January 2015

STEM Education For Girls Of Color

Kam Hung Yee

STEM EDUCATION FOR GIRLS OF COLOR

by

Kam H. Yee
Bachelor of Arts, University of Washington Bothell, 2006

A Thesis

of the

University of North Dakota

in partial fulfillment of the requirements

for the degree of

Master of Science

Grand Forks, North Dakota

December

2015

This thesis, submitted by Kam Yee in partial fulfillment of the requirements for the Degree of Master of Science from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done and is hereby approved.

Dr. James Casler

Dr. Margaret Zidon

Dr. Cheryl Hunter

Dr. Lynne Ipina

This thesis is being submitted by the appointed advisory committee as having met all of the requirement of the School of Graduate Studies at the University of North Dakota and is hereby approved.

Wayne Swisher

Dean of the School of Graduate Studies

December 7, 2015

Date

PERMISSION

Title	STEM Education for Girls of Color
Department	Space Studies
Degree	Master of Science

In presenting this thesis in partial fulfillment of the requirements for a graduate degree from the University of North Dakota, I agree that the library of this University shall make it freely available for inspection. I further agree that permission for extensive copying for scholarly purposes may be granted by the professor who supervised my thesis work or, in his absence, by the Chairperson of the department or the dean of the School of Graduate Studies. It is understood that any copying or publication or other use of this thesis or part thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to the University of North Dakota in any scholarly use which may be made of any material in my thesis.

Kam Yee

November 11, 2015

TABLE OF CONTENTS

LIST OF TABLES

ABSTRACT

Science, technology, engineering, and math (STEM) fields struggle to increase recruitment and retention of girls of color. The dominant framework in STEM education is the pipeline which assumes girls in general lack motivation and interest to persist in STEM fields. Recent public discourse shifts to address institutionalized discrimination and systemic barriers in STEM culture that filter out underrepresented populations.

Informal education or complementary learning STEM programs offer alternative opportunities for students to explore outside of rigid school academic and social systems. Few articles look specifically at STEM complementary learning programs, and even fewer focus on the effects on girls of color. This research is a quantitative study to categorize existing mission statements and training behind organizations that provide STEM programs. The results will provide a better understanding of the relationship between practices of STEM education organizations and the programs they create. Diversity training and inclusive language in mission statements had weak correlations with increased cultural responsiveness in the program offerings. The results suggest organizations must be more intentional and explicit when implementing diversity goals.

Keywords: Cultural responsiveness, girls of color, women of color, STEM education, complementary learning, pipeline model, organizational practices, training, mission statement

CHAPTER I

INTRODUCTION

Women of color are under-represented in the science, technology, engineering, and math (STEM) workforce (Committee on STEM Education [Co-STEM], 2013). One method to remedy this shortage is to cultivate higher participation rates among girls of color in extracurricular STEM programs. Program experiences that address the needs of the vulnerable population is critical.

Despite efforts in the last three decades to increase the number of women in general towards STEM, the results have been unsatisfactory. While 39% of STEM degree graduates were female, they only account for 24% of the STEM workforce (Landivar, 2013). Beyond the alarming 15% attrition rate for general STEM retention, the numbers were even more disconcerting in engineering fields, where women made up 20% of engineering school graduates, but only 11% of the practicing engineers (Fouad, Singh, Fitzpatrick, & Liu, 2012).

Societal Problem

In 2014, the Obama Administration's White House Council on Women and Girls (CWG) published a comprehensive report addressing the inequalities faced by women and girls. Topics spanned from economic security, to health, to violence against women, to criminal justice system conditions that exacerbate marginalization. STEM education is discussed prominently in this report, which cites lower college graduation rates and higher suspension frequencies for girls of color compared to white girls (Council on Women and Girls [CWG], 2014).

One of the STEM movement's goals is to achieve equity for the nation as a whole. In the context of social justice, the under-representation of women and girls in STEM fields present inequalities due to gender, race, and social-economic status (Smith-Evans, George, Graves, Kaufmann, & Frohlich, 2014). Systemic barriers that impact girls of color and prevent them from succeeding can perpetuate gender and racial discrimination.

