in this statement.

emphasize critical thinking and inquiry as opposed to rote memorization. As noted by Fusco (2001), however, science educators from feminist and multiculturalist traditions have suggested that constructive teaching might not go far enough if the nature of science is not questioned. In other words, the diversity of student experiences and perspectives needs to be included in the science they construct in schools.

One reason why CRP is valuable for this analysis is that it draws from the sense of placing power in the hands of the learners as intellectuals who are motivated to participate in learning new "knowledge, skills, and attitudes" (Ladson-Billings, 1994, p. 18) so that the learners from students from minority groups can find social, emotional, and political connections and relevancy. Ladson-Billings (1994) further argues that cultural references and connections that students and adults find are parts and parcel of "the curriculum in their own right" (p. 18). Gay (2000) and Nieto (2004) both envision CRP in the teaching and learning context as a matter of social and cultural justice because CRP allows teachers to utilize students' prior knowledge, experiences, and ways of learning as essential parts effective and respectful pedagogy. Gay (2000) points out that CRP is about teaching "*to* and *through* the strengths of students" (p. 29).

In the U.S., refugee groups often face the same educational issues and obstacles that other culturally marginalized groups experience. However, they differ in that their children have often been absent from formal schooling environments for extended periods of time due to forced migration, and/or discrimination for other reasons. This is particularly true for young women who were often expected to complete household tasks that interfered with their ability to attend school. These gaps in formal schooling play out

in many ways once the children and adults enter a new schooling system and strive for academic success. For example, immigrant Somali students are often placed in grade levels based on age, rather than on ability or experience in school. This results in significant challenges for both the students and the teachers when they try to find ways to mitigate the loss of months or years of building scientific vocabulary and skills, including ways of thinking in science. These challenges are magnified by the current paradigm of measuring achievement by standardized test results for all U.S. students, including refugees.

Many science education researchers report the benefits of CRP in the teaching and learning of science to students from poverty and underprivileged groups (Aikenhead, 2001; Aikenhead, & Jegede, 1999; Cajete, 1999; Upadhyay 2012). Work in the 1990s on culturally relevant pedagogy in science was led by Matthews and Smith (1994) and Aikenhead (1997, 2001) as they called for the use of Native American materials in the science classrooms of Bureau of Indian Affairs (BIA) schools in the U.S. and for cross-cultural science for First Nations students in Canada, respectively. Matthews and Smith (1994) conducted a quantitative study in BIA science classrooms that looked at elementary students' changes in attitudes and achievement as a result of including materials such as biographical profiles of Native Americans. This study found improved attitudes towards science and improved achievement of science concepts as a result of the inclusion of culturally relevant materials in the science curriculum. Although conceptual in nature, Aikenhead (1997, 2001) reinforced these findings by suggesting that teachers must be cultural brokers---in other words, they must identify the cultural border crossings

for their students and must facilitate the crossing of those borders while maintaining the validity of the students' own culturally constructed ways of knowing.

In 2001, Fusco completed an action research project in collaboration with an after-school program that operated out of a low-income housing facility. Working with urban teenagers, she created a *practicing culture of science learning* through the development of a community garden. In this case, science became relevant because it was created from participants' concerns, interests, and experiences inside and outside science, and it was an ongoing process of researching and then enacting ideas situated within the broader community (Fusco, 2001). Likewise, in his study of Hmong students, Upadhyay (2009) argues that linking students' lives and science using *participatory science* brings multiple social and cultural perspectives to science, and results in a (CRP) pedagogy that gives an empowering experience to Hmong students.

Other recent depictions of CRP in science include Mutegi (2009), Mensah (2009). Using Ladson-Billings' (1994) *Dreamkeepers* as a model, Mutegi (2009) showcased a summer camp with African American male students. Through the use of vignettes, Mutegi was able to show how the curriculum a) reconceptualized African American as intellectual leaders, b) established a community of learners, c) incorporated students' experiences into the intended curriculum, d) broadened conceptualizations of science, e) associated academic pursuits with social struggle, and f) reconceptualized the teacher's role as political. Although preliminary in nature, results indicated that students' were more interested in high academic performance once they returned to school. Using stories generated in an after-school science programs, Rahm (2009) illustrated how urban

students used culturally grounded experiences to develop cultural competence and critical consciousness, both integral components of CRP as defined by Ladson-Billings. She summarized that culturally relevant science teaching, although useful in teaching today, is still a vision that needs thought--- particularly with immigrant youth, and suggested that we need to question how the "polycontextual, multivoiced, and multiscripted" learning contexts of our immigrant youth intersect with the monolithic view of sites and practices of science that have informed research in the past (Gutierrez, 1999).

Because this study also looks at the implications for science teachers, I have included in the following section a description of a few studies of teachers implementing CRP. Two relatively recent studies have focused on how teachers have navigated CRP in science classrooms, Patchen and Cox-Petersen (2008) and Johnson (2011). Patchen and Cox-Petersen conducted a case study of two classroom teachers to investigate whether constructivism could be leveraged to develop culturally relevant pedagogy in science education. Using the themes of authority, achievement and affiliation, the authors noted that the teachers, who were white, were clearly using the fundamentals of constructivism with their students, who were Latino and African American. These fundamentals included a belief in the power of participation, the recognition of the value of student perspectives, and a desire to hear from students through questioning. Yet, a significant distance remained between their constructivist pedagogy and CRP because students' contributions were not explored beyond a superficial level. Implications for further leverage of constructivist pedagogies to CRP were discussed and included: 1) shifting the authority in the classroom by diversifying strategies, seating arrangements and student

responsibilities; 2) allowing more flexibility in the timing of classroom activities so students have more opportunities to learn; 3) shifting away from direct instruction to more inquiry based and student-led instruction; 4) actually discussing the power relationships in the classroom; 5) deepening responses to student contributions; and 6) truly establishing relationships by allowing for the sharing and recognition of students' lives (as opposed to the teachers').

Using qualitative case study methodology, Johnson (2011) asked the question, "How do middle-school science teachers who are participating in transformative professional development (TPD) transform their conceptions and practice as they enact CRP in their classrooms?'' This study focused on two white middle school science teachers in an urban school district with primarily high poverty Latino students. Johnson found that in order to successfully implement CRP in the urban science classroom teachers needed to be aware of their own conceptions of students and others; they needed to be cognizant of their own role in creating social structures in the classroom; and they needed to be open to new conceptions of knowledge, as displayed by the students, all three of which are integral to CRP as defined by Ladson-Billing and others. In short, Johnson found that teachers can be successful at implementing CRP, given time and support through specific professional development.

However, there are still science teachers who do not see any connections between CRP and science teaching and learning. In a study of pre-service teachers and their understanding of relationships between race, ethnicity, and class in science teaching researchers showed that the teachers did not seem to acknowledge these relationships

(Atwater, Freeman, Butler, & Draper-Morris, 2010). The failures of CRP in many classroom settings seem to link CRP with the cultural celebrations of underrepresented groups through ethnic food, dress or activities without any linkages to academic content areas and skills, thus, making CRP synonymous with non-academic events or celebrations (Sleeter, 2012; Upadhyay, 2012).

Critical Examination of connections between home and school in science

I believe that the connections between refugee students' home lives and school science is essential to their success. Moreover, I believe this to be a critical equity issue for immigrant refugee students and adults who enter U.S. schools. In many cases, the gaps between the students' home cultures and how school science is taught creates an uneven playing field for them. For example, because many teachers teach science as a culturally neutral, refugee students' rich and diverse experiences gained at home are rendered irrelevant, or worse, detrimental to their learning of school science.

Many studies of home-school connections in the areas of language learning show that students who see clear and strong connections between home and school languages learn better, engage better, and find school essentially as an extension of home (Au, 1993; Gee, 1990; Valdés, 1996). Similarly many science education studies show similar outcomes when science and home connections are direct and explicit (Barton & Tan, 2009; Carlone & Johnson, 2007; Upadhyay, 2006; 2010). Yet many schools and teachers struggle to appropriately implement home-school connections in science classroom settings. Such connections are especially hard to find in classrooms of refugee students. The literature in education suggests many possible reasons for the challenges of

connecting homes to schools in teaching and learning science (and other content areas). The following challenges are likely the most common for schools and teachers that serve refugee and immigrant students: (1) framing refugee and immigrant students through the model of cultural deficiencies (Valenci & Suzuki, 2000); (2) a mismatch between the science learned in school and the science experienced at home, as in the case of the effectiveness of the flu vaccine (the flu vaccine is only effective when flu viruses match the vaccine in a particular year) (Upadhyay, 2010); (3) the notion that everyday science is complex and filled with uncertainty which causes learners to be confused and less likely to value the worth of science in everyday life (examples include climate change and health issues such as HIV, AIDS, and Ebola) (Ryder, 2001); (4) the idea that everyday science competes with social, cultural, economic, political, and religious preferences so learners are reluctant to use risky science knowledge since it is still unresolved by scientists themselves;[18] (5) an increased emphasis on standardized testing and teaching from pre-packaged and highly scripted curricula to produce higher test scores rather than encouraging students to be creative, imaginative and risk-takers in science (Apple, 2014). These five factors constantly require that students and teachers separate personal experiences from the science knowledge espoused by the school curriculum. Furthermore, students are seldom challenged or even allowed to discover connections between their home experiences and the school science that they are required to master.

I believe that home-school connections are also central to building community in schools----communities with common missions and visions for the education of refugee

[18] Examples include the disagreements on the contributions of carbon emissions to the Greenhouse Effect (Aikenhead, 2006; Corrigan, Dillon & Gunstone, 2007); and the belief by Hmong elders that the flu vaccine lets good spirit escape from the body and makes individuals sick (Upadhyay, 2010).

and immigrant students. In the case of Somali students, the connection of school learning to community values and beliefs is important to gaining acceptance. Adults and students need to understand that what they learn at school in science, mathematics language, arts, and other related fields is relevant to how they go about their daily lives. Building trust is challenging for these communities and in fact, most schools are ill prepared to tackle the issues of linguistic, cultural, and religious differences as well as the challenges of pedagogical transitions when teaching Somali students. Many researchers have argued and shown that building a sense of community (through school and teacher actions) between marginalized groups and school yields positive outcomes both academically and relationally for students (Allen, 2007; Epstein, 2010; Goodlad, 2006; Nieto & Bode, 2008). A good home school relationship helps to build strong camaraderie between teachers and students from marginalized groups that can easily translate into a much more positive and fun school experience for personal and social growth. However, the social, political, and cultural differences between schools and homes of marginalized groups tends to undermine any cohesiveness that could be built between these groups to support constructive student learning outcomes. Some scholars of critical theory, multicultural education, and social justice argue that the barriers for school success for students from marginalized groups lie in the structural, institutional, and societal factors that are entrenched in school systems (e.g. Kozol, 2005; Ladson-Billings, 1994; Nieto, 2004; Young, 1990). These factors contribute to reduced school funding and resources; English language learner status; and continuous standardized testing, for example. All of these practices contribute to the perception that students from marginalized groups cannot

succeed academically. Other authors argue that one of the most detrimental effects of schooling is the continual cycle of oppression experienced by refugee students from the people in authority (Ellis, Miller, Baldwin, & Abdi, 2011). This is particularly relevant to refugee students and their parents because they and their families have already suffered atrocities as a result of the authority figures in their home countries as well as during their transitions through different refugee camps and countries as refugees. If teachers and other authority figures do not recognize this trauma from the perspectives of the students and families the students' education can suffer. Schools need to find ways to support teachers and students alike to mitigate the issues of trauma and/or distrust of authorities and help these students more fully learn and participate in class and school activities.

Given this, I believe we need to highlight the importance of understanding how and in what ways Somali adults' perceive classroom science. I believe understanding their perceptions and experiences will allow us to help prepare teachers who can more successfully support Somali students in science. Therefore CRP, along with funds of knowledge and other socio-constructivist theories, serve as useful constructs in helping us understand Somali adults' perceptions of science from multiple vantage points---including political and personal perspectives. These frameworks will be used again in Chapter 6 as the data from this study are analyzed and discussed in the context of making science teaching and learning more accessible and engaging to Somali students and their families.

Chapter 4: Research Methodology

Overview

In this in-depth interview study I explored the views and perceptions of Somali elders towards school science. The study investigated the following questions: 1) *What are the perceptions of Somali elders about school science?* 2) *How do Somali elders believe science teaching and learning can facilitate Somali students' engagement in science?* The study took place in a variety of venues in order to interview the adult participants at their convenience; all interviewees were parents who were (or had been) actively involved in their children's education in some way, most commonly by working or volunteering in their children's schools or in other community organizations that focused on youth and/or education.

This chapter begins with a description of the research methodology that was used to answer these questions. I describe qualitative research as an appropriate tool to explore questions about Somali elders and their perceptions of school science. First I describe its guiding principles and research practices, and then describe how these were employed in this study. Next I present general methodological information about this study including a brief description of the setting, and how participants were selected and introduced to the study. The final section details the methods of generating and analyzing qualitative data, and the criteria for establishing validity and trustworthiness.

Guiding Principles and Practices

In-depth interviewing represents one method of collecting data when using a qualitative methodology. As such it often employs methods that get at the very heart of

what a qualitative study is designed to do. According to Creswell (1998), qualitative research is an inquiry process of understanding that is based on distinct methodological traditions of inquiry that explore a social or human problem. The researcher builds a complex, holistic picture, analyzes words, reports detailed views of informants, and conducts the study in a natural setting (p. 15). Again, according to Creswell, qualitative research questions often start with a *how* or *what* (as opposed to *why*) and are chosen because a topic needs to be *explored* with the hope of presenting a *detailed view* of the topic. Individuals who are included in the study are often in their *natural setting* (p. 17). Likewise, according to Stake (2000), qualitative studies are defined by being holistic, empirical, interpretive, and empathetic (pp. 47-48).

The philosophical assumptions that underpin qualitative studies are summarized by Guba and Lincoln (1988) and cited by Creswell (1998, p. 75). In essence, qualitative studies are guided by the following assumptions:

1) Reality is subjective and multiple, as seen by the participants in the study;
2) Researchers attempt to lessen the distance between themselves and those being researched;
3) Researchers acknowledge that research is value laden and that biases are present;
4) Researchers write in a literary, informal style using the personal voice and use qualitative terms and limited definitions; and
5) Researchers use inductive logic, study the topic within its context, and use an emerging design.

These assumptions often result in the following practices in qualitative research (Creswell, 1998, p. 75):

1) Researchers use quotes and themes in words of participants and provide evidence of different perspectives;
2) Researchers collaborate, spend time in the field with participants, and become "insiders";
3) Researchers openly discuss values that shape the narratives and include their own interpretations in conjunction with the interpretations of the participants;
4) Researchers use an engaging style of narrative, may use first-person pronouns, and employ the language of qualitative research; and

Researchers work with particulars (details) before generalizations, describe in detail the context of the study, and continually revise the questions from experiences in the field.

Interviewing

In this study, interviewing was chosen as a means to collect data from the individual participants. As noted by Patton (2002), qualitative interviewing allows the researcher to understand the participants' perspectives, and assumes that these perspectives are meaningful, knowable, and can be made explicit (p. 341). Moreover, interviews allow opportunities for the researcher to personalize the conversation with extensive follow-up probes. In this study, the focus was defined as "Somali elders"[19], all of whom were also parents of students who attended U.S. schools. The elders were both male and female, both young and old. All were Somali-American immigrants with

[19] In this study, the term elders implies individuals who are respected in the local community for a variety of reasons.

experience in both East African and U.S. school systems and practicing Muslims. Although all of these parents had children in schools in a large metropolitan area, their choices of schools varied. Some had children in private Islamic schools, some had children in regular district schools, some had children in alternative or specialty schools, and some had children in public charter schools, for example. A significant number of these parents had children in more than one school setting for a variety of reasons.

General Methodological Concerns

Brief overview of research context.

This interview study was conducted in a large metropolitan area, home to one of the largest Somali-American immigrant populations in the U.S. Given its history of school choice, the area offered a variety of schools to students and their families. Elders who were interviewed in this study had children in a variety of educational contexts including regular (public) district schools, public charter schools, public and private alternative or specialty schools, and private Islamic schools. Notably, all participants had also sent their children to private Islamic religious schools as well, often called “Dugsi”. All interviews were conducted in places convenient to the participants, most often in or near their workplaces or homes or in local coffee shops. Since the focus of this study was school science education, the majority of the participants had children who had attended K-12 schools fairly recently or who were just about to enter the K-12 system.

The process of entering.

Although the process of entering is often used in an ethnographic context, entering an interview study can have parallel processes. In this situation, I had been a

middle and high school science teacher for several years before starting this study. My last eight years had been with schools that primarily serve East African students, including a public charter school and a private school run by a non-profit organization. My access to Somali-American elders was facilitated by student and family connections that I had made over the years. Finding willing adult participants through word-of-mouth with the Somali-American community was in large part enabled by trusted relationships that had developed over these years and Somali adults who were willing to suggest potential participants from their local communities.

Selecting study participants: Purposeful sampling.

I chose the participants of the study based on my prior experience with Somali-American students and parents. Specifically, I was looking for participants who could provide detailed and rich information on his or her perspectives on school science education. Seven elders were purposefully invited to participate with consideration given to 1) expressed interest in their students' education (most of the parents interviewed had spent time in their children's respective schools); 2) knowledge of educational systems both in East Africa and in the U.S.; and 3) connections to science and/or religious education either informally or formally. For example, two of the participants had been educated in Somalia and Kenya before initiating their undergraduate degrees in science areas in the U.S. Other participants had been educated in Somalia and/or Kenya, and then had gone on to raise children in several countries, including most recently the U.S. All of the participants were multilingual, and had lived in at least two other countries before immigrating to the U.S. as refugees.

Using what Patton calls “snowball or chain sampling” (2002, pp. 237-238), I initially started with a Somali-American elder whom I viewed as a cultural broker; in other words, a parent and educational leader who was able to speak to issues in science education in this country as well as to issues in Kenya and Somalia. The advice of this person was sought in order to find other participants who represented a range of educational and life experiences and who could thoughtfully reflect on his or her children’s experiences in science education. In other words, the researcher, myself, was purposefully selecting those participants from whom I could learn the most from, and those that could provide the most illumination of the questions under study. Although the educational backgrounds and life experiences of the subsequent participants varied, they all could articulate their individual perspectives on the school science experiences of their children.

It is important to note that this intentional diversity of participants was used in order to gain a more complex picture of the views of Somali American parents and science education. This design was not so much for comparison or for generalization, but for representing a complex picture of parents and students with complex life stories and school experiences. Table 4.1 lists the individuals who were invited to participate in the study.

Table 4.1

Invited Case Study Participants

Name	Age	Gender	Education	Location	Children
Ali*	40+	Male	Post-Secondary	Somalia, Kenya, U.S.	7
Ayan*	50+	Female	Primary	Somalia	9
Fati*	40+	Female	Secondary	Kenya, U.S.	5
Hassan*	30+	Male	Post-Secondary	Somalia, Kenya, U.S.	4
Anisa*	20+	Female	Post-Secondary	Egypt, U.S.	1
Khalid**	20+	Male	Post-Secondary	Kenya, U.S.	?
Mohamed**	50+	Male	Primary	Somalia	Many

*Note: *Included in data analysis and discussion; **Did not participate in interview #2 (see discussion).*

Role of the researcher as an instrument.

The role of the researcher in this study emphasized that of being a gatherer of observations and information, and an interpreter of that information as discussed by Stake (2000). It is the researcher's role to carefully describe the study elements, to provide thick descriptions and to provide interpretations for the readers so that they can construct their own understandings of the study. I am currently a graduate student in Curriculum and Instruction at a major University, as well as an experienced K-12 science educator who had worked with East African students in the recent past. Although I am not Somali, nor practice Islam, these experiences hopefully enabled me to capture the intent and meaning of the interviews more effectively since I was familiar with the Somali culture both as an educator and as a researcher. Prior research work included a year-long study with Somali students and their views on nature of science as well as many smaller contributions to the

formulating, drafting, data analysis and editing of related work of colleagues. In addition, I had given several presentations at local and national science education conferences and served as a strand reviewer for conference proposals for several years for the National Association for Research in Science Teaching (NARST).

Reflexivity and the researcher.

Reflexivity refers to the researcher's ability to think critically about the way that his or her values, experiences, and beliefs have shaped the research in its planning, implementation and analysis. Because of my previous experience teaching Somali students, it was important for me to consistently reflect on how my prior experiences might influence this work. For example, because I had already been teaching Somali students for some years before this study, I had already formed my own ideas about pedagogical challenges that involved new vocabulary and scientific concepts. In some senses, as an educator, I was an insider. On the other hand, even with years of experience with Somali students and parents, I had no first-hand experience with their educational experiences prior to immigration, nor with their languages, religious practices and home traditions. In this sense I remained an outsider.

Another important component of being an insider to a culture (or to a group that was not mine) was tied to the ethical and moral obligations to describe and understand the Somali culture in a way that the Somalis would understand and experience it. Yet, at the same time, as an outsider, I was also obliged to provide new ways to understand the Somali culture and its practices in the context of research. For example, since there was a heightened scrutiny around Muslims in the geographic area of the study, and more

specifically to Somalis, I was very careful not to stereotype adults' perceptions of science within the contexts of the Somali and Islamic faith. I understood that Somalis did believe in the value of science and science professions for their children and the growth of their own community. However I also understood that Islam was an all encompassing everyday practice, rather than just Friday obligation. Therefore, the potential contradictions seen in the analysis between Somali adults' perceptions of science and Islam were likely no different than what one sees between any other religious faith and science. On the other hand, I also noticed that two of the Somali adults were very keen on making science an empowering experience for girls and women. Therefore the analysis of the data, along with my experiences with Somali adults, led me to perhaps unique perceptions and understandings of the complex relationships between science and faith for Somalis.

Similarly, collecting data through interviews required me to respect what the Somali adults were willing to talk about, including what was important to them about science. Moreover, I needed to understand who they were (as they explained it), and how they wanted their Somali views understood by me (as well as by those whom they potentially would never meet). I was very cognizant of my dual position as both a science teacher of Somali students and also as a researcher from the University. Therefore, I allowed the participants to meet for interviews wherever they felt comfortable. In one case, one of the participants discontinued from the study as he didn't feel comfortable talking to me about science.

Methods of Generating Data: Interviews and Considerations

Interview format.[20]

The interviews followed a semi-structured interview format with questions following a guide that was prepared ahead of time by the interviewer. I chose this format because I wanted to be able to compare responses between individuals and I also wanted to allow some freedom in the conversation for thoughtful probes and follow-up questions. Based on my experience with cross-cultural work as a classroom teacher, I wanted to allow for flexibility in the discussion so that the participants could speak their own truths in their own ways. All but one participant was interviewed a minimum of two times with the first interview lasting an hour to an hour and a half, and the second interview lasting approximately one half hour to an hour[21]. For two of the participants, I was able to have several lengthy conversations following these interviews to follow-up on specific areas of discussion. All interviews were fully transcribed word-for-word. For all participants, I followed up with a summary of main ideas either in person or through email. See Appendix C for a list of interview dates and notes.

Interview questions.

The interview questions were developed to provide meaningful answers to the research questions: 1) *What are the perceptions of Somali elders about school science?and* 2) *How do Somali elders believe science teaching and learning can facilitate*

---

[20] The researcher also attempted to arrange focus groups with a Somali facilitator on two occasions. Both of those attempts were unsuccessful in attracting participants.

[21] Two individuals chose to withdraw from the study either during or after their first interviews. One was uncomfortable with the process of recording his answers (either through the use of a digital recorder or by hand) and the other, an Imam, said he was uncomfortable talking about science since he did not have enough experience with science.

Somali students' engagement in science? The questions themselves were developed by myself based on my previous experience with Somali students and families. Given that the Somali culture frequently uses oral traditions (as opposed to written traditions) the questions were designed to facilitate a flow of conversation, starting with background and demographic questions, and then proceeding to questions about school choices, and perceptions and connections between Somali culture and school science. Due to the flow of conversation, all interviews did not get to all of the questions. See Tables 4.2 and 4.3 for a list of typical interview questions and their relationships to the study questions.

All interviews were digitally recorded with the exception of two participants who were uncomfortable with the recording process. In those cases, I made extensive written notes throughout the interview process. All interviews were conducted in English; one interviewee requested a translator who was agreed upon by the participant ahead of time.

Table 4.2
Study Questions and Implications vs. Interview Questions

Research Question	Interview Questions
What are the perceptions of Somali elders about school science in the U.S.?	2; 3; 4; 7
How do Somali elders believe science teaching and learning can facilitate Somali students' engagement in science?	5; 6; 8; 9; 10; 13
What are the implications for science teachers of Somali American students?	6; 11; 12

Table 4.3
Guiding Interview Questions

Interview Question
1. Tell me a little bit about yourself and your family: Which country you were born in and raised, for example, and where you have gone to school?
2. Tell me a bit about your school science experiences. What types of subjects did you take in school and how were they taught? (or, can you describe any science experiences you have had outside of a school setting?)
3. Tell me the story of how your family came to choose a school…(prompt: how did you choose a school for your children? Do you expect children's science education to be any different in this school compared to other schools you could have chosen?)
4. How do you see the science classes Somali students take here being different from the science classes you had in Somalia/Kenya?
5. Thinking about the Somali culture…can you tell me about traditions and stories that you think might be useful in Somali children's science classes?
6. Thinking about Somali culture…is there anything in science that might be difficult for Somali students to understand, or to agree with? How might we make these things easier for Somali students to understand, from your perspective?
7. How do you see learning science in school helping Somali students in the future? (prompts: in their future education, in their jobs, in solving problems that confront the Somali community, both here and in Somalia?)
8. When you think about the country of Somalia, what are the issues that good science learning can help solve?
9. Are there cultural traditions that you are aware of that we could bring into the science classroom to help students learn science from a Somali perspective? Please elaborate.
10. How could a school help Somali children pursue science and also help them preserve their Somali values and beliefs?
11. What would be most helpful for science teachers (to know) to increase learning for Somali students in science classes?
12. What are some issues (complaints) your children talk about at home about learning science? Could you describe an incident or two related to them?
13. What are some examples that show how Somali people traditionally located water resources, preserved water and food, and raised animals? Who participates in these activities and who makes the decisions around them?

Interviewing across cultures.

As noted by Patton (2002), cross-cultural inquiries add layers of complexity to the already-complex interactions of an interview (p. 391). In my experience, these layers of complexity usually involve language (words), differing cultural traditions (gender-related norms, for example) and/or styles of communication. For example, I chose interviewing as my primary data collection method for this study. Previous work with Somali students (Albrecht et al., 2012) had indicated that using an oral tradition was much more likely to be effective in generating useable data than a written format such as a survey or questionnaire. At the same time, I took particular care with language issues in order to ascertain that my interpretation of what was being said was consistent with what the interviewee meant. To do this, I took the time to rephrase responses and to double-check my understanding of participant words before proceeding to subsequent questions. In addition, phrases and concepts that were confusing to me were asked to other participants so check for correct interpretation and understanding prior to the data analysis. This type of cross-cultural work took a great deal of thought and time along the way as I wanted to honor both the intent and the literal meaning of what was being said in the interviews.

Given that the Somali participants were also refugees to this country, I was also aware that potential participants might be wary of the motives behind this study and the fact that the researcher (I) was a non-Muslim white female. Because I had worked with Somali students and families for several years previous to this study, this understandable distrust was likely minimized for those who agreed to participate in the study. I was also well aware that my status as a highly educated white female might influence which

questions the participants were comfortable addressing and their answers to those discussed. Therefore, with the interviews with the adult females, only I was present with the hopes of getting more candid observations relating to gender-related issues in science education including health and reproductive issues. I was also aware that male participants might be uncomfortable meeting in public places with a white female so I always gave them choices about where and when to meet for the interviews.

Data Generation: Journal Entries and Other

Reflexive journal entries.

Throughout the data collection phase of this study, I wrote post-interview reflexive notes in a digital format. The purpose of these notes was three-fold: 1) I wanted to capture my description of the interview process in as much detail as possible; 2) I wanted to document my own thoughts and reflections on the interview processes and my reactions to those processes; and 3) I wanted to make additional notes that could be later used in the data analysis and writing process. These notes were helpful later as I wrote the initial description of each participant. They were also helpful as I contemplated my own biases as I examined and interpreted the data. For example, it was occasionally difficult for me to listen to males describing the roles of women in Somali communities given that my life experiences as a white female single parent and as a teacher of Somali children was so different. I had to weigh my own biases as I interpreted the meanings and value of their contributions to this study. Likewise, it was very difficult for me to not engage in conversation with the male participants about effectiveness of classroom

science teaching (by Somali teachers as well as by non-Somali teachers) when my own experiences would lead me to a different assessment of effectiveness.

Given that this study employed an iterative process, these post-interview entries also allowed me to make initial notes to myself about possible refinements of interview questions including better worded probes. They also helped me identify possible emerging themes to explore with future participants or in the data analysis that took place later.

Other data.

As part of the interview process, a couple of the participants offered additional data sources. For example, I included in this study a summary of additional notes on Dugsi and East African education (See Appendix A). Also, at Ali's recommendation, I visited a Somali Heritage Museum to make a list of potential funds of knowledge that could be used in the science classroom (see Appendix B).

Methods of Data Analysis

Ongoing analysis.

As noted earlier, this study employed an iterative process both in data collection and data analysis. Given my intent to provide a thick description of a complex of stories, the questions themselves were often refined as an interview progressed to get at the specific knowledge and experiences of the individual participants, and the data analysis was ongoing in the sense that I was carefully looking at emergent themes after each interview. In other words, as I learned more and more about how Somali elders talked about their perceptions of science education in this country, I was able to ask more

pointed questions related to emerging patterns and themes. In other words I learned, as stated by Patton (p.380), that the wording of questions affects the nature and quality of the responses received.

Initial structured review of data.

Following the collection of the data (in most cases, the first interview) I followed the example given by Patton (2002, p. 438) wherein he suggests that the initial look at the data should be focused on the individual cases. This allowed me to look deeply at each participant's contributions to the study relative to the questions asked. It also allowed me to identify potential themes per person before I did a cross-case analysis ---hence ensuring that unique individual ideas could be noted and not lost in the second process. To do this, I first read through the full transcript of an individual interview. Then, I made a written list of the salient topics/responses from the interview and then tried to group them into potential themes. Additional notes about further case exploration were made for each interview and included thoughts about shaping the story of each individual, potential chapter themes, and areas to explore in future interviews. These notes were done before I initiated a software-assisted cross-case analysis and were kept for future reference. In essence, this analysis by hand loosely followed the process of open coding as described by several authors including Strauss and Corbin (2015). Table 4.4 illustrates the initial within-case analysis for Ali's first interview.

Table 4.4
Themes from Notes: Initial Analysis: Ali #1

Possible Themes	Salient Notes from Interview
Refugee/Science Education	War refugee Science education in East Africa & Education as an adult in U.S.
Raising Children/Immigrant Identity	Children born in U.S. Somali children: independence is not valued, sheltered; learn Somali beliefs and religious teachings Somali students here: mixed culture; mid-point; in-between Somali culture and U.S. culture
Perceptions of Science	Science: Valued Assumed part of Somali culture Limited view, understanding Limited experience with Careers valued Conflicts with Islam Evolution = joke Science/religion, why/how
Pedagogical Changes/Challenges	Instruction/Pedagogy Constructivism not understood by parents, experienced with direct instruction/teachers give knowledge Memorization valued (in Arabic)
Classroom Science/Home Connections	Science/Home connections Need to set parent expectations; parent education Science at home not understood, could be taught, examples

Organizing and coding the data: NVivo.

Once most of the interviews were completed, I started to use NVivo software to analyze and code each participant's responses. I employed the node/theme function of the software to identify and note potential patterns and themes across participants. In addition, I used the word frequency and word tree queries to look for words and/or related concepts that were frequently used by the participants. For each participant, I completed an individual analysis to look for a list of potential patterns and themes. In Chapter 5, each participant is presented and includes an introduction to the elder's story and short discussion (by me) of noteworthy responses and observations based on that specific analysis.

Following this process, I used NVivo software to complete a cross-participant analysis. As with the individual analyses, I used the node/theme function of the software to identify and label potential patterns and themes. Themes identified included: 1) science education/what is science for; 2) hope and dreams (related to hopes for children/students in science); 3) home/school connections and relevance of science; 4) pedagogy; 5) science/religion struggles; 6) student identity struggles; and 7) memorable quotes. After another thorough look at the individual interview transcripts for more subtle patterns, these initial themes were collapsed for the final discussion and analysis.

Validity, Credibility and Trustworthiness

Although there are many different rubrics for establishing the validity of qualitative research results, I used those proposed by Creswell (1998; Creswell & Miller, 2000). Creswell suggests eight different categories of research procedures to establish the

credibility and trustworthiness of one's findings. These include: 1) prolonged engagement and observation in the field; 2) triangulation; 3) peer review or debriefing; 4) negative case analysis; 5) clarifying researcher bias; 6) member checks; 7) thick, rich descriptions; and 8) external audits (Creswell, 1998, pp. 201-201; Corbin & Strauss, 2015). In this study I have addressed prolonged engagement and observation in the field; triangulation; peer review; thick, rich descriptions (as described earlier); and member checks.

Prolonged engagement.

In this case, I had eight years of experience working with Somali students and adults in science education. My work with Somali families over the years enabled me to establish collegial relationships with many Somali adults who were happy to share insights, stories and laughter. It is likely that this study would not have been able to succeed without these long-term relationships and shared experiences in education. In addition, the interviews took place over a period of two years which allowed me time to reflect upon the initial responses and refine questions for the second round of interviews.

Triangulation and peer review.

In order to establish triangulation, I asked two additional people to review the first and last chapters of this thesis. The first person was a teacher colleague who had spent seven years teaching Somali students in social studies and other areas. In addition, she had recently completed a master's thesis that focused on the identity issues that confront Somali-American adolescents who attend U.S. public schools. The second person was a professor of education in a nearby state who was of Somali descent. The former provided

extensive comments and suggestions as the study progressed, as well as in the review of the final draft. The latter provided general observations and suggestions as the study progressed. Another aspect of triangulation that was used in this study was time triangulation. For example, I compared participant responses over time (both within individual participants and between participants) in order to ascertain whether responses varied or added new information to the earlier one.

Member checks.

Due to the complexity of working across cultures, I chose to use member checks both in the data collection process and after the data analysis process. For example, when interviewing the participants, I frequently asked for clarifications and examples so that I could have more confidence in the accuracy of my understandings of the participants' answers. This allowed me to focus my follow-up questions and probes more strategically. Likewise, after the data analysis was completed, I provided all participants with a summary of their interviews in order to ascertain that my conclusions were an accurate representation of what they had stated in the interviews. These member checks were done in person for those participants who were available, and via email or phone for those participants who chose to converse in other ways for logistical reasons. These conversations varied from two hours in the case of one participant, to no response in the case of two of the participants.

A Note on Transferability

Transferability refers to "the extent to which findings can be applied in other contexts or with other respondents" (Erlandson et al., 1993, p. 31). In contrast to

generalizability (which was not a goal of this study), transferability depends on thick descriptions such that the readers can make their own determinations about whether the study findings might apply to similar contexts. Towards this end, this study focused on fewer participants and thick descriptions of them and their responses. Moreover, I selected a variety of participants in terms of age, gender, and educational experiences with the hope that the complexity of the issues for Somali students and their parents could be presented. As stated in chapter two, the Somali culture is often thought of as one of the most homogeneous cultures in Africa. Having said this, it is also true that Somali-American immigrants, as part of the global diaspora, are developing new ways of living in their respective host countries, and hence do not always exhibit the same opinions on anything.

Constraints on Study's Claims

Given the focus on Somali elders now residing in one metropolitan area in the United States, this study is not able to compare findings across geographic areas or other contexts. Also given that it took place within a two-year framework, it cannot address changes in those elders' views over longer periods of time or geography. This is especially pertinent since most of the elders interviewed had lived in several countries in their lives, including several states in the United States with different school systems. And, although most of the elders interviewed had children of their own, many of whom who were no longer in K-12 science classrooms, their reflections on science classrooms were specific to their own contexts which ranged from public (district) schools to (public) charter schools to private Islamic schools.

Other considerations included the nature of the interviewing process. For instance, since the primary data were the results of semi-structured interviews that evolved into conversations, not all interviewees were able to respond to all questions planned or asked. Moreover, since all of the interviewees were adults, most of whom had completed their K-12 schooling in East Africa, these data do not represent the views of immigrant Somali students, but of their parents and other adults in their respective communities. Having said this, the adults could speak of the comparisons between their own educational experiences in Africa, and those that they see the younger generation experiencing now in their current schools. Given their vicarious experiences, I believe the parents and elders were very familiar with the local educational systems and how their children experienced school science in those schools. Furthermore, because Somali parents and adults typically exercise a tremendous amount of influence over their children (in the areas of the practice of their Islamic faith, their languages, and social and cultural practices), I believe the adult perspectives are important in terms of shaping how science should be taught in classrooms with Somali students. These conversations most often did not rely upon the interviewee's knowledge of pedagogy from a professional perspective (direct vs. student-centered instruction; constructivism vs. didactic teaching), but did allow the interviewer to infer these differences by further questioning with examples.

Chapter 5: Interview Results

Chapter 5 is divided into two sections: Section A: Elder's Stories & Context and Section B: Cross-Participant Analysis. This two-tiered analysis, along with the themes that I was able to generate, provided both a rich and an in-depth context of the individual participants through their life stories and facilitated the generation of cross-participant themes that were more nuanced and richer in meaning. Without knowing the stories of each of the refugee immigrants who participated in this study, the readers would miss important connections between who these individuals were and how they perceived science and science teaching and learning. I, therefore, start this section with each of the participants' stories.

Section A: Elders' Stories & Context

Overview

In this section, I present the stories of five of the elders, who were also parents, from the local Somali community. The chapter opens with Ali's story, continues with the stories of Hassan and Fati, and concludes with the stories of Anisa and Ayan. These stories were chosen because they provide a rich and varied sense of how Somali parents and elders viewed science and science education in their children's classrooms. The stories show how their shared and individual cultural traditions, languages, religious beliefs, and personal life journeys influenced their thinking about science and science education for Somalis. These short life narratives also help set the stage for understanding what the participants believed about science and science teaching and learning. They also shared their reflections on the Somali community and Somali students' desire to engage with science in ways that their community valued and supported. They tell the stories of

their own experiences in science education throughout their lives. Moreover, each of these stories highlights different types of border crossings (geographic, political, cultural, social, linguistic, religious and economic) that these individuals spoke of as they talked about their children's experiences in science.

In order to honor the conversations as they occurred, the structure of this section is by participant and in chronological order in terms of the topics addressed during the interviews. The range of topics included what aspects of their life stories the participants wanted to highlight and share with me as important in shaping who they were; what they valued about science; how they saw science within their life trajectories; how Islam played an important role in learning and doing science; and how they saw science and science learning influence their own lives and their children's lives. Hence the themes identified in the stories, through data analysis, are not always in the same order, or shared by all participants. Furthermore, the difference in themes represented the uniqueness of each of the life stories, allowing a true representation of a participant's life story and his/her voice with minimal researcher voice.

Ali: "Put your books on the shelves. The war has started."

> I had just gotten to school that day. It was the first day of my last year as a high school student in my school in Mogadishu. When we arrived, our teacher pulled us together and said, "Put your books on the shelves. The war has started. Go home and flee with your families."

And so the war commenced in 1991 for Ali and his family, and for all who called Mogadishu, the capital of Somalia, home. The eruption of the civil war was preceded by years of strife as Mohamed Barre, after staging a coup d'état in 1969, tightened his control on Somalia and competing clans vied for power. And as his teacher

recommended, Ali did indeed go home and flee Somalia with his family members, resulting in a complete disruption in his life, including his education. Following several years in Kenya as a war refugee, Ali eventually immigrated to the U.S. and finished high school through the GED process.

At the time of this interview, Ali had several years of experience working in a variety of roles in educational contexts. Through his Somali connections he was able to gain employment as an educational aide, a tutor, and then later as a school behavioral specialist. His work had led him to several states. Eventually he decided to go back to school and work on a science education degree. When we first talked he was just completing his first year as a director of a private non-profit that provided educational services to Somali youth. He was married with seven young children, the oldest being in middle school.

Cultural broker: Education for Somali youth in a new land

The quote at the beginning of Ali's story alludes to the value of education in his life and the resulting challenges. Unlike many Somali families in Mogadishu at the time, Ali's family members chose to stay in the city for as long as possible with the hopes of completing their education. It was only until the schools closed that they chose to leave. Even after immigrating to the U.S., Ali continued with his high school studies independently, completed his GED, and started in a science education license program. In effect, through his own life and in his community, Ali was often viewed as a cultural leader and broker, one who could straddle two very different worlds successfully and assist others to do so as well. In his case, he was playing the role of a cultural broker

between his newly adopted U.S. educational system and the Somali students and families he served as a community member. Being the director of a U.S. educational agency, yet living as part of the Somali community, he lived in both worlds, especially as he was trying to build bridges between a traditional Somali community and local school districts.

As we started to talk in his office, he was sitting behind his formal director's desk. He immediately stopped all calls and focused all of his attention on the interview. As with many adult Somali males in this community, he was formally dressed in a suit coat with matching dress pants, dress shoes and a pressed shirt with no tie. As we got further into the first interview, he moved to a chair alongside me. He appeared to be composed, thoughtful, and clearly aware of the significance of the study for Somali students. Because he had not received the questions ahead of time, he took his time thinking and answering as we talked. Given Ali's interest and training in science education, he was able to talk about areas of teaching and learning such as constructivism and inquiry science. He was also able to talk about science from a cultural perspective; it appeared as if his knowledge of science content allowed him to evaluate science teaching and learning in schools by his own cultural standards and expectations.

Identity Issues: Challenge of mixed cultural space

> I can share perspectives, but give no answers. One thing that is important to clarify is that students here do not ascribe to the Somali culture. They are midpoint, in-between. The difficulty really is that students are not really Somali, they are somewhere in-between American and Somali in terms of culture, mixed...

As we started, Ali wanted to talk about Somali children and parents in general. He noted that when raising Somali children, independence is not highly valued; Somali

parents do not provide choices for their children in most areas of their lives. He added, "every little thing is done for them while at home". He summarized by saying that it's mostly a very sheltered childhood and that in respect, this may be having a negative impact on Somali children. For example, children may behave well at home, but once not under the supervision of their parents (or other adults) they "do a lot of weird things". For Somali children, "if you're not rigid they don't take you seriously". He then moved on to talk about his observations that Somali students appear to be in-between cultures. For example, many youth show mixed cultural references such as praying five times a day but also listening to rock-and-roll and wearing baggy pants. This kind of mixed cultural accommodation appeared to be perplexing to Ali.

Value of Science

> Then to science---the community assumes this is part of Somali culture-- will be very limited for now---science equals a big concept that the majority of the community have little understanding of, a limited view of what this big concept is…

Transitioning to science, Ali described an example of how he thought that although the Somali community highly valued science, members have very little knowledge of current science concepts. His emphasis on "science equals a big concept" perhaps indicated that Somali adults did not find science particularly accessible as these concepts were generally in an abstract or complex form that they found less useful to their immediate lives. Furthermore, this abstractness also caused science knowledge to be less accessible useful in everyday chores to common Somali people.

> So for example, I had this friend from 5th grade, and I showed him that the Earth is really a sphere in space by showing him a picture---he couldn't figure out how the picture was taken---so somehow I'm trying to explain to him the simplest

> concept of science (that the Earth is a sphere in space)…I couldn't believe it! If my friend can't understand this, how much I am distant from the rest of the community … who have limited to none experience with science concepts.

The fact that Ali's friend questioned the authenticity of the picture and that the Earth is a sphere based on that picture, illustrated that there was much work to be done to generate acceptability of science knowledge in Somali communities. He further asserted that making science knowledge acceptable to Somali adults needed a massive amount of work.

When asked about science education in the Somali community, Ali noted that although science education was highly valued and respected, he believed that there was very little depth of understanding of common science concepts and vocabulary in most Somali families. Yet, parents urged their children to study science in order for them to become doctors and engineers, which were traditionally viewed as the most highly respected careers.

Some Controversial Areas in Science Education

> Controversial areas...these are a no go with the culture; the text in the Qur'an says man was created freely by God and that is the belief of every Muslim. When talking about apes and species for science---these elements of science are just like a joke to us, joking...a lot of people feel it's an insult to humanity and the greatness of Allah.

As we moved on to talk about problematic areas in science for Somali students, Ali provided this sophisticated view of the relationship between science and his religion, alluding to both the difficulties in reconciling them for practicing Muslims, and to his personal journey in finding ways to incorporate both of them in his life. As he went on to describe this personal journey, he stated that he did not view evolution as being very convincing, and that it was a dilemma for him.

> For me, since I studied science, it was a struggle---science and religion do not need to be in concert with each other; these are 2 ways of understanding how the world works; one answers why and the other answers how. It's (evolution) is not convincing, it's a dilemma really. In Galapagos islands with the finches there were similarities and differences—it is very difficult to explain any other way. This (dilemma) is not necessarily specific to Islam---all religions, all monotheistic religions have the same (under) standings…

Pedagogy and Home Connections to the Science Classroom

As we switched to talk about pedagogy in U.S. science classrooms, Ali noted that most Somali parents were experienced with direct instruction; in other words, they expect their children to be quiet in the classroom, and the teachers teaching directly ("giving knowledge") with the students listening and learning from them ("getting knowledge"). He stated that, "constructivism doesn't go a long way with Somali culture back home."

According to Ali, teaching and learning in Somalia was mostly memorizing, and memorizing in the Arabic language.

> For example, I memorized the physics theories all in Arabic (recited Newton's 3rd law in Arabic). When I asked my daughter if I could help her in science, I saw she was learning the same thing, but I could only respond in Arabic, that was all I could remember.

He noted that this change in pedagogy has been difficult for him as a parent in U.S. schools.

When asked if he thought Somali parents would be receptive to learning how to connect classroom science to their home experiences in the U.S., he was very optimistic, and thought we needed to work with parent expectations as well as with the science content we wanted the students to learn.

> How to work with parent expectations---setting (in US schools) is a bit different; need education for parents (like how we tell them how they might help their students with homework). We could tell them how science concepts can be taught at home---choose a topic for parent-teacher conferences…We can teach parents how learning can happen in the classroom and at home, mom using salt and water for cooking for example, is using science at home.

He thought the potential for learning through hands-on activities to be very high since he perceived Somali students to be naturally very curious. Inquiry, as a method of teaching and learning, was mentioned as a possible avenue to engage Somali youth in science. From Ali's point of view, Somali youth were not necessarily disinterested in learning science but perhaps had fewer opportunities to experience science directly linked to home settings. He explained this mismatch by reiterating his belief that Somali adults' thought "science is abstract", thus, difficult to understand. According to Ali:

> I see most of the time a lot of them are very curious and like to know more...that is evident when they are younger, I don't know where that goes when they are older, but more hands-on...I think that is used mostly, because the concept of science mostly is alien really to most Somali families. When you say science they think something that is very abstract, something that is very...um...it is nothing tangible. But the reality is that science is something they do everyday, in the main culture everyday. So bringing that also kind of meaning of science forward and trying to make it relevant, that it's not rocket science or...be able to say that science is something that is used every day...