National Security and Workforce Gap

The STEM education conversation is frequently based on a need to fill a predicted national shortage of STEM workers (Co-STEM, 2013). The proposed solution of the shortage is to recruit more workers from the previously neglected pools, including women and people of color in the United States. This national security-based rhetoric continues to be the primary catalyst on the policy level in the America COMPETES Acts of 2007 and 2010. Policy language regularly stress the continuing need for a robust STEM-proficient workforce as "crucial to the Nation's health and economy" (National Science Foundation, 2014).

The marginalized groups are positioned as a labor source to be leveraged as a tool to "fill" a hole in the workforce gap (Sinnes & Loken, 2012). The end goal is to keep the United States globally competitive. Failure to achieve this goal is seen as a threat to national security. Through this view, promoting opportunities and equality for people of color and women is a means to an end, and not treated as an end of its own merit. American public education and what types of skills are determined as desirable have been linked to economic development goals of the nation since the post-Civil War era (Watkins, 2001). After the Civil War changed the United

States' economic base, the nation developed a goal to be a global industrial power. Philanthropic and industrial interest groups pushed newly freed slaves and their decedents into a system of public industrial education in the form of industrial production training and domestic services to supply a workforce (Anderson, 1988). Reconstruction Era channeled Black education to focus on industrial trades and subservient roles as opposed to academic and liberal arts education shaped the racial relationship in US for the next century (Anderson, 1988).

A Systemic Problem of Discrimination

Historically, men barred women from science through legitimized studies supporting biological reasons such as menstrual cycle, physical limitation, and limited brain capacity (Blickenstaff, 2005). The common rhetoric assumes girls lack interest in STEM topics and continues to perpetuate female gender identity as a barrier to STEM interest. This logic does not support the girls but instead hides the real problem of systemic barriers (Blickenstaff, 2005; Maltese & Tai, 2011).

Title IX of the Education Amendments of 1972, most famously used to provide equal sports access for girls, is part of the Civil Rights Act and is a "comprehensive federal law that prohibits discrimination on the basis of sex in any federally funded education program or activity" (Department of Justice, 2014). This existing law can be apply to girls' equal access to STEM classes and activities as a social equity issue (Government Accountability Office, 2004).

It has been forty years since Title IX was passed and there is current momentum from the Department of Education, National Women's Law Center (NWLC), and The White House Council for Women and Girls to use Title IX to ensure girls are provided access to quality and equal STEM opportunities in a safe climate (National Women's Law Center [NWLC], 2012). To increase awareness of Title IX, there is support for school administrators from the Education Department's Office for Civil Rights (OCR) with "technical assistance presentations for principal investigators, faculty, and administrators at postsecondary institutions with practical examples of how Title IX applies to STEM" (CWG, 2014).

The Obama Administration's White House Council on Women and Girls' (2014) report *Women and Girls of Color: Addressing Challenges and Expanding Opportunity* is notable because the tone in discussing STEM education within this report do not follow the frequently used "inspiration" rhetoric. Instead, it is presented from an asset-based approach. Previous policy language often has aimed to "inspire" marginalized girls of color, with the implication that the girls inherently lack this quality. "The Council's mandate is to ensure that every agency, department and office in the federal government takes into account the needs and aspirations of women and girls in every aspect of their work" (CWG, 2014). The policy's viewpoint is based on the fact that girls of color already had aspirations and it was the system's role to address their pre-existing dreams. The slight change of phrasing is a paradigm shift in the policy narrative's perspective from fixing the individuals to fixing the systemic problem. The current argument is shifting from how to "fix" the girls' interest in science (focused on the individual) to address the systemic barriers and biases, which filter out girls and women (focused on the system).