In our second interview, Ali was asked to talk about specific concepts or activities that science teachers could use to incorporate students' home experiences in the science curriculum or connect school science to their everyday lives, making it less abstract for them and their parents. His answers first focused on cooking, and then switched to the medical and public health issues that he thought were relevant to the Somali community in this geographic area.

> We should be able to say that science is something that they use every day, every household, whether it's cooking, like when you are cooking you measure different ingredients…you are doing science. Every Somali family makes juice where there is a powder that they buy and water and some sugar…so you are measuring how much water you may need or … what amount of juice in the powder...

Medical issues he raised ranged from diet, to autism, to HIV, to exercise. Many of these issues appeared to be related to changes in diets and routines due to immigration to a country with a very different climate and very different availability of food resources. He noted that as immigrant families adapt their cooking to their new environments, they may not understand the health implications related to their choices.

> One is the diet, the dish that Somali families used to have back home… how that is different than you know from this weather and this climate, this is a new kind of environment. For example, you know, most of the food is kind of oily, a lot of oil, and sugar was not an issue (back home) because people used to walk a lot, and they ate lots of sugar, so consuming sugar was not really a problem, but now there's less movement, there's less exercise. In Somali tea, for example, there's a lot of sweet and sugar in it. So they used sugar and oil; vegetables and fruits were not really part of course in some areas; a general statement is that they weren't available as part of the daily diet.

When asked about diabetes in the community, Ali noted that it was a real concern, especially for older people and for women who stayed home with kids and exercised less here than they would have back in Somalia (as part of their daily routine). In Somalia walking was part of everyday life:

> Going from home to where you catch the bus, then coming back and going to a shop could be…maybe…one kilometer or more, and you walk there as part of the normal distance…so people normally walk there, they use the public transportation, really, having or owning a car was not really something that everybody has---it is something they dream of---but not for everyone---so everyone walks….

Although the concept of exercise (as in going to the gym, for example) was new to many Somali people, those who did want to exercise may not have felt comfortable doing exercise at an open gym or public area ---"they can't take their clothes off, it's kind of a mixed place, where everybody is there, it is part of the challenge and I don't know how this will impact the health of women if this continues." He went on to describe how his wife, who stayed home with the kids, went to the gym sporadically, and tried to find times when there were fewer people, but when she got there she could not use the swimming pool, and other things she wanted to try….he added that other women just stayed home and were not doing any sort of exercise. Another cultural connection to diet that Ali mentioned was fasting and Ramadan, suggesting that science educators could provide information on how to stay healthy during Ramadan. For example, when students fast from dawn until sunset, and then over-indulge with sugary and oily foods at the end of the day, they were probably at risk for many health issues including diabetes. He had recently found a pamphlet at a local community center that focused on how to stay healthy during Ramadan---and suggested that this type of education could be brought into the science classroom.

Social stigma of health issues

> One specific health issue in the family members that have siblings... is autism…in the past few years…they don't want to talk about it…so bringing forward this issue…the rate of autism in Somali kids is really, really high….also the statistics that came out last month, I think it was in April or May, there were the statistics on the numbers of people infected with HIV in Minnesota and there is a large number from the Somali community. Yes, I think they are the fourth highest compared to Ethiopians, and other countries from Africa…that is something that people don't really discuss…so this is something that we think is happening to everybody else, but also (is happening) to people you may know…that is really big issues now in the community.

As Ali mentioned autism, he noted the recent news about elevated rates of autism in the Somali community. He was also implicitly referring to the belief (in the Somali community and others) that autism was related to childhood vaccinations. As a community elder, I believe he was advocating for effective learning and teaching about these issues. Likewise, with HIV, although as he said these topics were not really discussed in the Somali community, he recognized the need for education about sexually transmitted diseases. Implicitly he was alluding to the social stigma that autism and HIV AIDS bring to the family and the community at large. He believed that making science education more accessible and more relevant to Somali life and habits could improve their engagement with science and make it more valuable to them.

Diminished Concern about Pollution and Sanitation

When asked about his impression on incorporating environmental issues (water and air quality) into the science classroom, Ali suggested that these were typically not a concern to Somali students because the sanitation here (in the U.S.) was quite high compared to that found in the areas of the world that most of the kids came from, especially those who lived in refugee camps in Kenya or Ethiopia. “So sanitation is not the first priority, if you can find anything good to drink, then you are good to go.”

Summary and Reflections

In terms of science education and science in general, Ali believed that science was highly valued in the Somali community, especially for future careers for the children. At the same time, he suggested that many Somali adults had limited understanding and experience with basic science concepts and did not necessarily connect classroom science

to their daily lives; science, to them, was "abstract", or intangible. Ali spoke eloquently about the perceived conflicts between science and Islam, and spoke of his personal journey in coming to an acceptance of the "dilemma" of being both a future science educator and a Muslim who could not accept evolution as currently taught. He recognized and spoke of the different missions of religion and science; one being to describe "why" and the other being to describe "how".

Given his observations that Somali children were naturally curious, Ali was a strong proponent of hands-on science activities, including inquiry science. Having said this, he was also concerned that Somali children were not raised to be independent by their parents, and that most Somali parents did not understand the switch in pedagogy between direct instruction and constructivism given that their own school experiences mostly followed the British or Italian models that were based on the former. Likewise, the parents' (and children's) schooling experiences were largely based on memorization in Arabic. By implication, the parents' school science experience may have provided them with limited means to assist their children in U.S. schools where memorization skills are not necessarily valued as highly as independent and/or critical thinking skills.

Although Ali saw many challenges with parent expectations and experiences with science education, he also saw many possibilities, including parent education and curricular adaptations. As he said, he thought there were many current health issues in the local Somali American community that could be addressed in science education including autism; diabetes; HIV prevention; and nutrition and exercise, especially during fasting periods such as Ramadan. All of these could be addressed in the context of

changing resources and traditions as a part of immigration to the United States. The contrasts in educational systems, climate, food resources, and belief systems were extreme and hence difficult for Somali parents to negotiate.

Ali spoke clearly of the pedagogical challenges both Somali parents and students face as they enter U.S. schools where student-centered teaching and learning were emphasized. As he said, "constructivism doesn't go a long way with Somali culture back home." In other words, the parents of current students did not have experience with constructivist learning practices in teaching and learning and were more appreciative of direct instruction models. This type of pedagogical mismatch could lead to a tension between parents and students, and between parents and teachers.

With regard to science content, Ali articulated many current health issues and applications that could be integrated into the science curriculum in K-12 schools here. His comments might support the rebuilding of the science curriculum in biology, for example, from the interests and needs of the students as opposed to content standards imposed from others, including the culture of power. His suggestions also supported exploring knowledge present in their families and communities in their daily lives at home that could add to the learning of science and could help teachers make science meaningful to Somali students.

Hassan: Between Two Countries and Identity Challenges

> I think that kids here, they are between two countries, they haven't adopted the American culture, and they are not raised to take the culture of the United States and they are not taking the culture of Somalia, so they have fragments of both cultures, and that may not make a good combination. The learning is not a good combination.

As I sat down to interview Hassan in his science classroom, I was impressed by his formality, sincerity and courteousness. It seemed to me that he embodied the values and experiences that I have often found in older Somali adults who adhere to a more traditional way of communicating with people like myself. In fact, when I originally asked him to be a participant in this study, he responded by bowing to me and saying that he would be "honored" to contribute to such a distinguished work. He was thoughtful and careful with his responses.

Hassan was born in Somalia where he started primary school. With the outbreak of the Civil War, he moved to Kenya where he lived and went to school for about 8-9 years before coming to the United States as a refugee. In the United States he finished high school, and then went to a public university where he graduated with a degree in biological sciences. He spent several years in adult and youth education, including K-12 schools and Dugsi; working in biological labs as a technician; and working in "assembly", as he said, "struggling" to find his way. The year I interviewed him he was subbing as a middle school science teacher at a private school in a large metropolitan area. His students were mostly of Somali descent although some had been born here after their parents had immigrated. Hassan was married with four small children.

School experiences in East Africa

We first started talking about his school experiences in Somalia and Kenya, and then moved to his reflections on how that compared to what he was seeing here in science education. In primary school he noted that the educational resources were non-existent both in Somalia and Kenya:

> They did not have a lot of things to show, like technology, so we just read books, and there were a lot of pictures in the books, and we tried to understand. We wanted more, we wanted to learn more…

However, as he entered (public) high school in Kenya, school resources were more plentiful with lots of labs and highly qualified teachers. In Kenya, for example, science teachers were considered experts in their respective fields, so physics teachers were specialized in physics, and biology teachers were specialized in that area; in other words, they had degrees in their specialized fields (as opposed to degrees in education). Because these countries used the colonial education system from the British, students were required to take end of year exams to pass on to the next grade level. He added that "you had to be good at math and science to go on to a good university" and it was well recognized that other fields did not necessarily lead to good jobs in Kenya. According to Hassan, this recognition of science still held true today with Somali families as he said "actually, the other subjects are not considered as good [for prestige and future financial security], so it would always be English, math, science, math and science….

Science education in the U.S: Islam and science

When I asked Hassan about how to motivate Somali students in science classrooms here, he explained that Islam actually encourages science,

> You know really, ah, I didn't know that Islam encouraged science, all the time, until when I came to the United States, you know, I had to learn that here in the United States, in my studies, before that I just used to hear, I didn't know how--how Islam is about science, until I read it, Islam encourages it, to really understand science.

At the same time, he noted that the lack of role models in science for Somali students was significant here, as well as the observation that Somali parents here might not be able to

connect the Qur'an with the science their children were learning in schools here. In other words, there were few people who knew both the Qur'an and modern science and could answer the questions the students raised in the science classroom as a result of their religious and cultural beliefs learned at home or at Dugsi:

> I think one factor that worries the students is when they look at their parents, who are not in science, most are like that, the career of your parents influences you, the career of your great great grandfathers may influence you, but most important is your parents, and so I am teaching here, and I am teaching in class, and I have students who ask me, is this a part of the Qur'an? and I say you're not going to find everything in the Qur'an, it doesn't include specifics like days of the year, it's a general guide, it's not going to answer all questions like how old is the Earth, but other than that I don't see a challenge in religion to science, so Islam encourages it, the history of Muslims in science..

He went on to describe what he viewed as an interesting lesson in a colleague's science classroom that he had observed recently:

> I was in another class here, with Ms. Anderson, and they were doing the history of engineers, learning the history, and one of them talked about…and Sears of Chicago, he designs buildings, he's Muslim, so they were talking about that, and then I said what happened then to the Muslims, they were good at science, what happened? Some said someone else can steal your ideas (white devil?), …

Hassan saw Muslims in fields of applied science as a symbol of acceptance of science by people of Islamic faith. He further talked about a Muslim architect's contribution in building the Sears Tower as a good example of how people from the Islamic faith pursued science and contributed in a productive way to build a landmark. By implication, without reconciliation between Islam and science in the mind of this architect, he would not have pursued a degree in architectural engineering.

Hassan extended his notion of the coexistence of Islam and science as a beneficial endeavor because Somali youths could become scientists and help Somalia in the future:

> … so I think also the fact that many of our communities are backward, there's a motivation for us to learn science, so that we can develop ourselves, like Somalia needs some more science, so that can be used as a way to motivate students, so you can complete something good, not only to the United States, your adopted country but also to your home country by becoming a scientist, it's a new thing, like becoming a pioneer,…

Staying on the thought of Islam and science, Hassan explained that seeking Muslim scientists and role models in Islamic texts and histories could aid young Somali Muslims in grasping the intimate relationships between their Islamic faith and science. He saw role models as being an essential part in showing that the Islamic faith and science have coexisted over millennia and there were no contradictions between these two sources of knowledge.

> … another thing maybe is to show Somali scientists, in the United States, who did a very good job, show them, we can invite them, to class, to talk about their history, and listen to their recommendations, I think. Well, it's not just in science that they are not interested, I think it's all the subjects, it's like if they are made to do it, they will do, and if not, they will not, they are not motivated to pursue more for their lives.

Identity issues for Somalis

When I asked him to explain this perceived lack of interest in science, and in school in general, Hassan contrasted his early educational experiences and motivation with those of the students he saw now:

> Really I don't know, I went to high school, I wanted to learn a lot, I had friends, who wanted to learn a lot, although we were in Somalia, outside of the United States, we wanted to learn. I think that kids here, they are between two countries, they haven't adopted the American culture, and they are not raised to take the culture of the United States and they are not taking the culture of Somalia, so they have fragments of both cultures, and that may not make a good combination. The learning is not a good combination.

Hassan understood that many Somali youths considered their temporary status in the U.S. as troubling as it created an in-between personal identity. The youths were pushed to learn Somali culture, language, religion, and many other practices (such as attending Dugsi) at home. Yet at school and outside of their homes the youths were required to follow and accept American culture, including food, language, and other practices. According to Hassan, in many instances this unsettling and temporary duality hindered learning, creating "fragmented" cultural allegiance.

Hassan went on to hypothesize that the process of immigration for Somalis to a new country was complicated, full of uncertainties, and evolving. Children's success and progress in a new country took precedence over religion as the sole vehicle for solving perceived and real problems:

> Before we were focusing on how to survive, to survive, it's too much to come from a country or society completely different from your community, so adapting to that has taken a long time, even we who understand who came to the United States, it takes a long time. There are things that you can't just read, you know, you have to live and we are the first focusing on how to survive, now I think we know how to survive, how to make things good, and we now can focus on the kids, we know what's wrong with our kids, you know there's a lot of focus on the religion, and the culture of the religion, but now we are changing our focus; also now in the community there are not a lot of specialists in science, like in medicine or engineering, they are not a lot…

His focus on the lack of Somali role models in science in K-12 school was also repeated in his experiences in postsecondary education in the U.S. where he noted that several factors appeared to contribute to the lack of Somali students and professionals in science in this country at this time. Most notably, Hassan believed that there was clear lack of positive relationships between professors and Somali students which resulted in Somali

students believing that they could not succeed in science. Consequently, they often feared science as a difficult subject that required a lot of effort but had very little potential for success for a Somali. He noted that when he was in school in the U.S. there was a clear lack of Somali peers in science subjects, both during his high school experiences and also during his college education. Hassan suggested that these factors contributed to his own thinking about going into science. He also believed that the lack of other Somalis in science created a dwindling desire of Somali students' to get into the science fields. As Hassan explained:

> There are a lot of Muslim scientists in the United States, but not a lot of Somalis, so other Muslims have an advantage. Another thing is that there are a lot of Somali students in college who do not major in science, one reason is that they were not properly prepared in science, likewise, I found that social studies teachers were more accommodating, you know, it was not easy to work in a lab in science because you did not know the teachers, so they choose to focus on other things, so there is no connection with the other professors, so I think this is just the lack of relationships between Somali students and science teachers, …

Similarly this kind of lack of relationship between professors and Somali peers carried over to his university education. Therefore the "set up" at the school level and also at the university level did not "inspire Somalis to be in science" which further influenced their future graduate studies and careers. As Hassan explained:

> …and then the fact that they had already made up their minds, "I don't like science", another challenge was that they had to do more, like graduate school and they didn't want to do that, the fact that they needed advanced degrees to get good jobs, they can't see themselves in that, they want careers that are more easy, and then there is the group effort, when you are taking a class and there are only one or two Somalis, that's a group influence.

Throughout this discussion, Hassan lamented on the fact (from his perspective) that U.S. schools did not force students to learn (memorize) basic concepts in mathematics and

science, and then again, from his perspective, they were unprepared and underprepared later for more difficult work in mathematics and science. According to him, these lower expectations in science had contributed to Somali students' underachievement in science, and also in mathematics. He believed that this lack of rigor and challenge in science and mathematics had resulted in the persistent underachievement in standardized tests for Somali students. Moreover, Hassan suggested that schools and teachers serving Somali students should not cut them slack just because they were immigrant students. For example, Hassan argued against any kind of open note or open book tests because he believed that this type of teaching led to lower efforts and lower expectations among Somali students. In other words, this kind of support in test-taking created psychological barriers to working hard and lowered academic expectations.

> The way we were learning, the way we were skilled, it is different [in Somalia and Kenya]. So here it is easy, it is easier with expectations. I think the expectation should be high. I think they should not be let go to do the easy stuff. They must, you know, it's just like I think, a human aspect is to find out what feels easy, so they are looking for the easy path, that's what. So sometimes it is easy but they have to made to know what counts. So some students they asked me in the beginning if they can use their notes on tests, and I said never. Don't dream of it. We will never use notes on tests. And I think that made them to study more. And when you have no notes you learn more. Really, there is more understanding. I think we should give more tests and exams and their grades should reflect this.

Home-School Connections in Science Teaching and Learning

Along with his recommendations for higher expectations in the classroom, Hassan talked about connecting classroom science to students' everyday lives, and the challenges of connecting science to the lives of Somali students when their families did not typically discuss scientific vocabulary and concepts routinely. In his experience, Somali families

did not share any information about any disease and health issues that a family member might be suffering from.

> …so what I'm finding here, I'm teaching them, one thing I figured out was I have to make connections to their lives, they may not grasp things, but when I show them clear things, like what is happening in life, they like this, they like [to know about] diseases, and you know, some practicalities [practical knowledge such as disease prevention], because it is something that is not discussed in their [Somali] culture a lot, so you're not going to hear [or] discuss in Somali culture like DNA, it's part of the American culture, everybody knows that, but not in Somali culture, so they may not be able to grasp it quickly, or have a mental image.

From Hassan's comments, I gathered that many Somali families were reluctant to discuss health issues as they entailed scientific knowledge which many Somalis perceived as being too abstract or less concrete and practical. One argument that I gleaned from Hassan's comments was that Somalis would care more if science could be linked directly to benefits that helped prevent disease or provided readily available remedies.

When talking about ways to visualize concepts in science, Hassan mentioned that videos often could do that for Somali students. He also described a perceived generalization about lack of motivation in school in general and the fact that the Somali students did not appear to exhibit the same worries about their schooling as their parents did:

> You know, I am also trying to see they are not motivated about their grades, I was thinking it was just about science, but it's all across. They are not worried about it, some are, but not the same way their parents expect them to worry. I think we should look at, if they become good at other classes, they will become good at science. There is a relationship. If there is one good aspect, then that can be transferred, so they will do better at the university.

Summary and Reflections

Hassan spoke from the perspective of a 30 year-old science educator, community member, and parent. During his interviews Hassan frequently compared the educational systems in East Africa to those in the United States; he also compared the students he remembered from Somalia and Kenya to the students he taught here in the U.S. From his perspective, the educational systems in East Africa, while limited in terms of resources, were more demanding of students, and forced students to learn mathematics and science early on so that they were adequately prepared once they got to high school and university. Without this rigorous preparation in mathematics and science, students could not succeed at the university level, and job opportunities would be few. He also remembered that the science teachers in Kenya were recognized experts in their fields, and were highly respected by students. In terms of resources, he mentioned that classroom resources (books, teachers, and technology) were somewhat limited in Somalia in primary school, but were more plentiful in Kenya in the middle and high school level.

In terms of student attitudes and motivation, Hassan remembered that back in Somalia and Kenya students wanted to learn and were highly motivated to do well in math and science. Jobs in those fields were most respected, while jobs in other fields were fewer and less lucrative. He mentioned, for example, that students who did not succeed in school were not often able to find employment. In contrast, he believed that students in the U.S. struggled with motivation and were hindered by the rules that allowed them to graduate to the next grade without knowing the content in math and

science. He also believed that Somali students had few (Somali) role models in the sciences and this negatively impacted their motivation. This included their parents, who were typically not scientists, as well as teachers and professors at the university level.

Hassan spent a good deal of time talking about the changing culture of the students (compared to their parents, for example), and how it could be negatively impacting their ability to learn in all areas. He believed that because Somali youth were no longer Somali (and were not truly American either) they were struggling with identity issues and this interfered with their abilities to learn. In essence, they had difficulty seeing how they fit into either culture.

On a positive side, after studying the Qur'an, he found that Islam encouraged science understandings and in fact, it could tell us a great deal about scientific concepts, although more in general terms rather than with much specificity. He believed that if teachers could point this out to Somali students, it might increase their motivation and understanding of science. This combination of Islam and modern science might appeal to Somali students since it might help answer the questions they raised during science classes. He also believed that science teachers needed to find ways to connect the science they were teaching in class to the home lives of the Somali students. This may be complicated due to the fact that Somali families typically did not discuss scientific concepts and discoveries such as DNA and therefore the students did not have mental images of scientific concepts or the familiarity with scientific ideas and concepts as part of their everyday interactions. According to Hassan visualizations may help in this endeavor.

In terms of motivation, he believed that Somali students would greatly benefit from Somali role models in science (i.e., university professors in science education and scientists in general) since there were very few Somali scientists in this country (although there are other Muslim cultures with many scientists). He suggested that science teachers might incorporate projects where Somali students learned about inventions and other scientific work that had been done by Muslim and/or Somali scientists. Alternatively, Somali students might be more motivated to learn science if they could see that the science they were learning would positively impact their home country, Somalia. Implied in all of his pedagogical discussions was the belief that Somali students were capable of learning whatever science they needed, if they were motivated and the teachers had high expectations for them.

As I interviewed Hassan, I was struck by his profound bewilderment over the progress of Somali students in U.S. school science. As he contrasted his school experiences in East Africa with those he was witnessing with Somali students here, he reflected on the apparent discrepancies in motivation and related these to changes in school expectations. In short, he believed that school was too easy here, and in his view, students always preferred to take the easier path---a path which did not give them a rigorous education in math or science from early on. Hassan also spoke of the Somali community's worries about Somali kids who were struggling with identity issues in the immigration process. It is interesting that, in his view, the first approach to dealing with this transition (religion) was now being second-guessed as parents and elders believed that there were other things they needed to do in addition to adhering to Islam and Islamic

faith. One of those he mentioned included providing good role models in science, for example.

As I talked to Hassan over time, he became more frustrated as the year progressed--- he noted that his rapport with students diminished over time, and his perceived ability to teach science was questioned. One could also hypothesize, based on his statements, that he, as well as his students, was undergoing a cultural transition. His science teaching, as he described it, resembled that which he had experienced in Somalia and Kenya; it was mostly direct instruction. At the same time, his Somali-American students were more likely to expect more of an American type of pedagogy with hands-on labs and inquiry science; it was possible that his authoritarian teacher-centered style of teaching was not received well nor respected. Moreover, unlike what he may have experienced in East Africa, his students here likely did not immediately grant him authority based on his position as a teacher; my notes suggested that his authority was routinely questioned both inside and outside of class. This apparent dilemma speaks volumes about the identity issues that Hassan faced as a Somali adult and parent living now in the U.S. where the power in families appears to be changing, and in fact reversing between generations, as the adults appeared to be assimilating slower than the children.

Hassan also spoke about the need for incorporating teachings from the Qur'an into the science classroom so that Somali students could see that their religious beliefs actually supported the science they were learning. Interestingly, this view as to how the Qur'an supported modern science was complicated by some differences that existed between the larger scientific concepts and the details in the Qur'an. I think it’s also

important to note that he believed that there were few adults who were capable of both interpreting the Qur'an and science for students. This was a major challenge for Somali students, parents, and teachers, especially those in public schools where the separation of church and state is required.

Fati: Single Parent in a New Country

At the time that we sat and talked, Fati was working for a neighborhood association that provided services and after-school programming for urban youth. Previously, Fati had worked for two different schools in administrative support and their respective after school programs. Fati was born in Somalia, but her family left for Kenya before the Civil War when she was 2-3 years old. She was educated in the Kenyan public school system until she married. She spoke of five children, three of whom were born in Kenya before she immigrated to the United States. She functioned as a single parent here as her husband remained in East Africa for business reasons. Her younger children attended public schools in a large metropolitan area; her two oldest children attended nearby community colleges so that they could assist with family responsibilities while attending college.

At the start of her interview, Fati talked about her own choices for schools for her children. Although many of her Somali friends had chosen charter, private and alternative schools that had primarily Somali students and families, she purposefully chose larger district schools for her own children. She believed that her kids would benefit from exposure to all types of people, including the “Hmong and other cultures” because they would eventually be working with people from all walks of life. She also sought out

schools where her children would have many options in terms of rigorous coursework (AP courses, for example) and electives and good lab equipment in their science classes. Fati also apologized for rescheduling our interviews because she needed more time to prepare thoughtful answers to the questions she had received ahead of time.

Education in East Africa

Fati started by describing her science education experiences in Kenya where she attended elementary, middle, and high school. She referred to them as standards 1, 2, 3, and 4, referencing the educational system used in Kenya. Her science classes included general science, chemistry, physics and biology with the three latter ones being taught in high school every year. She exclaimed with a laugh "I still remember the Periodic Table---I memorized it! Helium, lithium….I remember it all in English and in Swahili."

She noted that each year she had to pass final exams for each of the science subjects in order to be promoted to the next grade; these classes, including labs, "were not fun like here in America". The final exams could be in any form and were much more difficult than those found here. Her memories of science labs were that they were typical in both chemistry and physics and were much like what we might find here in terms of set-up and equipment.

Value of science education and science pedagogy

Fati noted that science was very interesting to Somali students, especially hands-on activities. These were much more interesting than just sitting and listening. She recommended that science teachers routinely set up big labs where students "had to work

hard to not break things" two to three times a week. This allowed students to learn how to handle materials and how to value them for their own learning.

In terms of the value of science and the potential future successes that learning science brought, Fati suggested that Somali people liked science a lot. She believed that excelling in science also brought social recognition in Somali community as well as economic security (much faster than excelling in other content areas). Fati pointed out that parents particularly valued science for their children who later studied to become doctors:

> They like science a lot, and uh, they would like it when they see sons and daughters doing very well in science, they like sciences a lot you know, when that child is in chemistry, biology, physics and math, [s]he can become a doctor, you know, [s]he can become a, you know, they can do anything, you know, engineering, so there's no obstacles…

In terms of parents assisting their children with their science studies she said,

> Uh huh, and they want them to become maybe a doctor, engineer and they always start with helping children, in first grade, second grade, they want to bring a tutor to them or maybe take them to a library where they gonna get help, so that's how they would like to build the foundation of the child, as young as first grade, second grade…

When I asked Fati about parenting and schools here (as opposed to in Kenya) she spoke about the difficulties with raising children here. Despite the fact that Somali parents wanted to help with their children's education, they often struggled with balancing jobs and family:

> Back home in Kenya we have a lot of help… we have the parents, we have relatives who work very close to you, maybe they live close to you, and you can get a helper, like a maid, someone to help you at home, and you know you don't think about raising your children, you know, there's a proverb that says, African children are raised by the village, they say that, it's right actually, we help anyone who is close to you or maybe a friend of yours will help you, you know, they see

> your child starting to be outside, you know, they will ask what's the part of you, what's the problem? Come home or you know, they will help you. But here, no help.

According to Fati, one factor that hindered Somali children's focus on science learning in the U.S. was the fact that there were inadequate or non-existent social support systems. Fati was concerned that as a parent of multiple children she could not rely on help from others, and she was always torn between more "work and at the same time tak[ing] care of your children". Parents here were more worried about the safety and security of their children than in Somalia or Kenya. Her fears and aspirations about family and science education were summed up as follows:

> The first I am always worried about daycare issues. That's my worst thing. And my other worst thing balancing you know, family and job, but all these other issues, so I had to change my job, I had to change a lot of jobs due to, you know the problems I had raising my children, cause I want them to be, you know, to work hard in school, you know, to get the education and at the same time I want to do, you know, bring the daily bread, you know, on the table. At the same time I want them to feel the motherly love, like I want to be home, you know, be with them, but it was a real obstacle for me and jobs I was doing…
>
> …so you will get your people who will help you or maybe other relatives, they're all related like aunties (yeah), you know, grandma, grandfather, you know, will come to you and help you so you don't have to think about the children. You can work at the same time go to school, you have someone to help taking care of the children.

And Fati's reflections on parenting in the U.S. were:

> We [Somalis] don't love children (here). I swear we don't love children. My daughter now, a 12 year old, seventh grader, she's home alone. I gave her a key, she has you know, she has something to get into the house; she will sit there, do her homework, until I come. So I will have to drive, get the other 2 other children at school, drove them at home. Khadija is in college, Mohammad is in college. They have classes, so, ah, it's hard.

Fati connected love and care for children with her presence at home when her daughter returned from school. She clearly expressed caring and love in her own way and did not believe that children could take care of themselves regardless of their age.

Home–School Connections and Controversial Areas in Science

Turning to the types of science knowledge applicable to Somali life, Fati suggested that there were several health related areas of knowledge that Somali students could benefit from if they were taught in science classes. She was particularly interested in the proper use of antibiotics. Therefore, according to her, Somali students needed to learn these in school.

> Back home Amoxicillin is passed around; we share medicines; there are small dispensaries and we want the easy way. We share; we don't take medicines very seriously; it's like drug abuse! Won't finish medicines for 5-10 days; it's a cultural thing; could talk about appropriate use of antibiotics.

Another controversial area of science among many Somali parents was connected to sex education or teaching reproductive health in schools. In particular Fati raised the need for sex education, particularly focused on women's health issues:

> Yah, you know, my culture, you know, students never get time to sit with their parents, you know, and get all the information about the processes [of women's body and reproduction], you know, the mom go from maturity, you know, to pregnancy, to having the baby, no one even sits with their children [daughters], and talks to them about, you know, it's not just the story that parents and a child can talk about that…so we don't talk to them unless maybe they come to school and learn the processes [how reproduction works], you know, of what people undergo [physiological and psychological changes], you know, having a baby, or even the process where, let's say, reproduction, we don't even talk to them about reproduction, organs, we don't talk to them, so, they learn from school…

Fati raised very essential questions about women's reproductive health and where those conversations needed to take place. She was quite clearly concerned that if the girls did

not learn this in school then they would have had no opportunity to learn what they needed to in order to be prepared for what was to come once they were married. According to Fati, women's health issues definitely needed to be a part of learning science, especially for girls. When I mentioned that I had heard that not all Somali parents were comfortable with sex education in health and science classes, she acknowledged that this was true, but her own opinion was that this knowledge was important to prevent "bad things from happening" to Somali girls:

> Actually, it's for me, sex education is very important, for our children because they need to learn, what's good and what's bad, because if we don't teach them, you know, they can do something bad, something bad can happen so…I don't think whether our people will be happy to see, if (the teacher) is teaching sex education, what is she teaching? That's bad, maybe they are learning bad things. It's not bad, but they are learning something good.

Through these quotes, Fati shared her view that although many Somali parents might not agree to sex education in health and sciences classes (as these parents believed that any type of discussion around reproductive health education was harmful and may encourage teenagers taking unnecessary risks such as premarital sex), she believed that Somali youths would be better served when they were knowledgeable about their own bodies and the many ways to safeguard them.

> I think, think it's good for them to learn, to be careful. To be careful about doing something, you know, that they are not allowed to do. So let's say the girl becomes 11, 12, and gets her period, you know, she has to be careful not to play, with a boy, you know, or not to go to next to someone who does not have parent, you know, she doesn't have to go out with other people, she has to be careful, anything can happen.
>
> I don't think the parents like it for the girls to learn, but like high school, I will prefer for them to learn than to becoming pregnant, we're not allowed to have sex outside of the marriage, you know, they need to be married and then that's when

> they can have sex, you know, so I don't think whether the parents will be happy (laugh), That's been my impression.

When I asked Fati about other areas of science that might be difficult for parents and students alike, she stated her opinion that evolution might be difficult for Somali students, but they needed to learn it if they were planning to go on to college.

> Evolution, it's OK because, that they need to learn, they need to learn, and of course as soon as they are done with high school, go to college and they will have to learn evolution, have to learn, you know, the different religions, and uh but it's OK for them, even in high school it's OK for them. For when you are teaching in that topic they will challenge you (laugh)…a lot of challenges, like hey what is she talking about?

Consistent with her views about sending her own children to diverse public schools, Fati suggested that learning about evolutionary science exposed Somali youth to other ways of thinking, other practices, and other values. In other words, learning about evolution is also about engaging with ideas and knowledge that were different from one's own. At the same time, Fati did acknowledge, with a laugh, that "Somali students would challenge their teachers" during the teaching of evolution. I understood her laughing response about teaching of evolution and student response as an expression of the difficulty that a non-Somali teacher will encounter in this type of class.

Summary and Reflections

Fati spent a good deal of her interview talking about the difficulties of parenting in the U.S. while working outside of the home. She contrasted her situation now (as a single parent) with that of what it was like in Kenya where family and community members stepped up to assist with child rearing. By implication, she indicated that she had no time to spend with her children here, especially in terms of assisting them with

schoolwork, or with spending time in their respective schools. Despite this, she also mentioned that Somali parents were highly supportive of their children's schooling in general and tried to seek out support for them in terms of tutors and homework assistance at public libraries.

From my own teaching experiences it appeared as if Fati's situation appeared to be typical of many Somali female-lead families, with many children to care for, and with children in different school systems. In general these choices (in addition to the need to work outside of the home) probably precluded parent involvement in their science classes, science fairs, and schools in general. By implication, Fati indicated that parents living in Kenya were busy either raising children, or raising children and working outside of the home, so involvement in their children's schooling was expected to be minimal. Teaching was left to the teachers.

Fati was highly supportive of science education, especially in terms of college and career readiness; she espoused the view that school science could lead to valuable careers in medicine and engineering, for example. These careers were highly valued by the Somali community. Noticeably, she also compared science in the U.S. to that which she had received in Kenya. She believed that science education in the U.S. was much easier than that in East Africa where students were obliged to pass yearly exams to pass on to the next grade level. Fati also believed that hands-on science was the most interesting to Somali students, and that rigorous laboratory experiences were appreciated by both students and their parents.

Fati appeared to be very pragmatic when it came to challenging subjects such as evolution in science education. In her view, students should learn these topics in high school because they were going to learn them anyway in college so they might as well be prepared. When prompted about other science-related topics that might be controversial, Fati talked at length about sex education in science (and health) classes. Again, Fati appeared to have a very pragmatic view that students, especially female students, needed to learn these topics in school so that bad things (teen pregnancy, complications in reproductive health, etc.) didn't happen to them out of ignorance. Her experience indicated that Somali parents did not spend much time talking about these areas with their children (especially the girls), so the schools should step in and teach this science content to educate girls to protect them later in life. She acknowledged that her view was not representative of Somali adult community in general, however, and that other parents felt differently about this delicate area of science/health education.

Anisa: Lies our Teachers Told Us

> "Science explores of lots of things, you know that religion, um, teaches um, a completely different way…"

Anisa, appearing to be in her late twenties, was born in Somalia. When she was two years old, her family left Somalia and moved to Egypt where she attended a private school until she was about ten years old. At that point, her family immigrated to the U.S. where she finished middle school and high school. She attended three different high schools in a large metropolitan area, and then two different community colleges. Her

degree was in English education. Anisa was married with one young child. Her child started school in a private Islamic elementary school, and then moved to a public school.

At the time I first interviewed Anisa, she was working as a media specialist in a large metropolitan area library. She indicated that she was taking time off from classroom teaching because she had a young son, and she wanted to spend more time with him, "teachers work all the time". This job allowed her a professional life along with a personal life.

Science Education in Egypt

Anisa described science education in Egypt as being very difficult for her, especially biology. In fact she said that she did not like or understand biology at all, and ended up taking it three times in college. In Egypt, the languages used in school were mostly Arabic and English; science was taught in English. She mentioned that she completed many labs in her science classes in Egypt. Once she started taking science classes here, she enjoyed physical sciences the best since she was able to see what the teachers were talking about.

Science Pedagogy

When I asked her about how to make science exciting and engaging to Somali students, she recommended hands-on activities and labs:

> Somali students LOVE hands on experiments and experiences—you can have them more motivated and ready to do what you want in a lesson if they have hands on experiences; —and of course relating things to teenagers is always the way to teach them something, but in science it should be hands on experiences; pulls in any crowd no matter where they are from…

Anisa asserted that Somali students prefer doing activities in science that allowed them to engage with materials which allowed them to learn from doing. This also allowed students an opportunity to find out how and what in science was connected to everyday life experiences.

Home-School Connections in Science

We went on to discuss how to make connections between Somali culture and science. At first, Anisa said she did not understand the question. When I prompted her to think about foods, cooking, medicines and other everyday traditions at home, she shared the practice of using honey as a preservative to increase the shelf-life for produce that were easily perishable. For example, Somali women often spray or brush strawberries with honey to increase shelf-life as well as to preserve freshness of other foods. Since many Somali immigrants grew up in a harsh climate with extreme temperatures and drastic humidity variations between the inland desert and the humid coastal areas, home preservatives such as honey allowed them to keep food for longer periods of time. This facilitated the transport of food without refrigeration facilities. She suggested that utilizing an example like this could improve interest and engagement for Somali students in science classes.

> Yes, spray with honey; so for example, strawberries, regular strawberries, if you buy them and stick them in the fridge like normal, compared to ones that you sprayed with honey, that one has a longer a longer shelf life. So that's something that you can easily do in the classroom.

Furthermore, she noted that the connection between science and home remedies are often present in many communities and the Somali community is no different--- in its use of honey as a remedy for colds and sore throats, for example.

> We believe that honey…honey is the best thing that you can have when you have a cold, or when you are sick; so how can things like that, can we figure that out in a science classroom? Can we figure out what elements does honey have that can help us, right?

Anisa mentioned a popular home remedy, anise seeds, used to relieve sore throats. These seeds are readily available in Somalia and often used as spices in many foods that they prepare. She suggested that science teachers could link the benefits of popular herbs and spices that are common in Somali communities to science topics.

Controversial Areas in Science Education

Next we moved on to discuss areas of science that she thought might be difficult for Somali students to learn either because of cultural or religious reasons. Anisa noted that the formation and age of the Earth were often difficult for Somali students because they have different beliefs:

> Yes, things like how the Earth was formed. That's a very difficult question. I mean, scientists have an answer but we have our beliefs. You know in the Qur'an it explains that to us how the Earth was made and things like that but then we are told in the classroom that a different theory, which is sometimes very hard for us to grasp.

Anisa's assertion was that that Somali beliefs about the age and the creation of the Earth were often based on the Qur'an and therefore could not be easily discarded and replaced with a scientific view. For many Somali youth, living by the words of the Qur'an is deeply personal and integral to their identity of being Somali. Therefore, learning and accepting scientific reasons in this case may be profoundly difficult. In a follow-up

question, I asked her what happens in your thinking, if these things do not go together, and it is difficult…

> So this is what some people, for me and my family, what we were told, hey, so this is something new that you are learning—you need to accept it, you don't have to believe it, but accept it though, it's an acceptable lie, move on; but it's like this in some families, "don't believe it, don't even accept it, it's not like something that you should even listen to"; sometimes the teacher is telling you lies so don't believe it, don't believe the teacher at that moment…

Significantly, Anisa's explanation of how Somali students deal with science and their beliefs about the age and creation of the Earth was that Somali students basically accepted these scientific theories as lies. As she noted, Anisa's family saw this scientific theory as an "acceptable lie", one that could be ignored whereas other families told their children to ignore or not even listen to the teacher. According to Anisa, Somali families saw teachers as the proponents of a "lie" in the name of science. Perhaps an even bigger issue that Anisa brought to the forefront was the fact that science teachers were often teaching science that did not match with what many Somali students had learned since birth (and practiced every day in their religious traditions).

I next asked her whether all Somali students came from families with similar beliefs, and whether beliefs differed in other types of families. She responded that she thought that ninety percent of the families at Somali-focused schools in the area came from similar backgrounds and had similar beliefs, although in a broader context Somali students and families did vary quite a bit in regular public schools.

> I feel, here's one thing that is just me talking…when we have schools that teach just Somali students …most of the students who show up there are students whose parents have the same [or] similar beliefs and so you have the same students in all those schools…but if you kinda expand your view, your horizon a little bit, at other schools, you will see Somali families that think a little differently…

Anisa claimed that there were variations among Somali families and youths as to the contradictions between science knowledge and home knowledge. She believed that students and families who chose to go to Somali-only public or private schools likely believed that science and religion were not complementary. On the other hand, Somali youth, including their families, who attended regular public schools tended to have more accommodating views about science including the scientific theories about the age and creation of the Earth. Overall, Anisa was cautious about grouping all Somali youths and families as homogeneous in terms of their cultural and religious beliefs (relative to science).

Value of Science

Anisa believed that science could prove valuable to Somali youths as it would prepare them to "become a doctor, or you [could] become a researcher, you [could] become, … you [could] go into health fields, … and, help out with so many things." Additionally Somali youth could be valuable human resources when they returned to Somalia – "their country". According to Anisa, in the current political environment Somalia did not seem to recognize the value of "scientists and researchers". However looking ahead, there was hope for Somali youth to return to Somalia as "scientists and researchers" to make a difference.

Anisa went on to describe the path that a good friend of hers had chosen in order to use her science expertise and experiences gained in the US to help people in Somalia:

> she[my friend] now she lives in Somalia, helping with health care, they're helping with different things right now ---they have jobs, things like that, I mean, so the

> possibilities are there, and if you have enough young motivated people that can do it, that would like to do it, that actually have the resources to do it.

One of the issues that Anisa believed many Somali youths faced was the pressure to be doctors; families wanted to send their children to school "to be a doctor" not "just whoever [they] wanted to be". Anisa believed that the support of science education in Somali families was largely derived from this view. In her own life, for example, Anisa experienced familial pressure to excel in science so she could become a doctor.

> Of course, yeah, it does add a lot of pressure…because growing up I thought I had to become a doctor…until I graduated high school and my dad…and I signed up for, I was the first one in my family to go to college, 'cause my parents finished high school and that's it…um, my mom did some college, but she never finished college…so, I thought I had to, I had to become a doctor, and then my dad told me, nope, you can become whoever you want to be…which is great, although my sister is becoming a doctor, so… but she showed us that…so good for her…

In the end, even though Anisa's father let her pursue her own interests, her mother was less supportive of her choice to become an educator. According to Anisa many Somali families applied similar pressure and likely contributed to elevated anxiety in Somali students as they participated in school science.

When I asked her what she thought might be most helpful for science teachers to understand about Somali students, she responded:

> I guess I can talk as a student, from what it might look like, from my teachers, you know, when we are learning about concepts, that are maybe a little bit, that are taught to us that are a little different, um, you know, to have like a little disclaimer, "you don't need to accept this, you don't need to believe this, you are learning about something new, something like this and like that, but you don't have to, you know, it's not, it's not like a religion, that you have to believe in , basically…yeah, things like that.

It was likely that with the above thought, Anisa presented two very important implications for engaging Somali students in science. The first was to acknowledge that

Somali students differed in their thinking about which kinds of science knowledge were useful to them. Second, Anisa asserted that science teachers needed to acknowledge that science knowledge had a particular purpose (that of describing how a natural system works) and uncertainties were essential and necessary parts of science. On the other hand, religion, for her, was all about believing in a system without any uncertainties. As a student, Anisa would have valued science learning and her science teachers more if the science teachers had framed science learning as a process of learning new skills and knowledge through trial and error. Also, she would have appreciated her teachers knowing that Somali students should be given time and space to ruminate about their newly acquired science knowledge and skills in order to decide if they could accept them.

As Anisa reflected about her own science learning experiences, she noted that she struggled to fit into science. She wondered about the validity of learning science as it seemed incongruous to the way she had learned to understand nature and natural systems at home. Her parents would reconcile her conflicts by assuring her to not believe in the science she learned in school but to just accept it. According to Anisa, her parents compared science learning to accepting a rule of society even though they did not believe in it. Another reason her parents gave her to "accept" science was to show respect for her teachers. Somali children were taught to respect their teachers in the class; therefore, questions about the validity of the material could be raised at home with parents. Anisa stated:

> ...I would have gone, when I finished with a class and it was a concept that was different to me, I would go home and ask my parents, "why are we told this? Why are we taught this?"and they would tell me, "accept it, but not believe it"; "in it" "not believe in it".

As a researcher, I shared my own experience of Somali students asking me how I knew something was true. Anisa indicated that that question was always "in the back of [their] minds"

> Right…that's basically what's in the back of our minds…even though we do have scientists that have reached some kind of, that kind of status where they would say "hey, we know this and we believe this"; we do believe them; for some reason, our kids, for some reason, if it's not, if you're not, it might seem a bit harsh…If you're not from the same religion (Muslim)…then I'm a little, you know…suspicious…

Anisa suggested that Somali students would perform better in science if the teacher were also a Somali. She noted that Somali scientists and researchers would fare well with Somali students because they would see themselves in those teachers. Furthermore, Somali students were also more likely to accept a Somali teacher's science teaching because the students and the teachers had the same faith and similar life experiences. Nonetheless Anisa acknowledged that science and religion were teaching "different things … [and] in completely different ways."

Anisa observed that Somali families and students seemed to categorize science teaching and learning differently based on the Qur'anic teachings. For many Somalis, in order for them to accept science teaching, it had to be in harmony with their religious values and beliefs, which they had to incorporate into their daily lives. Anisa also asserted that many Somali adults and students believed that the Qur'an answered all the questions about nature, life, and the environment, therefore there was "very little reason for the students to take science learning all too seriously". Additionally, for many students, this discrepancy gave them a strong rationale to be less receptive to the science

they learned at school. Anisa also clarified that when students viewed their experiences and learning at home as incongruent with science, they often abandoned science rather than question their home experiences and learning. As Anisa explained:

> Most of everything we know, in fact everything that we know, as Somali, as Muslims, it comes form the Qur'an…there are a lot of concepts that have happened after the Qur'an was revealed, and, or way before, For example, we have Earth was inhospitable by humans at first, surrounded by poisonous gases. And the density of water, salt water… everything we want to know about our lives, and the future, our whole lives, what happens when you die, the whole package…

Summary and Reflections

Anisa, in her mid-twenties, was a Somali-American immigrant who was born in Somalia, and then schooled in both Egypt and the United States following the turmoil of the Civil War in Somalia. In talking about her science education, Anisa mentioned that she struggled with most sciences, but enjoyed the physical sciences the most since she could "see" what she was learning.

Anisa recommended "hands-on" science learning for Somali students since she found those types of activities to be engaging. When asked whether she could think of examples of activities that Somali students do at home that could be brought into the science classroom she initially balked, but once prodded, talked about the uses of honey as a preservative and anise as popular home remedies.

Anisa shared extensively about the conflicts between Somali students' (and parents') beliefs and what they were being taught in science classrooms. When asked how Somali students deal with these conflicts she said they often brought them home and talked to other members of their families who generally suggested to them that these were

acceptable lies that they didn't have to believe in. Other families told their children that the teachers were lying to them (and by implication, unacceptable lies) and that they should not believe or listen to them.

In terms of the value of science, Anisa spoke of Somali parents' hopes that their children would become doctors and that this added pressure to many students. She spoke of the possibility that students here would learn about potential scientific careers and then return to Somalia to help as the country stabilized.