Background

The President's Council of Advisors on Science and Technology's report *Prepare and inspire: K-12 education in science technology, engineering, and math (STEM) for America's future* (2010) admits that the current federal STEM programs "lack systematic knowledge about which types of programs serve best to inspire students to pursue STEM, and which qualities of successful programs are important to replicate" (p. 92). The President's Council of Advisors on

Science and Technology (PCAST) needs a more coherent federal strategy and leadership to increase effectiveness. PCAST recommendation urges federal coordination, as a response to federal STEM programs' fragmentation. The group encouraged infusing STEM in general education in the school-day curriculum that will benefit all students. In addition to formal school-day, PCAST (2010) recognized the necessity for museums, corporations, and philanthropic sections to continue to contribute to STEM education in informal settings.

Complementary Learning

Education opportunities that take place outside of the regular school hours cover a broad range of activities that supplements youth and general public learning. Commonly referred to as informal education, enrichment programs, or education and public outreach (EPO), this field includes out-of-school time (OST) activities such as after-school or mentoring programs, summer camps, internships, science expositions, and family engagement events. This research study will use the term *complementary learning*, as defined by the Harvard Family Research Project (2008) to include "out-of-school time, family involvement, and early childhood education." The intention behind moving from the term "informal education" to complementary learning is to establish the practice as one that works in collaboration with formal school day learning by aligning "resources to maximize efficiency" (Harvard Family Research Project [HFRP], 2008). The adaptation of the term "complementary learning" is intended to more accurately reflect the reality that OST learning opportunities operate in organized ways. Complementary learning is also a significant market. Extracurricular activities have become a robust industry. School-break camps alone was a $15 billion annual industry (American Camping Association, 2012).

Complementary learning programs are not the opposition of formal education, but can be seen as *one of many approaches* for authentic learning experiences. STEM programs in OST spaces offer alternative opportunities for students to explore outside of the rigid school, academic, and social systems. Extracurricular learning that operate outside of school structures and family expectations becomes a “third space” for youth to explore their interests and identities. This space is especially conducive for girls of color to develop a science-identity (Tan, Calabrese Barton, Kang, & O’Neill, 2013). Multiethnic student populations participating in extracurricular program can use "science practices that made hybrid positioning possible and turned the rich zone of learning or third spaces owned by youth" (Rahm, 2007, p. 99).

Youth participation in extracurricular activities is highly influenced by family support such as permission, time management, transportation, and associated costs. Parents and guardians are the ultimate deciders of enrolling students. Beyond accessibility due to resources, families’ views of programs are important and they preferred holistic STEM programs that contain real life experience, nurture students’ cultural identities, as well as present science content (Simpson & Parson, 2008).

Activity Gap

Parents and educators are well aware of the positive benefits of afterschool activities. However, this new unregulated space for competition favors the privileged (Zaff, Moore, Papillo, & Williams, 2003). An “activity gap” is present as higher income families with more opportunities can outperform the resource-limited families. OST is a significant amount of time in students’ lives.

To illustrate how the activity gap becomes problematic, consider student's daily schedule. Regular school hours are around 6.5 hours a day (U. S. Department of Education [DE], 2008). Students enrolled in OST programming are engaged in a guided learning environment for an additional 1-2 hours each day. That environment leaves potential for a 15-30% daily increased learning time for students who have access to programs. During one school year, students are in session about 180 days (DE, 2008). The remaining 185 non-school days of the year are made of weekends and school vacation days. Affluent or high socioeconomic status (SES) families with more financial, time, and cultural resources are able to utilize this time to enroll their children in complementary learning programs to develop STEM knowledge (or other specialized talents). High SES youths have more access to learning opportunities during OST and non-school days compared with low SES peers. The activity gap presents high SES youths with academic and social advantages gain through complementary learning (Zaff et al., 2003). Higher SES families have the resources to augment the traditional school day learning. Complementary learning is a space where social-class and access disparities are amplified (Chin & Phillips, 2004).

CHAPTER II

PURPOSE

The purpose of this quantitative study is to categorize existing organizational practices that produce culturally responsive STEM programs that recognize students as resources in their own learning experiences. A further purpose is to provide a better understanding of the relationship between organizational practices used by STEM education organizations and the programs they create. The results will contribute to the body of knowledge that STEM education leaders can use to increase recruitment, services, and retention of girls of color in STEM education paths. The results can inform organizational leaders on professional development focus areas. Refining practices has a potential to produce more effective STEM programs that will benefit girls of color.