Anisa clearly talked about the conflicts that some Somali students experience when confronted with the science that is taught in U.S. classrooms. From her point of view, the beliefs that Somali students and parents brought to school were often challenged, and families always choose their beliefs over the lies of science, when choices needed to be made. She also indicated that non-Muslim science teachers often met with skepticism from Somali students and families, because it was perceived that they didn't hold the same Muslim beliefs. Despite this apparent conflict, she believed this situation could be mitigated by the teachers if they were to provide some sort of disclaimer at the start of teaching those parts of science that were likely to be in conflict with Somali beliefs. As did other interviewees, Anisa believed that hands-on inquiry science was much appreciated by Somali students and their families.

Ayan: Traditional Female Elder

> Teachers are different (here) because in Somalia they talk the same language, so they can explain to the students in Somali. Makes it harder here, especially for students who have been here just one year or less than one year. The teacher can't speak the same language, to explain things.

Ayan was the oldest of the participants in the study and hence spoke from the perspective of a traditional Somali female elder. Her dress, for example, communicated a traditional stance; she consistently wore a full-length hijab of brown or gray without any additional adornments. In her communication with Somali children at the time, she exhibited a blunt, and seemingly dictatorial management style. As a non-Somali, I assumed this was her normal way of communicating with children of all ages. As I sat down to talk with Ayan, I immediately saw a more thoughtful and reflective manner towards me. I also quickly realized that although we had been able to communicate about the consent and logistics of the interview, we would soon run into a number of language barriers with the questions I was about to pose. To remedy this dilemma we asked a nearby adult to sit down with us and translate as needed. The resulting interviews with Ayan were somewhat shorter in content because of the time it took for the mutual translations, but longer in terms of the time it took to have a meaningful conversation.

Ayan was born in Hargeiza (Hargeysa), the capital of Somaliland, a self-declared republic within Somalia. This area was once colonized by the British and gained independence in 1960. Hargeiza is one of the largest cities in Somalia, second in size only to Mogadishu. At some point, Ayan left Hargeiza to live in Mogadishu until 1995 when the fighting from the Civil War became too much for her. She then left Somalia all together with her husband and children and moved to Pakistan, where her husband could more conveniently travel to and from India and other East African countries for his medicinal business. Ultimately, Ayan and her children went to the United Nations in Pakistan and requested refugee status in order to immigrate to the United States.

Ayan had nine children, the youngest of whom was in college in the United States. All but the last two were born in Somalia. The first four were born before the Civil War in a hospital, three were born during the Civil War in a doctor's home (since the hospitals closed during the war), and the last two were born in Pakistan. Due to their transnational experiences, all of the children were multilingual and could speak Somali, Arabic, Urdu, English and Persian (since they attended private Iranian schools in Pakistan). As she described her children, Ayan spoke proudly of their schooling and career trajectories, one of whom was now in medical school in the United States.

Science in East Africa

As we started to talk, I asked Ayan if classroom science in Somalia was different than the classroom science that her children had experienced in the United States. She replied that the science in Somalia was the same, or "science is science" indicating no difference. What was different, in her opinion, were the teachers because in Somalia the teachers spoke the same language as the students. She stated that this difference made science harder here, especially for the students who had been here for just one year or less. If the teachers could not speak the same language as the students, they couldnot explain things to the students in the science classroom.

Value of science education

When I asked her about her hopes for her children in science she responded, "If children stud[ied] science, they [would] understand science; become a doctor in the future. For me, I like[d] science; if you [understood] science, it open[ed] your mind and you [understood] how to think". I believe that Ayan's point was that science was not only

a path to professional success but also a path to a better understanding of the world. She also firmly believed that going to a medical school and attaining a medical degree was one of the primary reasons for learning science. As she noted, a medical degree was highly prized in Somali communities as it brought high status, as well as financial security, to the family. In addition, because of the scarcity of access to efficient and timely health care in Somalia (and other countries where she had immigrated), she, along with many Somalis, preferred to have someone from within their own family tend to them for their health needs. Ayan also noted that some people with medical degrees returned to Somalia to help people there.

Home-School Connections in Science

When I asked her about things that she did at home that could be explored in the science classroom, Ayan mentioned cooking as one of the easiest ways to make Somali students understand the connections and usefulness of learning science. She described how cooking typically had taken up a large part of her day as she prepared lunch, dinner and breakfast, both at work and at home with her children. To connect home to science, she suggested that students and parents could come to science classes and show students and teachers how they cooked in Somalia.

Ayan's examples of connections between science and home involved usage of various animal and plant products to remedy common headaches and stomach discomforts. In her view, many of these physical discomforts were a normal result of long hours of fasting followed by large meals during Ramadan and other Muslim traditions. For example, people might eat breakfast as early as 3:00 am and then break their fast at

9:00 pm with a large, buffet-type meal. Common remedies she shared included yogurt, or milk and ice (or very cold milk) with sugar. She said that if people had a headache, they drank tea. If you "[made and drank] tea, headache [was] good."

Another example that illustrated science and everyday activities included traditional ways of carrying water in special vessels made either out of animal pelts or treated wood and the use of henna as skin decorations. These could also be brought into the science classroom, as examples of Somali life and science connections.

Ayan also noted that traditional gender roles were breaking down as families were so busy in the U.S. and everyone had to help to support a family. For example, she described how cooking and cleaning of her own home was now shared by all of her children who still lived at home (or who spent time at home). She also noted that her own roles in the home were changing as she worked more than one job.

Controversial Areas of Science

The next question I asked her was about her perceptions of parts of science that might conflict with Islam. She responded that Somali students often were uncomfortable with health classes because in those classes they often talked about things that were not permissible to talk about in the culture. For example, Somali girls were not allowed to have boyfriends; boyfriends were considered "haram". In fact, by the age of 17, 18 or 19, the girls were most often married so the talk about boyfriends, dating, condoms and birth were not liked and were unacceptable as a normal social conversation in the Muslim culture (although some cultures could talk about this). According to Ayan, if a girl was of age, she was either with her husband, or at home with her family, so the whole

conversation about sex education and women's reproductive health was not relevant, in her opinion, or worse, could lead to haram ways of living.

Summary and Reflections

Ayan was chosen for an interview because of her age and life experiences. Like many Somali adults who have immigrated to the U.S., she had lived in several countries, experienced the trauma of Civil War, and had watched her children negotiate many kinds of schools, both private and public. Ayan noted that science "opens [one's] mind" and allowed one to "understand how to think". To her, science was science, no matter where an individual learned it. She also talked about the value of science education for Somalia and the people who struggled to get health services.

Rather than talking about the content of science, Ayan spent a good bit of time talking about how it was difficult for Somali students in the U.S. because of the language barriers. Interestingly, she did not view this as a student issue, but as a teacher issue. In other words, Somali students found science learning difficult in the U.S. because the teachers could not translate scientific terms into Somali language and could not, therefore, help them learn scientific concepts. This was not an issue in her children's education in Somalia, Kenya, or Pakistan, where the teachers spoke the same languages as the students. Given the lack of licensed Somali teachers in the U.S. this is a problematic issue. Notably, her view was different from the typical U.S. view that language acquisition was a student issue, not a teacher issue. In the U.S., the responsibility of learning lies with individual students.

Ayan also spent a good deal of time trying to communicate to me (who didn't speak Somali) her objections to sex education in health and science courses in U.S. schools. Ayan believed that this was considered "haram" or wrong in the Muslim faith, and that Somali girls, in particular, were not to be encouraged to think about boyfriends or birth control in any way. She added that most Somali girls were of marriageable age in high school, and since sex was prohibited outside of marriage sex education only encouraged bad behavior by implication.

When prompted, Ayan spoke a bit about Somali traditions in food preparation and home remedies for headaches and stomachaches, some of which could be explored in a science classroom. Her remedies for these types of ailments were talked about in the context of Ramadan, a season of extensive fasting followed by large meals. She noted that Ramadan could be challenging from a dietary perspective, and that home remedies such as tea and dairy products could be explored for their efficacy and perceived or real health benefits. In terms of Somali homes, Ayan also noted that traditional gender roles were breaking down because families were busy as they had to keep two or more jobs to feed a family. For example, she described how cooking and cleaning in her own home was done alternately by both her sons and her daughters, depending on who had the time to do it. She also implied that her own responsibilities, as a single parent, and as a sole provider of the family, were complicated as she spent a good deal of time at home preparing food rather than helping children with their school work.

Section B: Perceptions of Conflict/Tensions and Acceptance

Overview

In this section I present the common themes, as well as a few unique themes, resulting from a comparison of the interview data across participants.. Using the two research questions as a guide (What are the perceptions of Somali elders about school science?; How do Somali elders believe science teaching and learning influences Somali students' engagement in science?) my analysis looked broadly at the Somali elders' perceptions of science education in the U.S., some of which presents conflicts and subsequent tensions; some of which presents acceptance of the new reality about teaching and learning science in the U.S.; and some of which presents opportunities for participation in science teaching and learning. Implications for science teachers of Somali American students will be addressed in Chapter 6 as a discussion of the findings and their broader implications to science education in the contexts of refugee and immigrant students and teachers**.**

Science Education as a High Value Teaching and Learning Experience

A common theme presented by all of the elders who participated in this study was that science education is highly valued by the Somali community, both here and in Somalia and countries where Somalis have lived as refugees. As Hassan noted about education in Kenya, "you had to be good at math and science to go on to a good university". He also stated that this recognition of science still holds true today with Somali families as he said "actually, the other subjects are not considered as good, so it will be always English, math, science, math and science…." Most participants stated that

science education was considered good because students could go on to careers in medicine or engineering. In addition, research in any of these fields was highly valued. As Fati stated,

> Once you are good in math and sciences, there is no obstacle, you can do anything so parents always think about a child becoming a doctor, especially the Somali people, say you want to become a doctor? Yes, that's good, become a doctor, become an engineer, that's the two things they will like. A lawyer, no, I don't know why, but they like sciences, you know, their child will end up (better) later in life…

Fati and Hassan both believed that the Somali community puts a premium on professions that were science and mathematics related. Accordingly, all parents were very supportive of science and mathematics and actively strived to encourage their children to become doctors or engineers. Fati asserted that parents would rather have their children study to become a doctor or engineer than a lawyer. Fati, in particular, was quite bemused as to why Somali parents did not want their children to pursue legal careers. It was likely that two important causes for these aspirations were the perceived economic security and higher social status that these professions (as a result of education in science and mathematics) bestowed to families and individuals and, in some cases, to the whole ethnic group that a student belonged.

Anisa added to this theme by speaking about the pressures that Somali students felt from their parents and their communities about doing well in science and becoming "doctors". In her case, her parents eventually allowed her to become something other than a doctor, she became a teacher of English and Language Arts. Juxtaposing the current mathematics scores of Somali students in Minnesota (Taxis, 2014; see Chapter 3) and the strong desire of Somali parents for their children to become professionals in

science-related fields, one might hypothesize that this is an unreasonably strong (and perhaps unhealthy) pressure for immigrant Somali students as they settle into a new country and education system. Limited parent knowledge of the education system in the US, along with high parent expectations for their children to succeed in medical professions, may place young Somali students in a difficult situation. For example, at the same time that young students are being urged to become doctors, their parents and elders are not able to provide them with the essential academic language, skills and scientific ways of thinking that might help them succeed in science. Having said this, Anisa also quite strongly believed in setting high academic standards, including strong work-ethics, in order for Somali students to achieve these (parent desired) goals.

The other reason given for valuing science education was the hope that Somali students here would be able to use this knowledge to improve the lives of Somali people back home in Somalia. For Anisa, studying science and doing well in science were directly related to how much the students could help Somalia through both their accomplishments in science and their utilization of science to help the Somali community in their home country. Furthermore, Anisa argued that when Somali students became scientists, including doctors, engineers, nurses and other professions in science-related fields, they could then likely directly assist Somali people during natural disasters such as famines and epidemics. For Anisa, a Somali scientist or doctor could provide a much better and appropriate support to "deal[ing] with natural disasters like famine" than non-Somali scientists. By implication, in some cases, non-Somali scientists may not be trusted

as honest and reliable individuals who could truly understand their socio-cultural values enough to assist them during tough times such as famines.

This focus on assisting other Somalis back home is consistent with Farid's description of important cultural values in the Somali community including a collective identity (Farid & McMahan, 2004). In his view, a person who "behaves properly" and has accomplishments in his life is seen not only as a credit to himself and his immediate family, but also as a credit to his father and his forefathers. Additionally, helping the community is considered an important aspect of charity for Somalis, charity being a central tenant of the Muslim faith---a person who helps dig a well where there is no water or build a mosque where there is no place to gather for prayer, is a person who is living a full life (Farid & McMahan, pp. 1-2). It is also consistent with the concept of diaspora wherein displaced individuals remain connected to their actual or imagined communities in many ways (Bigelow, 2010). As noted by Hassan, this can be a source of motivation for Somali students who study science here:

> So I think also the fact that many of our communities are backward, there's a motivation for us to learn science, so that we can develop ourselves, …

Like Anisa, Hassan saw science as a means to uplift the Somali community. He also envisioned the potential benefits of science as a motivator for Somali students---one that might encourage them to invest in learning and engaging in science. With reference to Hassan's claim that "Somali communities are backward", I believe he was likely indicating that the Somali community, both here and abroad, is in dire need of improved basic human necessities including better health care systems, better schools, and better access to clean drinking water and agricultural systems in order to reduce famine and

malnutrition. Additionally, "backward" could also be interpreted as the belief that some of the traditional practices prevalent in Somali communities need to be re-evaluated and re-imagined; science could be the bridge between the old and the new for Somalis.

Struggling to Reconcile Scientific Knowledge with Personal Value Knowledge

Throughout the interviews it became apparent that the participants were typically open to scientific concepts as taught in U.S. schools[22], unconditionally supportive of science careers for the next generation AND that their frame of reference was their internal belief system which was firmly anchored in Islamic teachings. As many authors have made the case, for Muslim cultures, Islam is not a religion in the same sense that Christianity or Buddhism are. Islam, for Muslims, is much more than a moral philosophy of life, system of belief, or spiritual order; it is a "complete and comprehensive way of life". For Somali people, as noted by Farid and McMahan (2004), Islamic teaching is so integrated into the fabric of Somali society that it is often difficult to see where religious influences end and where local culture begins. For many, it is impossible to separate religion from culture. Given this, the participants of this study frequent reference to Islam and/or the Qur'an indicated that they viewed Islam as the foundation of their culture, both in East Africa, and here, as recent immigrants to the United States. The preservation of this Somali culture, including Islam, was not questioned by the participants and could be seen as their need to preserve their "soomaalinimo" as part of the global Somali diaspora. From the Somali perspective, Islam represents a historically constant source of meaning

[22] With a few exceptions in individual cases

and guidance that may have greater salience for these participants (and, by extension, Somali youth) than national, ethnic, or racial identities (Shepard, 2008).

Authors in the science education community have occasionally referenced the potential conflicts between an Islamic worldview and that presented by western science, particularly for teachers and students (Mansour, 2010; Haidar, 1999). However, Mansour makes the case that historically, Islamic conceptions of science did include experimentation and theoretical reasoning, although not exclusively. Mansour (2010) and Golshani (2007) both argue that for many students and adults from the Muslim faith, knowledge of natural phenomena is an amalgam of knowledge based on scientific experimentation and knowledge based on faith. These two sources of knowledge are not mutually exclusive, but somehow have to be complimentary. Therefore, science taught in classrooms has to account for knowledge gained from the physical and spiritual components of one's experiences. In his references to the Qur'an and the exploration of science by Muslim scholars, Mansour (2010) notes that the pursuit of scientific knowledge is tantamount to becoming closer to understanding creation and God himself. Interestingly, only one participant spoke of the consistencies between the Qur'an and scientific endeavors.

Hassan, in his interview, spoke about how he found out and how he then believed that the Qur'an encouraged teaching and learning science. Hassan saw connections between science and Islam in that Islam "encourag[ed] to really understand science…[and provided] general guide" to seeing nature for its own sake. It is possible that Hassan's understanding of science (and its support in the Qur'an) was rooted in the

belief that an understanding of nature would lead him closer to god, as noted by Mansour, 2010. Hassan further argued that the historical contributions to science by Muslims is an important part of the history of science. Hence, he believed that science classrooms needed to make that connection when interacting with Somali students. It is possible that the general acceptance of science education by the participants was likely not only related to their perceptions of science as part of career trajectories for their children, but also was more deeply rooted in the recognized contributions of Muslim scholars to the broader scientific community throughout history (Mansour, 2010).

On the other hand, conflicts were apparent in most of the participants when they discussed specific areas of science they perceived to be in opposition to Islamic teachings (and by extension their own lives).. Although Hassan believed there were many consistencies between science and the Qur'an, other participants believed that many scientific concepts were in conflict with the Qur'an. Evolution by natural selection, sex/reproductive health education (as part of health education), and geological concepts (age of the Earth; formation of the Earth) surfaced as the most contradictory areas of science. Depending on the individual, these conflicts were perceived as either not resolvable given the existing scientific knowledge that was available (Ali and Anisa), or perhaps not significant because they were more detailed than what the Qur'an specified (Hassan). For example, Ali, a trained science teacher and respected Islamic elder, clearly understood the concepts elaborated by Darwin in the Galapagos Islands. In fact he described them in detail in terms of species “similarities and differences” yet had to conclude that it remained a dilemma for him:

> For me, since I studied science, it was a struggle---science and religion do not need to be in concert with each other; these are two ways of understanding how the world works; one answers why and the other answers how.

In addition, he believed that the evolution of humans, as described by modern science, was basically a joke. Moreover, he stated that this was a common belief of all Muslims, Somali or not, and all believers of monotheistic faiths. This apparent conflict between his religion/culture and his knowledge of science was not resolvable, but could be rationalized by his belief that religion answered the question of "why" and science answered the question of "how".

On the other hand, Hassan, working as a science teacher, recognized differences between what the Qur'an taught and what modern science taught, but was able to accommodate these differences by his understanding that the Qur'an was not meant to supply details about general scientific phenomena:

> … So I am teaching here, and I am teaching in class, and I have students who ask me, is this a part of the Qur'an? and I say … it doesn't include specifics like days of the year [or how old Earth is], it's a general guide,…

Anisa spoke more directly about perceived conflicts between science and the Qur'an when she said that science explored many areas that her religion, Islam, treated differently.

Anisa's view was that in some cases science and the Qur'an were in conflict and that this was unresolvable due to a difference in how each of the sources saw the theories of creation of the Earth. For Anisa the cognitive and cultural dissonances between science and religion seemed to make science learning, as well as participating in it, highly challenging. In her view, students put in this position often discussed these dilemmas

with their parents or other elders. According to Anisa, these elders and many parents typically advised the students to categorize these scientific beliefs as either "acceptable lies" that could be tolerated as part of the education process, or worse, as "unacceptable lies" that should not be listened to at that moment.

On further examining Anisa's comment about "accepting" science but not "believing" science, I observed a couple of important layers that Somali parents struggled with in science. I saw Anisa as :1) a parent who accepted science for the sake of knowledge; 2) a Somali Muslim who did not believe in science knowledge; 3) an advocate of teachers; and 4) a parent who understood the game of academic achievement. Anisa had the inclination to accept science knowledge as tolerable at the personal level. She would rather have had Somali students do well in science than not, her intention of stating "accept but don't believe" was her recognition that doing well in school science had its own long-term benefits. However, she cautioned that, for her, science knowledge did not rise to the same level as her own beliefs based on the Qur'an. Anisa also separated her thinking about science from how other families thought about science as she cautioned that there existed many more Somali families who would not accept science just for the sake of passing the test. For those families, being true to Somaliness was more important than excelling in school science. Anisa valued what teachers were teaching in science but she cautioned non-Muslim or non-Somali science teachers to recognize that Somali students would challenge them during science class, or would completely ignore what the teachers were teaching.

Anisa suggested a solution for the dissonance between Somali students and science teachers. Her recommendation was that science teachers who are non-Somali (or not Muslim) should provide disclaimers at the start of controversial content so that the students would have a way of accommodating this potentially conflicting information. She also noted an inherent lack of trust for non-Muslim teachers by Somali students, implying that Islam was perhaps the ultimate source of knowledge for Somali students and parents.

The other areas of potential conflict that surfaced with three of the participants (Fati, Ayan and Ali) were sex education, women's reproductive health, and health education. Ali volunteered HIV education as necessary for Somali students since he had just become aware of the statistic that HIV was a serious threat to the Somali population in the U.S. Surprisingly he did not link this explicitly to sex education.

Ayan brought up the topic of sex education as being a challenging one for Somali students since she considered the whole topic "haram" (forbidden or sinful) for Somali students to think and learn about[23]. Given this, I can imagine why Somali adults and students typically hedge around the issues of teaching and learning reproductive health, often called sex education. Furthermore, it is possible that the participants might have believed that they were committing haram just by talking about this issue, and the consequences might have been the disruption of communal integrity.

Given the apparent gender-related differences here, I brought this topic up to Fati to check on her view as she had taken science at the undergraduate level. Interestingly,

---

[23] Haram in Islam is an act that is forbidden by the Qur'an and therefore learning about it or engaging in it is also forbidden. Furthermore, anyone who encourages participation in these acts is also considered to be committing haram.

she advised providing sex education in school to Somali students because, according to her, Somali students did not get this valuable science knowledge at home; without this knowledge "anything [could] happen". Fati's concern that "anything [could] happen" to girls indicated to me that in Somali families girls urgently need reproductive health education, both for greater protection from social pressures (because of being a girl) and also for prevention of future health issues. Furthermore, this sentiment from Fati might have included a sense of distrust of a patriarchal society where girls or women had very little power. In this conversation, I believed that Fati raised an important issue about the cultural practices within the Somali community about who should educate youths (girls in particular) about reproductive health and pregnancy. Although she believed that parents should be the first line of educators on this topic (reproductive health, pregnancy, and the cultural norms surrounding them), she also emphasized that schools should teach human reproduction as a part of health education and that it should not be taken out of the science curriculum, especially at the high school level. Throughout this discussion, it was apparent that Fati was bringing an important but radically challenging issue concerning the Somali community to the forefront. She believed that if parents did not educate their children about human reproduction then it should be the job of schools to do it.

Moreover, Fati's commentary on reproductive health education clearly indicated that this aspect of science teaching and learning should be focused on the safety of girls as the first priority (as opposed to generalized learning about reproductive health, disease, genetics or nutrition issues.) This argument may have its foundation in the larger cultural and social beliefs tied to a girl's suitability for marriage (and safety in the Somali

community). In any case, I believe that Fati's stance on the importance of teaching science topics that are considered "haram" in the larger Somali community (and her ability to withstand the ire of the community) should be considered quite progressive (as well as controversial).

As noted, the views on sex education differed among the three participants, but not necessarily by gender. Although Fati and Ayan disagreed on the inclusion of sex education in science classes, I believe they both had the best interest of Somali girls in mind. They just disagreed on the best approach to protect girls in the community. Perhaps the reasons for teaching or not teaching sex education (reproductive health) in schools are as complicated for Somali parents as those for non-Somali parents.

Pedagogical Challenges:

All participants spoke, either explicitly or implicitly, about the challenges associated with pedagogical changes that they had experienced in U.S. science classrooms. The participants who had familiarity with the practice of teaching itself spoke more directly about the teaching and learning styles that they had had experience with, both here and in East Africa. The participants who did not have personal experience with teaching in the U.S. (or Africa) spoke from the perspective of being students in East Africa, and also from the perspective of being parents or community members who observed either classrooms or homework practices of their children and other Somali children. In both cases, most participants talked about a clear switch in pedagogy from teacher-centered instruction ("direct instruction" or "lecturing") to student-centered instruction ("constructivist science").

Those participants who had some experience in U.S. classrooms compared their East African education to their U.S. education. These participants talked about differences in teaching styles and differences in learning styles of the students. According to Hassan and Fati, schools in Africa were much more challenging as they required year-end exams and higher levels of motivation. Both of these participants suggested that U.S. mathematics and science classes were much easier--- which was related to their perceived lower motivation on the part of Somali students. Ali, Fati, Hasan, and Ayan all expressed dissatisfaction with the U.S. K-12 education system because it allowed schools to promote students from one grade level to another even when students did not master mathematics and science content.

> The way we were learning, the way we were skilled, it is different. So here it is easy, it is easier with expectations. I think the expectation should be high. I think they should not be let go to do the easy stuff (Hassan).

Fati noted that in Kenya her science classes included general science, chemistry, physics and biology with the three latter ones being taught in high school every year. She said that each year she had to pass final tests for each of these science subject areas in order to be promoted to the next grade; but these classes, including labs, "were not fun like here in America". She believed that the final exams were much more difficult than those found here. In addition to noticeable differences in rigor, Hassan also spoke to his belief that science teachers in Kenya were recognized experts in their respective fields. Hence physics teachers had majored in physics, and chemistry teachers had degrees in chemistry. By implication, these teachers were better prepared and recognized as authorities in their fields. On the other hand, most teachers in Africa lacked a diversity of science pedagogical skills .Hassan's assertion was that a physics teacher without a

physics degree did not command respect from Somali students. Furthermore, most parents doubted the effectiveness and expertise of a teacher without a content-focused degree. This expectation of a content-specific degree in science potentially created disrespect towards science teachers who taught without it. Hassan recognized that in the U.S. many middle school and high school science teachers taught science outside of their specific science content area expertise (such as a teacher with an undergraduate degree in biology teaching chemistry or physics).

Ali spoke explicitly of the change from direct instruction in East Africa[24] to constructivism and inquiry science used in U.S. science classrooms today. According to Ali, most Somali adults do not understand constructivism or any type of student-centered pedagogy, such as inquiry science. Ali believed that the switch from direct instruction, which was the experience of most Somali parents in East African schools, to constructivist pedagogies was creating confusion in the Somali community for parents. In addition, because most Somali parents most likely spent a good deal of time memorizing science facts in East Africa, they questioned the lack of memorization in U.S. classrooms. In subsequent conversations, Ali indicated that the confusion in pedagogy sometimes led Somali parents to thinking that U.S. schools were weak in comparison to East African schools, and that U.S. schools were actually failing their children.

According to Hassan, the preference for direct instruction and memorization as effective pedagogies of teaching and learning is established early with Somali elders, parents and students. He stated that the first learning experience that all Somalis have is

[24] Due to their colonization histories, both Somalia and Kenya developed schools using the British or Italian models of education using mostly direct instruction.

during Qur'anic education in Dugsi (Qur'anic school) where memorization and teacher-directed learning are valued and preferred[25]. As noted by Fati, Ayan, Ali, Anisa, and Hassan, Qur'anic education, considered vital to students in East Africa, also continues to play a large role in Somali students' lives in the U.S. Almost all Somali students in the U.S. attend Dugsi (Qur'anic school) either on the weekends or after their regular school hours. Therefore many students and parents viewed memorization and recitation as important pedagogical tools in all learning contexts including science classes.

In addition to the apparent switch in pedagogies, other participants spoke of language issues that challenged Somali students in U.S. science classrooms. As Ali noted, he could assist his children with their science homework only in Arabic as that was the language he had originally used to memorize his science content. He stated that he understood science better in Arabic than in English. Similarly, Ayan saw Somali students often struggled in science in the U.S. because the teachers did not know the language of the students. According to her, this resulted in a lack of understanding science, especially for those who were new to the country. [26] One might also hypothesize that Somali adults preferred to have teachers speak the languages of their children because of their previous experiences in refugee camps. In these settings Somalis who knew the host country's language served as mediators to those who did not. This resulted in Somali-facilitated

---

[25] Dugsi is a religious school and attending it is an important rite of passage for all Somali children. Attending Dugsi fulfills the religious obligation of teaching and learning the Qur'an. Memorization and recitation remained the favored methods of teaching and learning in these schools because of the belief that as Muslims, they needed to memorize and be able to recite the Qur'anic verses at any place and time. However, most teachers at Dugsi did not place greater value on understanding the meaning of these verses. On the contrary, the community placed very high value and prestige on the ability of individuals to recite Qur'anic verses by heart.

[26] Anecdotal experience suggests that Somali parents are skeptical of ELL classes; they are more likely to support bilingual classes for their children with classroom aids or teachers who speak their children's languages.

education in the camps (when education was available at all). The result of this was that Somali youths in camps had access to Somali speakers in all walks of their lives.

Both Ali and Hassan spoke of science being "abstract" to Somali students and families---meaning that the scientific concepts they were learning in schools were not tangible but in fact "alien" to their everyday lives—and hence were not discussed at home. Hassan also spoke to this challenge as he noted that very few Somali families here used any type of classroom science discourse at home. They did not speak of such things as DNA or heredity, for example. This resulted in the students not being facile with scientific vocabulary or concepts and having difficulty with visualizing what teachers talked about in science classrooms.

Home Cultural Practices and Connections to Science

All of the participants suggested, once prompted, that there were a significant number of Somali cultural practices that might lend themselves to connecting the students' lives to the science classroom. Some of these suggestions were connected to religious practices such as fasting, and changes in lifestyles due to immigration. Others were related to everyday practices in the home such as cooking and treating illnesses. As Hassan explained, it was important to him to try to make connections between the science he was teaching and his students' lives. Making science real and practical was one of his many goals with his students. In this case, Hassan's experience with science and Somali-American students was based on the understanding that what mattered at home mattered at school too. He believed that Somali-American students might find "grasping" science ideas and concepts challenging, but when linked to their own everyday practices, science

ideas and concepts were less challenging. As Ali argued, even Somali students "[did] science everyday [and brought] that kind of meaning of science forward" in class would encourage students to locate themselves in science and science practices.

The challenge, as noted by Ali, was that Somali parents often did not recognize their own valuable contributions to their children's lives. Also, the traditional role of parents in Somalia did not include involvement in their children's schools. This is consistent with the literature. According to Farid and McMahan (2004) parents could send their children to school and expect that all of their children's educational and spiritual needs would be met by the teachers. In fact, teachers were expected to be disseminators of content, as well as role models in the Muslim faith. This intertwining of religion and school was taken for granted. Given this, the separation of church and state in U.S. schools is likely to be confusing to Somali parents, and, in this case, might have contributed to their lack of faith in the system in which they placed their children.

Identity Challenges

As the interviews progressed, it became apparent that all of the participants were struggling with identity challenges, both within themselves and for their children. Much has been written about the identity challenges that immigrant children face in U.S. and other diasporic schools, including those from the Muslim faith (see Chapter 2 for a more complete discussion of the experiences of Muslim students in European and North American schools). As Ali so astutely noted, Somali students were in transition in terms of their cultures, and their identities. Ali also noted that he thought Somali students were "somewhere in-between American and Somali in terms of culture, mixed." And as

Hassan added, the students appeared to be between two countries, their home country of Somalia, and their newly adopted country. He believed that they were essentially fragmented, and not able to learn as well because of this. Both Ali and Hassan perceived their identity as mixed and between two differing spaces.

In other words, the culture of the parents and also of their children appeared to be changing as they chose to integrate or participate in their new American culture. I believe that Ali presented an important glimpse into the layered and overlapping cultural space in which Somali youths, and to some extent the adults, live in the U.S. At one level, the youth are taught at home the skills and socio-cultural habits and beliefs consistent with their parents' traditional expectations. For example, they routinely attend Dugsi where they are steeped in Qur'anic teachings. At another level, they often attend public schools where the knowledge and values learned at home are sometimes challenged, obscured, or trivialized in unsettling ways . Although most of the participants recognized this dichotomy, they were at a loss about how to mitigate these tensions in their children's lives. And at the same time, it is likely that the adult participants (apart from Hassan) were limited in their ability to accept new ways of living their lives.

These apparent generational differences may lead to intergenerational communication gaps and conflict as noted by Huismen et al. (2011). This juxtaposition of a relatively stable parent culture and an evolving youth culture may present a significant barrier to border crossing, both for the parents who strive to maintain their Somaliness, and for the children, who are choosing to adapt to new opportunities, lifestyles and perhaps, beliefs. This tension may play out in science classrooms in many ways as

students grapple to understand and/or to accept relatively new concepts, some of which conflict with their religious beliefs and challenge their social and cultural practices about engaging in and learning science. It is possible that the burden of leaving one's core identity (that is tied to one's Somaliness) and accepting a much more peripheral way of life (or identity as a science learner or scientist) is too much for some Somali students. In other words, the constant burden of living "in-between" or at "midpoint" or in common parlance here, in no-man's land, may cause some Somalis to lessen their investment in science education. This may be made more difficult by the lack of science teachers with Somali credentials---hence, the students' abilities to mitigate issues of distrust and hostility is minimal.

In essence, both Ali and Hassan believed that these cultural changes were negatively impacting the learning of Somali students. Future work needs to address this concern more specifically. One could easily hypothesize that the constant challenges of assimilation and/or accommodation to the culture of power was troubling Somali adults. One could also hypothesize that the pressure from Somali community members to maintain traditional cultural values vis-à-vis the pressure from adults to adapt other values presented Somali youths and parents with difficult choices. ((Check literature on Latino students---not a new idea))

The identity challenges of the adults also became apparent as it appeared as if the adult participants themselves were in the process of questioning their own identities (as immigrant parents in a somewhat alien society, as Muslims in a largely non-Muslim society, and as teachers and caregivers in an educational system that functioned on

(perceived) different values). Fati, for example, spoke at length about how difficult it was to be a single parent in the U.S. with the expectation that she, alone, should not only provide for her family financially, but also provide support for them psychologically and spiritually. The fact that she had very little time to participate in her children's various school activities, including science---which she highly valued, was frustrating to her. Hassan spoke of the challenges he had teaching science to Somali students here due to changes in pedagogy, and larger systemic issues he could not address; and Ali spoke of the challenges of maintaining Muslim practices (such as fasting, and appropriate clothing during exercise) while immersed in a society that is structured otherwise. These examples suggest that the participants were struggling to find a balance between preserving their own Somaliness (and that of their children) and also adapt to changing environments.

Chapter 6: Findings, Discussion and Implications

Overview

Based on the premise that the endeavor of science education is socially and culturally based, this study focused on the specific cultural experiences and beliefs of one group of recent immigrants to the United States, Somali-American adults. As relatively recent immigrants, as well as refugees, the adults who participated in this study spoke of their hopes and dreams for their children, as well as perceived challenges for them, as they navigated K-12 science classrooms in this country. I believe these conversations have many implications for K-12 science teachers, as well as for the pursuit of equity in science education more generally. In this chapter I discuss the major findings of this study, its contributions to the literature on culturally relevant pedagogy and funds of knowledge, and implications for classroom teachers and schools. Specifically, I suggest that this study makes two significant contributions to the research on science education: 1) The study is the first to explore the views of Somali elders and parents about science teaching and learning; and 2) the study suggests that Islam is an additional fund of knowledge for Somali students that needs to be addressed by science teachers. Finally, I suggest areas for future research and practice in science education.

Finding: Science Education is Valued

As noted by the participants, science education is highly valued in the Somali community, both in East Africa and in their newly adopted homes. And, although all participants talked about how science could lead their children to more economic security, and to perhaps a higher social status, they also spoke eloquently about the

connections they saw between science education and bettering the community at large. Implicit in this view is a distinct aspect of "Soomaalinimo" that merits further mention, that of a collective identity and collective purpose. As one of my students recently (and rather loudly) broadcasted in class "we are Somali, we do everything together."

In this sense, science education is viewed not only as a means to a respected career for an individual, but also as a vehicle for improving the quality of life for all Somalis, both local and global. As with many diasporic communities, Somalis are acutely aware of the responsibilities they have toward their families and friends regardless of where they live. Over the years I have heard many times how students wish to become "doctors" so that they can go back to East Africa and assist their relatives who were left behind in a war-torn country or in nearby refugee camps. They are also acutely aware of the lack of proper medical facilities and sanitation technology available to the people who were left behind, many of whom have suffered or died from treatable diseases. This strong sense of collective caring was expressed by all of the adults I talked to (as well as the students I have taught over the years). Noddings (2005) argues that in caring relationships between a learner and a teacher there is an intrinsic suggestion that the learner feels that learning is beneficial to him/her and to his/her larger community. Therefore in the case of Somali science classroom an environment of caring could be realized through science topics that are supportive of Somali desires for better health and better access to health.

Along with this, the participants also talked about science education as providing a bridge between the more traditional aspects of their culture and their changing

environments and needs. As noted by Hassan, science education might allow Somali people to reimagine their traditions in order to seek healthier lives and communities in a changing world. Ali expressed this with specific examples including the need to educate people about appropriate diets and exercise in the U.S. given the availability of many differing food choices here, and the lack of culturally appropriate exercise facilities, especially for Somali women. This finding is consistent with the literature in science education. Several studies have suggested that there are clear linkages between the value of science teaching and learning and socio-cultural and personal connections (e.g. Aikenhead, 2006; Calabrese Barton & Upadhyay, 2010).

Finding: Science is Viewed as Abstract

At the same time that participants viewed science education as a means to bettering lives, they also spoke of classroom science being "abstract" or alien to their everyday lives. My experience with teaching Somali students in science suggests that this notion of abstractness stems from a variety of issues, language being just one of them. As noted by Ayan, when teachers and students do not share a language (as is the case with most science teachers of Somali youth in the United States), then students have more difficulty understanding new vocabulary and concepts because the teachers cannot explain them in the student's first language (Collier, 1995; Miller, 2009). This is sometimes mitigated by the use of bilingual classroom aides.

I believe this statement of science being abstract is also related to the perceived lack of connection between Somali culture and family practices and what the students are learning in school. This is similar to what scholars such as Moll et al. (1992), Ogbu

(1992) and Sleeter (2012) have argued in their works with marginalized students, teachers, parents, and communities. As Hassan stated, terms like "DNA" are not talked about in Somali families at home; and genetics, in general, is so little understood that people do not make connections between the genetic diseases they may have observed in their families and communities and school science that include genetics. Moreover, I think that it is possible that the practices of science, especially as practiced in western countries, may be entirely alien to traditional Somali culture. For example, the processes of hypothesizing, designing experiments to test data and then coming to conclusions based on evidence, may be new to Somali adults, even those who were educated in East Africa and/or the United States. As one participant mentioned to me, "science was about doing things…like mixing chemicals and making circuits…we didn't think the same way about it there (as students)." It is possible that everyday thinking and decision-making strategies are likely based on other systems of knowing (Aikenhead, 2006; Gay, 2000). In a sense, they may view science education as a means to improving the lives of their children and their communities, but only in the long-term, once the students have acquired a sufficient amount of knowledge to become a doctor or other type of professional.

An alternative view on abstract concepts is presented by Farid (2004). In his handbook for teachers of Somali students, he suggests that "critical thinking skills" are more valued in societies where independence and individualism are also considered important (p. 68). In his view, Somali people, who value collectivism as opposed to individualism, tend to be more concrete thinkers (as opposed to abstract thinkers), so

concepts that they view as abstract may be more challenging for them. He suggests that Somali students need more practice with working and thinking independently (and critically).

Finding: Islam and Science Teaching and Learning-Perceptions of Conflict and Acceptance

As noted earlier, throughout the interviews it became apparent that the participants were typically open to most scientific concepts as taught in their children's schools[27], and unconditionally supportive of science careers for the next generation of Somalis. Underlying all of this, however, was their frame of reference based on their internal belief system--- which was firmly anchored in Islamic history and teachings. This deep rooted connection to Islamic history and teachings has many implications for how Somali adults (and students) view science education. In this section I will focus on perceived relationships between science education and Islamic education, changes in pedagogies, and perceived conflicts between Islam and science.

I believe that the generalized acceptance of science education by the participants was also related to how they viewed science as an endeavor supported by the Qur'an. Hassan, in his musings about the relationships between science and Islam, noted that in his readings and understandings of the Qur'an, the pursuit of science was not just supported but encouraged. In his teaching of science, he said he often reminded students that learning science was a good thing, and consistent with their Islamic faith. Mansour (2010) also noted that ancient Muslim scholars have always provided a pathway and/or

[27] With a few exceptions in individual cases

model for current Muslim students, and that the processes of science, including experimentation and gathering and weighing evidence, were not foreign in many historic Islamic traditions. Given the apparent contradiction between Mansour's interpretation of the role of science in ancient Islamic cultures and the abstractness as mentioned by this study's participants, one might hypothesize that although scientific endeavors are valued, they are not typically part of their everyday activities and discourse.

Having said this, it was also apparent that there were some aspects of science education that caused conflict for the study participants since they could not reconcile what they had learned in Islamic school (Dugsi) with the science they had learned in public or private schools. The areas talked about included evolution, origin of the Earth, and geological processes in general. As described by both Ali and Anisa, these differences were puzzling, unresolvable for them as adults, and often led to students disregarding the scientific concepts all together. Anisa advocated for disclaimers on the part of the teachers so that Somali students could more easily navigate their way through these topics. Fati counseled a more pragmatic approach that encouraged students to learn about evolution because they would need that knowledge to succeed in college later.

These different approaches to working with conflicts can be thought of as different styles of border crossings based on the literature in science education. Some adults, such as Fati (and those in her family), appear to be able to succeed in science by using Fatima's rules, a combination of coping mechanisms that allow success in school even when the science instruction is at odds with the students' world views. Other students, such as Anisa, were less successful at this border crossing, possibly related to

perceived irreconcilable differences between her worldview and that of Western science. In both cases, assimilation is resisted. Moreover, the literature suggests that deeper understandings of the science subjects at hand can be elusive, if even possible (Jegede & Aikenhead, 1999).

Given the fledgling research in this area of science education, it makes sense to me to tread cautiously in these areas, both as a researcher and as a practitioner. I think the possibility of symbolic violence was real for the members of this community. Symbolic violence is often characterized as a power imbalance between those in power who create cultural codes of conduct that others must follow, and those who are not in power who must choose to follow those rules of conduct even though they conflict with their own values, beliefs and ways of operating (Bourdieu, 1984; 1998; 1999). Hence symbolic violence, in this case, may covertly contribute to inequitable science teaching and learning for Somali students and families because the science we teach is not consistent with explanations found in the Qur'an. I think that science teachers should be aware of the potential to alienate their students. In addition, science teachers should be aware that Somali students might resist learning these topics as a part of a larger political stance--some in the community might view the teaching of these topics as a means of subverting Islamic beliefs and traditions or even outright coercion (DeCapua, Smathers, & Tang, 2007; Epstein, 2010). Acknowledging this possibility and creating safe classroom environments (Epstein, 2010), wherein students and teachers can raise issues and talk about their personal beliefs and conflicts, might facilitate better learning for all.

Finding: Pedagogical Challenges

One of the most surprising results to me was the apparently unspoken distress that many Somali adults have about constructivism in science classrooms. I had seen glimpses of this phenomenon in my science classrooms over the years as parents questioned the amount of rigorous homework that teachers, including science teachers, sent home with their children.. As Ali said in his first interview, "constructivism doesn't go very far with Somali parents".

One of the findings of this study relates to how deeply Somali parents and elders believe that rigorous science education (as well as all other education) is related to how much students are asked to memorize or learn directly from the teacher who is viewed as the knower and expert authority. 'Dugsi" (the traditional Muslim school system) had significant influence on Somali parents' views about school teaching and learning. It is important to remember that Qur'anic schools existed for centuries in Somalia before European colonists tried to establish their own schools, and continued to exist alongside of the colonial schools throughout the history of Somalia. Once established outside of Somalia, Somali immigrants have also set up Dugsi schools in their host countries and communities as well, and all Somali children are still expected to attend Dugsi on the weekends and/or weekday nights.

Today, the pedagogy in Dugsi remains the same as it was in Africa, with the teacher reciting verses, and the students writing those verses down in Arabic and/or reciting them in Arabic exactly as the teacher has said them. This listening, memorization and recitation process is meant for acquiring the literal verses of the Qur'an, but not

meant for discussion, comprehension or understanding of what those verses mean. Although there are opportunities for students to acquire more comprehension of what they are memorizing, those opportunities are not part of Dugsi and most students do not participate in them. Given this, it is much easier to understand how Somali parents and elders are confused about constructivist pedagogies and student centered teaching that typically do not require vast amounts of memorization, and on the surface, may look like they do not require much student effort. Hence, as Ali implied, Somali parents find this confusing and may even view U.S. school systems (and science classrooms) as failing their children because they are perceived as so much easier. Regarding memorization, it is likely that the Somali experience of memorization is viewed as critical because it allows for the preservation of their oral histories, traditions and cultural knowledge--- no matter where they are. For cultures based on oral traditions, this process of memorization may be viewed as a key to their survival in changing conditions and environments.

For the students, it is important to remember that this type of educational experience (using direct instruction) was not only the experience of their parents interviewed for this study, but is also their current educational experience when they attend Dugsi concurrently with their regular schools. Although one might argue that memorization and recitation were also a routine part of American pedagogy in the last few generations, the salient point for Somali students is that they are expected to perform in two different schools, with two very different types of pedagogies at the same time. Other studies have noted these challenges, For example, studies that focus on teaching and learning in indigenous schools, where knowledge is passed from elders to young

community members, show that similar issues exist between parents and students on one hand and between teachers and science content on the other (Aikenhead, 2001).

Finding: Identity Challenges

As so eloquently described by Ali, Somali students, as immigrants or even as children of immigrants, struggle with identity issues. At home they are expected to follow traditional Somali traditions, and outside of home, they are making their way in an American teenage culture with its own changing practices. In essence, and as noted by many studies of immigrant youth (eg. Ngo & Lee, 2007), they have hybrid identities, and these identities are changing as they acclimate to a new environment---they are not Somali and they are not American, they are "in-between".

Directly related to this is the perception that this mix of identities is not good for the learning process. For example, constructivist pedagogies (such as inquiry science) may actually be viewed (by parents) as a threat to their traditional way of raising children and may be viewed by the students as a reason for not taking teachers seriously. Underlying this is the traditional Somali belief that children should be raised with very little independence, and all decisions are made for them by the parents. Likewise, Hassan stated that this dual identity (in the students) likely fragments their connections to science learning. In other words, it becomes more difficult to psychologically and emotionally connect to classroom science when you are being pulled in two directions, one from your parents' traditions and culture, and the other from your school's traditions and culture. Both Ali and Hassan linked this hybrid identity to lower school performance in science for Somali-American students. Using border crossings as a metaphor, the science

education literature suggests that cultural clashes between students' life worlds and the world of Western science can create significant barriers to the learning process (Jegede & Aikenhead, 1999).

Finding: Connecting Classroom Science to Home

As noted in the findings to the first research question, Somali people value science education not only from an individual perspective, but also from a community perspective. I believe this attachment to the betterment of the community is deeply rooted in Somali culture, and provides a means for making science education more attractive to Somali students. As suggested by all participants, when science learning is connected to the caring of individual members of a family, or to the community at large, it can become more meaningful to Somali students. This focus on the creation of a caring environment and its relationship to learning has been demonstrated in other contexts; many studies have shown that students exhibit greater academic achievement, better behavioral adjustments, and increased emotional health and well-being when their learning is connected to a caring environment and purpose (Denham, Brown & Domitrovich, 2010; Watson, 1979; Durlak, Weissberg, Dymnicki, Taylor & Schellinger, 2011).