Statement of Problem

This research study tests: Do organizational practices in STEM education programs positively affect the program's cultural responsiveness for girls of color?   This analysis focuses on two practices, mission statements wording and training, and examines for correlation with programs exhibiting culturally responsive characteristics. The question leads to two hypotheses: H_1: Organizations with mission statement keywords, diversity and education equality, will exhibit more culturally responsive indicators and H_2: Organizations that provide diversity training, will exhibit more culturally responsive indicators.

Scope

The study was interested in the design and preparation phase of STEM programs by measuring perceptions and reported practices by STEM program staff and volunteers. Participation was open to STEM program designers, over the age of 18, who were involved in the planning of K-12 complementary STEM learning programs that take place outside of the normal school hours. The primary targets were United States complementary learning providers, i.e. science centers, museums, summer camps, afterschool programs, and higher education institutions. This was a cross-sectional study on the program perspective. This screening study will identify areas of interest to guide future research directions.

Program designers create the curricula and implement the programs for youth, while facilitators work directly with the youth through service delivery. However it was expected that the designers were frequently also the program facilitators. Participants self-selected into the study. Participants could be involved in the STEM program either as paid staff members or as unpaid volunteers. The study did not separate non-profit and for-profit workers or organizations, since both groups could offer similar STEM youth programs.

The study treated all girls of color as one group and did not collect disaggregated data. It should be noted this design element was less than ideal. Treating the data on youth of color only in aggregated forms can mask the many disparities that exist within communities of color. For example Asian American and Pacific Islanders are frequently treated as one group in data analysis. The data management lead to results that assume the needs, access ability, language proficiency, and resources are the same for multiple diverse populations. This misrepresentation continues to conceal significant resource disparities between the racial and ethnic subgroups. It is recommended that future studies consider methods that will allow for more differentiations in data collection and analysis.

CHAPTER III

LITERATURE REVIEW

Structural Oppression

Racism and sexism have manifested in education through systemic ways. The literature on education as it related to oppression traced back to the post-World War II decades during the decolonization of African and Asian countries from white European colonial imperialism. Through those political transitions, foundational works such as Frantz Fanon's (1965) *The Wretched of the Earth* and Paulo Freire's (1970) *Pedagogy of the Oppressed* shifted the narrative to recognize oppression as the root cause of social distress.

Fanon's work spoke of oppression's effect on a national consciousness level. An oppressed population viewed their identity in relation to the oppressor. An oppressed nation forced the non-dominate groups into a binary view of "us" and "them", the oppressed and the oppressor, respectively. The oppressor continuously insisted the oppressed had "no culture" and were "by nature barbaric" (Fanon, 1965). This tactic systematically maintained the non-dominate population as inherently inferior and lacking desirable characteristics.

Similarly to the dichotomy Fanon described, Freire focused his work to challenge the traditional "banking" concept of education as an instrument to oppress people. The banking system treated students as empty vessels that could be filled with knowledge. This teacher-student relationship was limited to a narrating subject (the teacher) and patient, listening objects (the students) (Freire, 1970). The students were presumed to hold no prior knowledge that was of value and the teacher's task was to fill the students (empty objects) through narration. In this one-way relationship, teachers became the gatekeeper of knowledge and students were passive objects without power. In addition, teachers were the holders of knowledge, discipline, and power (Freire, 1970). Students only became of value after teachers "deposits" enough information. In this view, there was no room for dialogue between student and teacher in the banking system of education.