Participants of this study shared many examples of how classroom science could be connected to the everyday lives of Somali students and their families and communities. Health issues, like learning the correct use of prescriptions, as well as proper general nutrition and exercise, were frequently cited. Other examples included food preparation and storage. Moreover, some participants clearly wanted to connect classroom science with the betterment of Somali people who remain in Africa, as they

had first-hand experience with famines, easily preventable diseases such as dysentery, and the lack of routine medical services for Somali refugees in other East African countries.

One finding that seemed particularly relevant was related to the specific health needs of Somali-American immigrants. In other words, due to changing resources (climate, foods available and exercise patterns), Somali-American immigrants are experiencing different health issues than they have in the past. These include increased rates of diabetes and obesity, for example. Ali talked about the need to teach proper nutritional practices to students and their families while fasting (sunrise to sunset) during the month of Ramadan, for example, so that students and their families learn the value of refraining from easily available (and cheap) low quality food resources when they are breaking fast. This is a particularly salient point because binge eating after the breaking of fast is common in the Somali community and also known to be unhealthy. The need to balance one's health with the religious and moral purposes of fasting during Ramadan could be addressed in science teaching and learning. For example, aligning topics in nutrition with those in the human organ systems (e.g. the anatomy and physiology of the digestive system) might be a way to encourage Somali students to engage with science and to find science more valuable in their everyday lives.

Connecting science to home was also linked to changes in daily exercise patterns (Africa vis-à-vis the United States) and the implications for women's health in particular. The issues of women's and girls' reproductive health and the need for protecting girls

against future harm by educating them seemed important. Further study in this area by linking it to gender issues and science could be very valuable.

When talking about how best to engage and excite Somali students in science, participants recommended hands-on activities and labs since Somali students love hands-on activities and experiences. Although their own educational experiences in science labs seemed to vary, all of the participants recognized an innate curiosity in Somali students, and recommended building on it in science classrooms in the U.S. Even though this appears to contradict the parents' own educational experiences, this type of education is likely consistent with the learning that naturally takes place in Somali families whereby children learn from parents by watching and replicating as in an apprenticeship model. As stated earlier, it is likely that early learning in Somali families and communities followed this model, as boys had to gradually learn from adult males how to take care of livestock, and girls had to learn from adult females how to take care of the home (Rogoff, 2003; Good, 1999). Rogoff (2003) claimed in her works with young children in various ethnic groups in Africa, Asia, and South America that learning from adult experts as an apprenticeship follows learning by doing with immediate feedback from the elders or adults. Therefore I believe that the constructivist and inquiry oriented science teaching and learning methods could draw from an apprenticeship model to bridge the pedagogical gaps to support learning for Somali students.

The Role of Science Teachers

As I have heard from many Somali colleagues and parents over the years, it is a well-established norm that teachers are viewed not only as ultimate content authorities,

but also as second parents. In traditional Somali schools, teachers served not only as instructors of content, but also as models for Islamic living. In this sense, teachers were also expected to contribute to the moral development of students and were highly respected members of their communities. As Somali students participate in U.S. science classrooms, this expectation is often held, and yet, in my experience, impossible to meet for white teachers of Somali students.

In this study, participants noted that cultural sensitivity to Somali students must also include sensitivity to their religion, Islam, as it is considered an essential part of their culture and everyday life---for them, Islam and everyday living go hand-in-hand. Non-followers of Islam need to understand that for Muslims, Islam and everyday activities (including everyday decisions) are not separate. White (non-Muslim) science teachers of Somali students can be viewed with skepticism, or even more alarmingly, as the messengers of "lies" when we teach theories such as evolution and the geological formation of the Earth. Alternatively, non-Muslim teachers can mitigate this situation for Somali students by providing disclaimers at the outset of teaching these content areas. In a more positive sense, participants suggested that non-Muslim teachers can assist Somali students in bridging these perceived gaps by being sensitive to these discrepancies between science and Islamic teachings. Mansour (2011), in his study of Egyptian teachers suggested that Muslim teachers carry a view of science based on their Islamic religious beliefs which often generates conflicting views about science and Islam. Furthermore, according to Mansour, Islam in many contemporary Muslim communities is not just about moral and spiritual beliefs but for those who follow Islam it is a 'complete and

comprehensive way of life' (Mansour 2011, p. 285). BouJaoude et al. (2010) also made a claim similar to that of Mansour saying that Muslim teachers' religious tendencies influenced their pedagogical practices on the topic of evolution. BouJaoude et al. (2010) further claimed that Muslim biology teachers and professors interpreted the Qur'anic verses on evolution in multiple ways to reconcile with scientific views or completely reject scientific views when there was a conflict between the two.

In the case of Hassan, it became apparent that as a Muslim science teacher, he was able to bridge this chasm more easily. He could not only connect his recognized knowledge of the Qur'an to its support of science (in general, although not in details, as he said), he could also engage in a pedagogy of humor and politics that engaged Somali students in science that helped him and students reconcile Qur'anic verses with the science they were learning. Hence, science teachers can serve as cultural brokers (Jegede & Aikenhead, 1999), or as facilitators or resource people (Atwater, 1996) in order to guide students between their own cultures and the culture of science.

Other Funds of Knowledge

Given the support of science education by Somali parents and elders, and the dearth of knowledge (by non-Somali people) about home traditions and practices, there appears to be high potential for funds of knowledge research and practice in science education. Although there is much research in the area of funds of knowledge with other populations (see chapter 3), I have not found any research that has looked at funds of knowledge as it relates to the teaching and learning of science in the context of Somali students. Moreover, there is very little work with refugee families and students in science

education. A study by Upadhyay (2010), for example, attempted to connect Hmong refugee experiences and science education, but did not specifically look at the intersections between refugee experiences and beliefs and science learning. Moreover, for Somali parents and students, the requisite that faith in Islam supersedes any other type of learning presents a unique perspective and challenge in the current notion of funds of knowledge research.

Moreover, I believe it is highly unlikely, given my K-12 experience with Somali students and families, that this area has been explored from a teacher perspective. The challenges are real. As refugees, and immigrants to a somewhat alien American culture, Somali families are likely to be initially mistrustful of authority figures in any context. As one of the participants explained when I later asked about this possibility, Somali families frequently live in abject poverty and hence are not willing to share their living situations with strangers. It is likely that this challenge can only be surmounted with the building of trustful relationships between practitioners and community members, or researchers and community members, with Somali people who are willing to serve as cultural brokers.

Culturally Relevant Pedagogy

Likewise, but perhaps easier, there appears to be high potential for working with Somali students and families to develop culturally relevant pedagogy in science classrooms, both in research and in practice. My initial attempts at working on this as a teacher have been successful as long as I have been willing to let the students define what is culturally relevant. As I described in Chapter one, when developing a schoolyard garden, my initial idea to try to grow herbs and plants that are commonly used in Somali

teas, cooking and medicines was vetoed by my students who were more interested in growing a "salsa" garden because they were all fond of salsa and chips. It was a good reminder that culture should be defined by those who actually participate in the traditions and practices. And, that the culture of immigrant students is always in the process of change.

As a result of this study, I believe that we need to further extend the notion of cultural sensitivity or culturally relevant teaching to religion and faith sensitivity in this case. Both the content and the style of pedagogy matters for Somali students, as well as their religious beliefs which appear to be intrinsic to their identities as Muslims and Somalis (Mansour, 2011; BouJaoude et al., 2010). Teachers who are aware of Somali student experiences and beliefs outside of the classroom are more likely to be able to build safe environments for discussion of controversial topics in science like evolution and more likely to scaffold pedagogical approaches that work. Science teachers who ignore basic Somali cultural practices and beliefs are less likely to be successful at creating good teaching and learning environments for these students (BouJaoude et al., 2010).

Other culturally relevant areas that could be explored with Somali students include the historical contributions of Islamic scholars in science, as well as the current contributions of Muslim scientists (AAAS, 1990). The apparent lack of accessible (Somali) role models for Somali students was concerning for the elders who participated in this study. The participants recognized the power that role models could have on students' developing perceptions of science, their motivation and their interest in careers

in science. It was clear that trust in role models and teachers was not easily gained, especially for teachers who do not practice or understand Islam.

Changes in Pedagogy

Although changes in pedagogy could easily fall into the category of culturally relevant pedagogy, I think educators need to be very thoughtful about additional pedagogical strategies in science education with Somali students. The transition from learning by rote memorization and recitation to constructivist thinking appears to be significant for the Somali students that I have taught. Moreover, parents and elders in the community appear to be perplexed or completely unaware of this latter style of learning for their students. This transition also appears to be significant for Somali teachers of science who appear to be more comfortable with a teacher-centered model. My recommendation for this transition is to think about explicitly scaffolding it for younger Somali students in science so that by the time they get to middle and high school, they have some familiarity with the inquiry processes of science learning. In the cases where older Somali students immigrate, I think we need to be even more explicit and provide models of both types of learning so they can see and appreciate the pros and cons of each in specific teaching and learning settings. More attention needs to be given to early science literacy, which should include the thinking and habits of scientists as they define questions and seek to answer them. There is much work to be done in this area with Somali parents and communities.

Methodological Implications

Sensitivity to Refugee Participants & Gender

I begin by acknowledging that the issues of immigration are hotly debated in the political, cultural, and social arenas and therefore the research on immigrant and refugees is not neutral. Some people support immigrants and refugees as their presence benefits the U.S., whereas others argue against these populations because they view immigrants as draining valuable resources. Given the specific social, cultural, religious and political experiences of the participants of this study, I tried to be as sensitive as possible to the needs of the participants who agreed to be interviewed. From the beginning, I was well aware of the refugee status of all potential participants, and that I was working with a community already in duress (due to many recent negative stereotypes portrayed in the media). I was therefore also aware of their likely distrust of authority figures from outside of the culture. Thus this raises the issue of authenticity of the data collected through interviews as refugee participants are sharing very personal information with an individual who is in power (Fisher et al., 2002).

I believe that getting participants to agree to the study was largely a result of my prior work with Somali students in two different educational settings. In other words, I was a known quantity to most of the participants, albeit through word of mouth, if nothing else. Often viewed as a snowball or chain sampling (Patton, 2002), I used my prior connections to locate participants for the study. Based on this experience, I think it is important to note that in the case of refugee and immigrant populations, these types of conversations may only be possible when there are trustworthy relationships with the

culture one is trying to understand and study. To minimize anxiety, each participant was approached personally. Great care was taken to explain the study's purpose, and examples of questions were given ahead of time when requested. In many refugee groups outsiders are always viewed with a certain degree of suspicion and the motives of out of group individuals are in constant question at all phases of the study from consent form signing to interviewing (Yu & Lieu, 1986). I was also aware that things and actions that are ethical or permissible in the white U.S. culture may not be considered ethical and/or permissible in the Somali refugee culture. For example, in mainstream white U.S. culture a male researcher is permitted to interview a female participant but in the Somali culture that would be considered both impermissible and unethical. Given this understanding of the gender roles in traditional Somali culture, I alone interviewed the female participants in the study so that they could speak more freely about anything they wanted to, including reproductive health as part of science education.

Additional Implications for Educational Systems

Apart from the above discussed findings and their implications in science teaching and learning of Somali students and parents' perceptions of science, I find implications discussed below challenging and important.

Cultural Training and Professional Development

I believe that cultural training (and other related professional development for educators) needs to look more deeply at the underlying belief structures, languages, cultural practices and traditions, and pedagogical practices of our students and families. Moreover, these trainings need to view culture as non-static, especially for immigrant and

refugee students who are in the process of redefining their own identities as they accommodate or assimilate to their new host countries. This process of redefining identities brings with it a mix of characteristics for students that are often different from those represented (and advocated for) by the elder generation. This can lead to confusion in the teaching and learning of science, on all sides.

Perhaps more important, however, is my own anecdotal experience that the professional development for teachers of immigrant and refugee students often focuses on "best practices" such as quality work, teaching to standards, and developing learning targets and rubrics, and essentially misses the mark for these students. An essential component, frequently missed, is the more difficult practice of actually getting to an understanding of the student populations (and cultures) at hand. Although most of these best practices are based in research, and likely effective with most students, I think immigrant and refugee students, by their very nature, are less likely to buy into the dominant culture's view of education for them. I believe that resistance to learning for Somali students is also about their involuntary immigrant status in the U.S. (Ogbu, 1992). As involuntary immigrants, it is likely that they are not willing to give up what they view as the essential parts of their own culture, practices, values, and Islamic beliefs for education, science or otherwise. For most Somali students and families in the U.S., living in concert with one's culture is not viewed as one possible option of many, it is the only acceptable option, even with the tensions they experience as a result of being "in between" cultures, as noted by the study participants. In essence, it is only working with

them, and with their buy-in on content and pedagogy, that effective teaching and learning can happen in science classrooms.

Ideas for Future for Research & Practice

Research & Practice: Immigrant Parent Involvement in Science Education

As noted in the literature review, parent involvement in science education can take many forms. Parent involvement with immigrant and refugee families has its own complications due to many issues such as language, belief structures about the role of parents in education, and trust. I believe that most immigrant families are well aware of the power differentials between mainstream schools and immigrant families, and as a result, are sometimes reluctant to have a conversation about supporting their children in school. For example, the schools that I have worked at have been largely unsuccessful in recruiting parents to attend "family nights" or to "volunteer" in their children's classrooms for a variety of reasons.

Having said this, I also think there is good potential for studies that focus on family practices (funds of knowledge) in homes or community centers, in ways that are non-threatening and more convenient to working parents. Research in this area is emerging in early literacy practices and could be extended into early science literacy practices, for example. Using the work of Mutegi (2009, 2013) with African American student families, I believe that similar research could be done with Somali families. Given the needed transition between pedagogies in Somali families, this could be a focus as well with providing examples of culturally relevant science activities for the home.

Research & practice: Culturally relevant pedagogy

Due to the absence of any models for Somali students that use culturally relevant pedagogy, science education research could explore this area in specific science content areas. Areas that come to mind include traditional medicines, and food preparation and storage in chemistry and/or biology. Students and teachers working with parents could develop these models for the science classroom.

Research & Practice: Teacher Sensitivities and Cultural Competencies

Research needs to focus on how to best develop teacher sensitivities and cultural competencies in science education. As noted by Ryan (2012), we have a long way to go in terms of changing science teacher belief systems related to multicultural issues. I am not aware of any research in this area that looks specifically at the role of teachers in mitigating border crossings for Somali students in science education. Likewise, there is very little information available to practitioners on scaffolding pedagogical approaches for students who come from cultures that have different ways of teaching and learning.

Conclusion

The analysis of these interviews with Somali-American adult refugees supports the idea that Somali adults' perceptions of science and science teaching and learning are mostly positive and directly linked to their children's and community's future. These perceptions were framed by the adults' home experiences, including Islam as a central part of their culture, and by their experiences as refugees. Furthermore, this study supports the idea that learning and engaging in science, for Somali students and adults, is all about building caring, positive experiences that pragmatically connect the science they

are learning to the betterment of their community, both local and global. I believe that as science educators and researchers interested in furthering equality for all students, we need to be mindful of the importance of our students' cultures in everything we do.

References Cited

Aikenhead, G.S. (1997). Toward a First Nations cross-cultural science and technology curriculum. *Science Education, 81*(2), 217-238.

Aikenhead, G. (2001). Integrating western and aboriginal sciences: Cross-cultural science teaching. *Journal of Research in Science Teaching*, *31*, 337-355.

Aikenhead, G. (2006). *Science education for everyday life.* New York: Teachers College Press.

Aikenhead, G.S., & Jegede, O.J. (1999). Cross-cultural science education: A cognitive explanation of a cultural phenomenon. *Journal of Research in Science Teaching, 36*, 269-287.

Aikenhead, G. S., & Otsiji, H. (2000). Japanese and Canadian science teachers' views on science and culture. *Journal of Science Teacher Education*, *100*, 277-279.

Ali, M. (2008). *Statement of special circumstances.* Unpublished manuscript prepared for Admission Possible, Ubah Medical Academy Charter HS, Minneapolis.

Albrecht, N., Reese, A., Roehrig, G., Upadhyay, B. (2012, March). *Exploring NOS with immigrant Somali youth in a charter school biology curriculum.* Paper session presented at the meeting of the National Association for Research in Science Teaching, Indianapolis.

Allen J. (2007). *Creating welcoming schools: A practical guide to home- school partnerships with diverse families*. New York: Teachers College Press.

Allen, N. J. and Crawley, F. E. (1998), Voices from the bridge: Worldview conflicts of Kickapoo students of science. *Journal of Research in Science Teaching, 35*,

111–132.

American Association for the Advancement of Science. (1989). *Project 2061: Science for All Americans.* New York: Oxford University Press.

American Association for the Advancement of Science. (1993). *Benchmarks for scientific literacy.* New York: Oxford University Press.

American Community Survey (2011). Retrieved from www.factfinder.census.gov.

Apple, M. W. (2014). *Official knowledge: Democratic education in a conservative age.* New York, NY: Routledge.

Atwater, M. (1996). Social constructivism: Infusion into the multicultural science education research agenda. *Journal of Research in Science Teaching*, *33*, 821-838.

Atwater, M. M., Freeman, T. B., Butler, M. B., & Draper-Morris, J. (2010). A case study of science teacher candidates' understandings and actions related to the culturally responsive teaching of" other" students. *International Journal of Environmental and Science Education*, *5*(3), 287-318.

Au, K. H. P. (1993). *Literacy instruction in multicultural settings*. New York: Harcourt Brace College Publishers.

Barton, A. C. (1998). Teaching science with homeless children: Pedagogy, representation, and identity. *Journal of Research in Science Teaching*, *35*, 379-394.

Barton, A. C. (2003). *Teaching science for social justice*. New York: Teachers College Press.

Barton, A. C., Hindin, T.J., Contento, I.R., Trudeau, M., Yang, K., Hagiwara, S., & Koch, P.D. (2001). Underprivileged urban mothers' perspectives on science. *Journal of Research in Science Teaching, 38(6),* 688-711.

Barton, A.C., & Roth, W-M. (2004). *Rethinking scientific literacy*. New York: Routledge Farmer.

Barton, A. C., & Tan, E. (2009). Funds of knowledge and discourses and hybrid space. *Journal of Research in Science Teaching*, *46*(1), 50-73.

Barton, A.C. & Upadhyay, B. (2010). Teaching and learning science for social justice: Introduction to the special issue. *Equity & Excellence in Education*, *43(1)*, 1-5.

Barton, A.C. & Yang, K. (2000). The culture of power and science education: Learning from Miguel. *Journal of Research in Science Teaching, 37*(8), 871-889.

Basford, L. (2008). *From mainstream to East African charter school.* (Unpublished doctoral dissertation). University of Minnesota-Twin Cities, Minneapolis.

Basford, L., Hick, S., & Bigelow, M. (2007). *Educating Muslims in an East African US charter high school* (Occasional Paper No. 147). Columbia University, New York, NY: National Center for the Study of Privatization in Education.

Bell, J. (2001). High performing, high poverty schools. *Leadership*, *31*(1) 8-11.

Bigelow, M. (2008). Somali adolescents' negotiation of religious and racial bias in and out of school. *Theory into Practice. Special Issue on Immigrant Education, 47*(1), 27-34.

Bigelow, M. (2010). *Researching and educating Somali immigrant and refugee youth in Language Learning* 60:Suppl. 1, September 2010, pp. 147-156. Copyright 2010

Language Learning Research Club, University of Michigan.

Bigelow, M.H. (2010). *Mogadishu on the Mississippi: Language, racialized identity, and education in a new land.* University of Michigan: Wiley-Blackwell.

Bouillion, L. M., & Gomez, L. M. (2001). Connecting school and community with science learning: real world problems and school–community partnerships as contextual scaffolds. *Journal of Research in Science Teaching*, *38*(8), 878-898.

BouJaoude, S., Asghar, A., Wiles, J.R., Jaber, L., Sarieddine, D., Alters, B. (2010). Biology professors' and teachers' positions regarding biological evolution and evolution education in a Middle Easter society. *International Journal of Science Education*, *33*, 979–1000.

Bourdieu, P. (1984). *Distinction: A Social Critique of the Judgement of Taste.* London: Routledge & Kegan Paul.

Bourdieu, P. (1998). *'Acts of Resistance: Against the New Myths of Our Time'* [translated by Richard Nice], Cambridge: Polity Press.

Bourdieu, P. (1999). Rethinking the state: Genesis and structure of the bureaucratic field. In G. Steinmetz (Ed.) *State/culture: State-formation after the cultural turn*. Ithaca, NY: Cornell University Press.

Boyson, D.A., and Short, D.J. (2003). *Secondary school newcomer programs in the United States* (Research Report No. 12). Santa Cruz, CA and Washington, D.C., Center for Research on Education, Diversity & Excellence.

Brown, J. L., Jones, S. M., LaRusso, M. D., & Aber, J. L. (2010). Improving classroom quality: Teacher influences and experimental impacts of the 4Rs Program.

Journal of Educational Psychology, 102(1), 153-167.

Carlone, H. B., & Johnson, A. (2007). Understanding the science experiences of successful women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching*, *44*(8), 1187-1218.

Carlyle, E. (2008, November 10). Minneapolis somali community facing dark web of murders. *City Pages.*

Collier, V.P (1995). Acquiring a second language for school. Retrieved from www.thomasandcollier.com/assets/1995_v1_ncela_acquiring_a-second_ language_pdf.

Cajete, G. (1999). Igniting the sparkle: An Indigenous science education model. Kivaki Press, Skyand, NC.

Capobianco, B.M. (2007). Science teachers' attempts at integrating feminist pedagogy through collaborative action research. *Journal of Research in Science Teaching*, *44* (1), 1-32.

Carlone, H.B. & Johnson, A. (2007). Understanding the science experiences of women of color: Science identity as an analytic lens. *Journal of Research in Science Teaching, 44*, 1187-1218.

Cohen, L., Manion, L., & Morrison, K. (2000). *Research methods in education* (5th ed.). NY: Routledge Falmer.

Corbin, J., & Strauss, A. (2015). *Basics of qualitative research: Grounded theory procedures and techniques*. Thousand Oaks, CA: Sage Publications.

Corrigan, D., Dillon, J., & Gunstone, R. (Eds.). (2007). *The re-emergence of values in science education*. Rotterdam: Sense Publishers.

Costa, V.B. (1995). When science is "another world": Relationships between worlds of family, friends, school, and science. *Science Education,* 79, 313-333.

Council of the Great City Schools. (2001). Retrieved from www.cgcs.org.

Covington Clarkson, L. M. (2008). Demographic data and immigrant student achievement. *Theory into Practice, 47*(1), 20-26.

Creswell, J. W. (1998). *Choosing among five traditions. Qualitative Inquiry and Research Design.* Thousand Oaks, CA: Sage Publications.

Creswell, J. W., & Miller, D. L. (2000). Getting good qualitative data to improve educational practice. *Theory Into Practice*, *39*(3), 124-130.

DeBoer, G.E. (1991). *A history of science education: Implications for practice*. New York, NY: Teachers College Press.

Darling-Hammond, L. (2010). Recruiting and Retaining Teachers: Turning Around the Race to the Bottom in High-Need Schools. *Journal of Curriculum and Instruction, 4,* 16-32.

DeCapua, A., Smathers, W., & Tang, L. F. (2007). Schooling, Interrupted. *Educational Leadership*, *64*(6), 40-46.

Denham, S. A. Brown, C. E., & Domitrovich, C. E. (2010). Plays nice with others: Social-emotional learning and academic success. *Early Education and Development*, *21*, 652-680.

Diaspora. (2014). Random House. Retrieved from

http://www.wordreference.com/definition/Diaspora

Dogan, N., & Abd-El-Khalick, F. (2008). Turkish grade 10 students and science teachers' conceptions of nature of science: A national study. *Journal of Research in Science Teaching*, *45(*10), 1083-1112.

Durden, T. (2008). Do your homework! Investigating the role of culturally relevant pedagogy in comprehensive school reform models serving diverse student populations. *Urban Review*, *40*, 403-419.

Durlack, J.A., Weissberg, R.P., Dymnicki, A.B., Taylor, R.D., & Schellinger, K.B. (2011).Caring chp. 7

Durlak, J. A., Weissberg, R. P., Dymnicki, A. B., Taylor, R. D. & Schellinger, K. B. (2011). The impact of enhancing students' social and emotional learning: A meta-analysis of school-based universal interventions. *Child Development, 82*(1), 405–432.

Elias, M. J., Zins, J. E., Weissberg, R. P., Frey, K. S., Greenberg, M. T., Haynes, N.M., Kessler, R., Schwab-Stone, M. E., & Shriver, T. P. (1997). *Promoting social and emotional learning: Guidelines for educators*. Alexandria, VA: Association for Supervision and Curriculum Development.

Ellis, H.B., Miller, A.B., Baldwin, H., & Abdi, S. (2011). New Directions in Refugee Youth Mental Health Services: Overcoming Barriers to Engagement. *Journal of Child & Adolescent Trauma, 4*, 69–85.

Epstein, J. L. (2010). School/family/community Partnerships: Caring for the Children We Share: When Schools Form Partnerships with Families and the Community, the

Children Benefit. These Guidelines for Building Partnerships Can Make It Happen. *Phi Delta Kappan, 9*2(3), 81.

Erlandson, D. A., Harris, E. L., Skipper, B. L. & Allen, S. D. (1993). *Doing naturalistic inquiry. A guide to methods*. London: Sage Publications.

Farid, M., & McMahan, D. (2004). *Accommodating and educating Somali students in Minnesota schools: A handbook for teachers and administrators*. Saint Paul: Hamline University Press.

Fisher, C. B., Hoagwood, K., Boyce, C., Duster, T., Frank, D. A., Grisso, T., et al. (2002). Research ethics for mental health science involving ethnic minority children and youth. *American Psychologist, 57,* 1024–1040.

Fusco, D. (2001). Creating relevant science through urban planning and gardening. *Journal of Research in Science Teaching, 38*(8), 860-877.

Gay, G. (2000). *Culturally responsive teaching: Theory, research & practice*. New York: Teachers' College Press.

Giddens, A. (1984). The Constitution of Society, Polity Press: Cambridge.

Giroux, H.A. (2005). *Border crossings: cultural workers and the politics of education.* New York, NY: Routledge.

Golshani, M. (2007). Science for humanity: An Islamic perspective. *Islam and Science*, *5*(2).

Gonzalez, N., Moll, L., & Amanti, C. (2005). *Funds of knowledge*. Mahwah, N.J.: Lawrence Erlbaum Associates.

Good, M.F. (1999). *Somali refugee perceptions of factors impacting the learning of their*

children in high schools. Unpublished doctoral dissertation. University of Massachusetts, Amherst.

Goodlad, J. (2006). *What schools are for: Stimulating necessary dialogue for the reconstruction of schools in our democracy.* New York: Teachers College Press.

Guba, E. G. and Y. S. Lincoln. (1988). Do inquiry paradigms imply inquiry methodologies? In D. M. Fetterman. (ed.) *Qualitative approaches to evaluation in education: the silent scientific revolution.* (pp. 89-115.) London: Praeger.

Gutierrez, K.D. (1999). Culture matters. Rethinking educational equity. *Understanding Educational Equity and Excellence at Scal*e, 43-49.

Hagiwara, S., Barton, A.C., & Contento, I. (2007). Culture, food and language: Perspectives from immigrant mothers in school science. *Cultural Studies in Science Education*, *2*, 475-515.

Haque A.(2004). Contributions of Early Muslim Scholars and Challenges to Contemporary Muslim Psychologists. *Journal of Religion and Health,* 43, 4.

Hammond, L. (2001). An anthropological approach to urban science education for language minority families. *Journal of Research in Science Teaching*, *38*(9), 983-999.

Haidar, A.H. (1999). Emirates pre-service and in-service teachers' views about nature of science. *International Journal of Science Education*, *21*, 807-822.

Haque, A. (2004). Islamophobia in North America: Confronting the menace. In B. van Driel (Ed.), *Confronting Islamophobia in educational practice* (pp. 1–18). Sterling, VA: Trentham.

Haw, K. F. (1994). Muslim girls' schools--a conflict of interests? *Gender and Education, 6*, 63-76.

Hernandez, D. J., Denton, N. A., & Macartney, S. E. (2009). School-age children in immigrant families: Challenges and opportunities for America's schools. *Teachers College Record,* 111, 616–658.

Hughes, M., & Pollard, A. (2006). Home-school knowledge exchange in context. *Educational Review*, *58*(4), 385-395.

Huisman, Kimberly A. (2011). *Somalis in Maine: crossing cultural currents*. Berkeley, Calif.: North Atlantic Books.

Huisman, K., Hough, M., Langellier, K., and Toner, C. (Eds.). (2011). *Somalis in Maine: crossing cultural currents*. Berkeley, Calif.: North Atlantic Books.

Jegede, O. J., & Okebukola, P.A. (1992). Differences in sociocultural environment perceptions associated with gender in science classrooms. *Journal of Research in Science Teaching, 29*, 637-647.

Jegede, O.J., & Okebukola, P.A. (1991). The relationship between African traditional cosmology and students' acquisition of a science process skill. *International Journal of Science Education, 13,* 37–47.

Johnson, C.C. (2011). The road to culturally relevant science: Exploring how teachers navigate change in pedagogy. *Journal of Research in Science Teaching*, *48*(2), 170-198.

Kliebard, H.M. (2004). *The struggle for the American curriculum, 1893-1958*. New York, NY: RoutledgeFalmer.

Kozol, J. (2005). *The shame of the nation: The restoration of apartheid schooling in America*. New York: Random House.

Kusow, A., & Bjork, S. R. (2007). *From Mogadishu to Dixon: The Somali diaspora in a global context*. Trenton, N.J.: Red Sea Press.

Ladson-Billings, G. (1994). *The dream keepers*. San Francisco, CA: Jossey-Bass.

Ladson-Billings, G. (1995). But that's just good teaching! The case for culturally relevant pedagogy. *Theory into Practice*, *34*(3), 159-165.

Leach, J., & Scott, P. (2003). Individual and Sociocultural Views of Learning in Science Education. *Science & Education, 12,* 91-113.

Learning First Alliance. (2001). *Every child learning: Safe and supportive schools.* Washington, DC.

Lee, O. (1999). Science knowledge, worldviews, and information sources in social and cultural contexts: Making sense after a natural disaster. *American Educational Research Journal, 36*(2), 187-219.

Lee, O. (2001). Culture and language in science education: What do we know and what do we need to know? *Journal of Research in Science Teaching*, *38*(5), 499-501.

Lee, O., & Buxton, C.A. (2010). *Diversity and equity in science education*. New York: Teachers College Press, Columbia University.

Lee, O., & Fradd, S.H. (1998). Science for all, including students from non-English-language backgrounds. *Educational Researcher*, *27*, 12-21.

Lee, O., & Luykx, A. (2006). *Science education and student diversity*. New York: Cambridge University Press.

Limage, L. J. (2000). Education and Muslim identity: The case of France. *Comparative Education, 36*(1), 73-94.

Mansour. N. (2010). Science teachers' interpretations of Islamic culture related to science education versus the Islamic epistemology and ontology of science. *Cultural Studies of Science Education, 5*(1), 127-140.

Mansour**,** N**. (**2011**).** Science teachers**'** views of science and religion vs. the Islamic perspective**:** Conflicting or compatible? *Science Education*, 95(2), 281–309.

Matthews, C.E. & Smith, W.S. (1994). Native American related materials in elementary science instruction. *Journal of Research in Science Teaching*, *31*(4), 363-380.

Mayberry, K.J. (2015). How the identity of Somali-American youth affects learning. (Unpublished master's thesis). Hamline University, St. Paul.

McGown, R. B. (1999). *Muslims in the diaspora: The Somali communities of London and Toronto*. Toronto: University of Toronto Press.

McNamee, S.J. & Miller, R.K. (2009). *The meritocracy myth.* Maryland: Rowman & Littlefield.

Megarry, H. (Ed.). (2006). *Turning into roses: Poems of our lives*. Minneapolis: Ubah Medical Academy Charter High School English Department.

Mensah, F. M. (2009, April). Elementary preservice teachers' microteaching in an urban classroom: A case for culturally relevant teaching and lessons learned. Presentation at the 2009 AERA conference, San Diego.

Merry, M. S. (2005). Social exclusion of Muslim youth in Flemish and French-speaking Belgian schools. *Comparative Education Review, 49*(1), 1-22.

Migration Policy Institute. (2014). Retrieved from http://www.migrationpolicy.org/programs/data-hub

Miller, J. (2009). Teaching refugee learners with interrupted education in science: Vocabulary, literacy and pedagogy. *International Journal of Science Education,* 31, 571-592.

Minnesota Department of Education (2010). *Minnesota Academic Standards Science K-12*, 2009 version. St. Paul: Minnesota Department of Education.

Minnesota Department of Education. (2014). Retrieved from http://rc.education.state.mn.us/

Mohamed, A. (2008). *Wasted talent: The absence of Somali students from post-graduate education*. Retrieved from www.hiiraan.com/op2/2008

Moll, L. C., Amanti, C., Neff, D., & Gonzalez, N. (1992). Funds of knowledge for teaching: Using a qualitative approach to connect homes and classrooms. *Theory into Practice*, *31*(2), 132-141.

Mutegi, J. W. (2009). Sankore vanguard summer science camp: An example of culturally relevant pedagogy. *Paper Presented at the 2009 AERA Conference,* San Diego.

Mutegi, J.W. (2011). The inadequacies of ‘‘science for all’’ and the necessity and nature of a socially transformative curriculum approach for African American science education. *Journal of Research in Science Teaching*, *248*(3), 248-316.

Mutegi, J.W. (2013). ‘‘Life’s first need is for us to be realistic’’ and other reasons for examining the sociocultural construction of race in the science performance of African American students. *Journal of Research in Science Teaching*, *50*(1),

82-103.

National Center for Educational Statistics. (2015). Retrieved from https://nces.ed.gov

National Commission on Excellence in Education. (1983). *A nation at risk: The imperative for educational reform: a report to the Nation and the Secretary of Education, United States Department of Education.* Washington, D.C.: The Commission on Excellence in Education.

National Science Board Commission on Precollege Education in Mathematics, Science and Technology (1983*). Educating Americans for the 21st Century* (CPCE-NSF-04). Washington, DC: National Science Foundation.

National Research Council (U.S.). (1996). *National Education Standards: Observe, interact, change, learn.* Washington, DC: National Academy Press.

Ngo, B. (2008). Beyond "culture clash" understandings of immigrant experiences. *Theory into Practice, 47*, 4-11.

Ngo, B., & Lee, S. J. (2007). Complicating the image of model minority success: A review of Southeast Asian American education. *Review of Educational Research, 77*(4), 415-453.

NGSS Lead States. (2013). *Next Generation Science Standards: For states, by states*. Washington, DC: The National Academies Press.

Nieto, S. (1994). Lessons from students on creating a chance to dream. *Harvard Educational Review, 64*, 392-426.

Nieto, S. (2004). Critical multicultural education and students' perspectives. *The RoutledgeFalmer reader in multicultural education*, 179-200.

Nieto, S., Bode, P. (2008) *Affirming diversity: The sociopolitical context of multicultural education.* Boston: Allyn & Bacon.

Noddings, N. (2005). 'Caring in education', *the encyclopedia of informal education.* http://infed.org/mobi/caring-in-education/.

Oakes, J. (1990). *Multiplying inequalities: The effects of race, social class, and tracking on opportunities to learn mathematics and science.* Santa Monica, CA: RAND Corporation.

Oakes, J. & Lipton, M. (1999). *Teaching to change the world*. Boston: McGraw-Hill.

Oakes, J. (2000). *Course-taking and achievement: Inequalities that endure and change*. A keynote paper presented at the National Institute for Science Education Forum, Detroit, MI.

Ogbu, J. (1992) Understanding cultural diversity and learning, *Educational Researcher, 21*(8), 5–14.

Ogbu, J., & Simons, H.D. (1998). Voluntary and involuntary minorities: A cultural-ecological theory of school performance with some implications for education. *Anthropology & Education Quarterly 29*(2):155-188.

O'Reilly, J. (2008). Refugees doing it for themselves. Readers' blog, *Ode Magazine. Retrieved from www.odemagazine.com/blogs.readers_blog/1489/refugees*

Patchen, T., & Cox-Petersen, A. (2008). Constructing cultural relevance in science: A case study of two elementary teachers. *Science Education,* 995-1014.

Patton, M.Q. (2002). *Qualitative research and evaluation methods* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Rahm, J. (2009). *What we can learn about culturally relevant pedagogy from after school and community science programs that make a difference in the lives of diverse youth.* Paper presented at the meeting of the American Educational Research Association, San Diego.

Random House. (2008). Definition for Diaspora. Retrieved from www.dictionary.com.

Riojas-Cortez, M. (2001). Preschoolers' funds of knowledge displayed through sociodramatic play episodes in a bilingual classroom. *Early Childhood Education Journal*, *29*(1), 35-40.

Roble, A., & Rutledge, D. (2008). *The Somali diaspora: A journey away*. Minneapolis: University of Minnesota Press.

Rodriguez, A. J. (1998). Strategies for counter resistance: Toward socio transformative constructivism and learning to teach science for diversity and for understanding. *Journal of Research in Science Teaching*, *36*(6), 589–622.

Rogoff, B. (2003). *The cultural nature of human development*. New York: Oxford University Press.

Rosebery, A.S., Warren, B., Conant, F.R. & Hudicourt-Barnes, J. (1992). ChecheKonnen: Scientific sense-making in bilingual education. *Hands On! 15*(1), 16-19.

Roth, W. M., & Barton, A. C. (2004). *Rethinking scientific literacy*. New York: Routledge.

Ryan, M. (2012). *Senior science teachers' experience of teaching in a changing multicultural classroom: A case study*. (Unpublished dissertation). University of

Minnesota-Twin Cities.

Ryder, J. (2001). "Identifying science understanding for functional scientific literacy", *Studies in Science Education,* 36, 1-44.

Sadler, T.D. & Donnelly, L.A. (2006). Socioscientific argumentation: The effects of content knowledge and morality. *International Journal of Science Education 28,* 1463-1488.

Schleicher, A. (2006). Where immigrant students succeed: A comparative review of performance and engagement in PISA 2003. *Intercultural Education, 17*(5), 507-516.

Schmoker, M. (1999). *Results: The keys to continuous school improvement*. Alexandria, VA: Association for Supervision and Curriculum Development.

Shepard, R. M. (2008). *Cultural adaptation of Somali refugee youth*. New York: LFB Scholarly Publishing.

Sizemore, B. (1985). Pitfalls and promises of effective schools research. *The Journal of Negro Education, 54*(3), 269-288.

Sleeter, C. E. (2012). Confronting the marginalization of culturally responsive pedagogy. *Urban Education*, *47*(3), 562-584.

Sleeter, C. E., & Grant, C. A. (1991). Mapping terrains of power: Student cultural knowledge vs. classroom knowledge. In C.E. Sleeter (Ed.), *Empowerment through multicultural education* (pp. 49-67). Albany, N.Y.: State University of New York Press.

Stake, R. E. (2000). *The art of case study research*. Thousand Oaks, CA: Sage

Publications.

Taskin, O. (2014). An exploratory examination of Islamic values in science education: Islamization of science teaching and learning via constructivism. *Cultural studies of science education*, *9*, 855-875.

The Free Dictionary (2015). In loco parentis. Retrieved from http://legal-dictionary.thefreedictionary.com/In+Loco+Parentis

Tobin, K. (1996, September). Cultural perspectives on the teaching and learning of science. *Effect of traditional cosmology on science education symposium.* Faculty of Education, Ibaraki University.

Trawick-Smith, J. (2000). *Early childhood development: A multicultural perspective* (2nd ed.). New Jersey: Prentice Hall.

Truscott, D. & Watts-Taffe, S. (2003). English as a second language, literacy development in mainstream classrooms: Application of a model for effective practice. In A.I. Willis, G.E. Garcia, R. Barrera, & V. Harris (Eds.), *Multicultural issues in literacy research and practice* (pp. 185-202). Mahwah, N.J.: Erlbaum.

Turner, E.E. (2003). *Critical mathematical agency: Urban middle school students engage in mathematics to investigate, critique and act upon their world*. (Unpublished doctoral dissertation). University of Texas, Austin.

Upadhyay, B. R. (2005). Practicing reform-based science curriculum in an urban classroom: A Hispanic elementary school teacher's thinking and decisions. *School Science and Mathematics,* 105(7), 343-351.

Upadhyay, B. (2006). Using students' lived experiences in an urban science classroom:

An elementary school teacher's thinking. *Science Education, 90*(1), 94-110.

Upadhyay, B. R. (2009). *Connecting lives: Connecting science in a science classroom of immigrant students.* Presentation at the American Educational Research Association Annual Conference, San Diego.

Upadhyay, B. (2010). Middle school science teachers' perceptions of social justice: A study of two female teachers. *Equity & Excellence in Education*, *43*(1), 56-71.

Upadhyay, B. (2012). Elementary students' ways of seeing globalization in science. In Bianchini, J., Akerson, V., Calabrese Barton, A., Lee, O. & Rodriguez, A. (eds.) *Moving the Equity Agenda Forward,* Rotterdam, The Netherlands: Springer.

United Nations High Commission for Refugees [UNHCR]. (2013). UNHCR Statistical Yearbook 2013, 13th edition. Geneva, Switzerland. Retrieved from http://www.unhcr.org/54cf9bd69.html.

United States Department of State. (2014). Proposed refugee admissions for fiscal year 2015 [Report to Congress]. Washington, DC. Retrieved from http://www.state.gov/documents/organization/232029.pdf.

Valdés, G. (1996). *Con respeto: Bridging the distances between culturally diverse families and schools*. New York: Teachers College Press.

Valenzuela, A. (1999). *Subtractive schooling: US-Mexican youth and the politics of caring*. Albany: State University of New York Press.

Valencia, R. R., & Suzuki, L. A. (2000). *Intelligence testing and minority students: Foundations, performance factors, and assessment issues.* Thousand Oaks, CA: Sage.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes* Cambridge, Mass.: Harvard University Press.

Watson, J. (1979). *The philosophy and science of caring*. Boston: Little Brown.

Yin, R. (2008). Chapter 2: Designing a case study. *Case Study Research: Design and methods*. Thousand Oaks, CA: Sage Publications.

Young, I. M. (1990). *Throwing like a girl and other essays in feminist philosophy and social theory*. Bloomington: Indiana University Press.

Yu, E. S. H., & Lieu, W. T. (1986). Methodological problems and policy implications in Vietnamese refugee research. *International Migration Review, 20*(2), 483–502.

Yusuf, A. H. (2012). *Somalis in Minnesota*. St. Paul, MN: Minnesota Historical Society Press.

Zine, J. (2000). Redefining resistance: Toward an Islamic sub-culture in schools. *Race, Ethnicity and Education, 3*, 293-316.

Zine, J. (2001). Muslim youth in Canadian schools: Education and the politics of religious identity. *Anthropology & Education Quarterly, 32*(4), 399-423.

Zine, J. (2006). Unveiled sentiments: Gendered islamophobia and experiences of veiling among Muslim girls in a Canadian Islamic school. *Equity & Excellence in Education, 39*, 239-252.

Appendix A

Notes on Dugsi & Schooling in Somalia

Source: Informal Conversations with Ali, 2013 – 2014

Qu'ran (Dugsi)

Memorize and recite; recite from the Qur'anic teacher and write it exactly; all 48 students, for example, participate in choral reading.

Read it and tell me what it means (not common) vs. read it and tell me what it says (Dugsi)

Requires a transition for the students in U.S. public schools

Students have difficulties following many directions; break down directions into steps one-by-one; demonstrate, do, and move on.

Learning in East Africa

Very classical, direct instruction, teachers are knowledgeable, a lot of lecture (80%). Community learning, where students can learn from each other (25%); homework, exercises in classroom, teacher-centered.

Schooling (HS) in Somalia:

12th grade, 60 students, teacher-centered, education is scarce so quiet all the time; direct instruction; Kenya is much the same; not many labs or lab demos because don't have the infrastructure; grading A-B system but just 2 or 3 questions to answer (no multiple choice); everybody just works and is quiet; 100% teacher centered; corporal punishment is common; students from poor families; knowledge should be organized like core

knowledge; must master algebra 1 before algebra 2; need the background knowledge before you move on; textbooks; comprehensive exams; after the British system.

Recommendations for U.S. Schools

The art of memorization is an important skill; students go to Dugsi and memorize the Qu'ran; this is a huge talent. In the U.S., perhaps make them memorize the Periodic Table, or the quadratic formula; I know we try to get away from rote memorization, not in Bloom's taxonomy; but use it, like there is a poem in English class, make them; parents think they are learning when they are memorizing, they think they are not learning anything because we are not making them memorize. I think it's a great tool.

Appendix B: Examples of Artifacts and Possible Science Ed Connections

Source: Somali Cultural Museum, http://www.somalimuseum.org/

Artifact Type	Relevant Attributes	Science Ed Connections
Milk & Water Containers	Sources: Woven plant materials, dried animal skins, clay	Which plant materials lend themselves to weaving and why?(biology) How do people dry animal skins for future use as liquid vessels? (chemistry, biology) Which natural substances can be used to waterproof dried animal skins so that they can hold liquids in the future? (chemistry) How do different cultures use natural materials to create vessels for liquids? (biology, earth science) How do people in desert climates preserve milk (in this case camel milk)? (chemistry)
Textiles/Weaving	Natural plant fibers, natural dyes	What are the sources for natural dyes? Which plant materials are harvested and used for textiles? Which animal sources are used for textiles? (biology)
Wooden tools and Eating/Cooking utensils	Natural woods, stone/clay	What are the native trees that are used as sources of wood in Somalia? How are they related to trees in the U.S. (or elsewhere)? What physical and/or chemical attributes do they have that allows them to be good for

		cooking, food preparation and serving? (biology, chemistry)
Camels	Water retention; nomadic; source of milk & food	How do camels retain water in deserts? (biology) What are the biochemical constituents of camel milk that make it so important to Somali nomads? (chemistry)
Nomadic Houses	Sources of Materials: Plant fibers, native wood, textiles; architectural design for nomadic traditions	Which plants are used for structural support? How are plant materials treated to enable them to be used for architectural structures? (biology)

Appendix C
Study Participants and Interview Dates/Notes

Name	Interview Date	Interview Date	Notes	Data Used ?
Ali	July 2013	November 2013	Formal interviews were followed with numerous informal conversations	Yes
Ayan	July 2013	March 2015	Used translator	Yes
Fati	August 2013	September 2013	---	Yes
Hassan	November 2013	January 2015	Formal interviews were followed by numerous informal conversations.	Yes
Anisa	April 2014	---	Did not respond to requests for further information/interviews	Yes
Khalid	March 2015	---	Declined to participate after first interview	No
Mohamed	July 2013	---	Declined to participate during first interview	No