Deficit-based Thinking

A subset within the banking system was the deficit thinking approach, which also treated individuals or groups outside of the dominant culture as lacking or empty (embodying a deficit). While there was no record of a specific person or organization to coin the term, the deficit model was derived during a prolific publication period to address systematic oppression. Valencia (2010) suggested the term "deficit model" or "deficit-based thinking" began to appear amongst activist scholars in the 1960s to counter the common belief that the poor were responsible for the cause of their own social demise through substandard personal choices. The most comprehensive examination of this model was Richard Valencia's (1997) *The Evolution of Deficit Thinking: Educational Thought and Practice.*

Deficit thinking is widely considered ineffective and damaging when working with immigrant students of color in urban locations (Bell et. al., 2009; Harper, 2010; Ladson-Billings, 1995; Norman, Ault, Bentz, & Meskimen, 2001; Parsons, Travis, & Simpson, 2005; Simpson & Parson, 2009). When classroom pedagogy felt oppressive and threatening to a student's identity, the student would disengage. The solution to deficit-based approaches in education is a strength-based approach called culturally responsive pedagogy.

Cultural Responsiveness

The 1990s was an active period in developing theories to best engage historically marginalized students. Competing theories on the most effective teaching pedagogies for underserved students created controversies and continue to divide the education profession today. One school of thought, culturally responsive pedagogy, often interchangeably called culturally relevant teaching, encouraged culturally competent instructors and curricula. The popularity of this pedagogy was credited to Gloria Ladson-Billings (1995) and has been widely adopted in the education field as a pedagogy that benefits all learners, not just historically marginalized populations. The theory was then expanded upon by Geneva Gay (2000) as a culturally responsive teaching method. Both writers influenced education philosophy significantly in the last two decades. Gay (2000) suggested that culturally responsive teaching was based on a strength-based approach and reaches into a students' lived experiences, sociocultural realities, community, and family as an integrated part of student's learning success. Culturally responsive teaching took care to avoid the pitfalls that often plagued deficit-based programing. In avoiding these shortcomings, Ladson-Billings (2007) encapsulated well-intentioned adults' harmful deficit-based assumptions toward the students and their families, as follows:

1) The parents just don't care
2) These children don't have enough exposure/experience
3) These children aren't ready for school
4) Their families don't value education
5) They are coming from a "culture of poverty"

Culturally responsive practices were encouraged and accepted in education and have expanded broadly across social work. To achieve the desired equitable outcomes, Gay (2000) urged that teachers should be “trained in the knowledge and skills of culturally responsive pedagogy for ethnic diversity, systematically supported in their praxis efforts, and held accountable for quality performance within the context of cultural diversity” (p. 247). Further, holding an organizations’ practices accountable to change cannot happen sporadically and instead changes must be “deliberate and explicit, systematic and sustained” (Gay, 2000, p. 248).

However, deficit-based teacher trainings persist today. Payne and Lemov’s works were highly regarded and circulated through teacher training programs. Ruby Payne’s (2001) best-selling *A Framework for Understanding Poverty* used a deficit-thinking approach to explain populations that continue living in poverty through generations. Payne (2001) asserted the cause for generational poverty is the population’s inferior attitudes and amoral values. Payne (2001) constructed that the low graduation rate of students from low socioeconomic status (SES) families was due to the families’ indifference toward education. The framework’s solution to escape poverty relies on changing an individual’s “poor” attitudes. Payne’s framework received criticism as a view based on stereotyping and classism (Bomer, Doworin, May, & Semingson. 2008; Valencia, 2010).

Similarly, Doug Lemov’s (2010) *Teach Like a Champion* method was a foundational work for Teach For America teacher training and has been adopted into school districts and charter schools across the nation. The method emphasized teacher techniques for conforming students to demonstrate rigid words, precise behaviors and posture, and tightly monitored schedules, with the intent to “fix” student motivation. This view assumes that student struggles stem from lack of internal motivation.

Research supports that culturally responsive practices not only benefits marginalized learners, but was a pedagogy that was beneficial to students from all ethnic groups and for all level of learners (Ladson-Billings (1995; Gay, 2000). The pedagogy recognized and responded to students' prior knowledge. This approach was especially helpful for ethnically diverse students because builds on the strength of each student (Gay, 2000). The practices seek to provide a variety of ways to engage different learners.

Despite the robust literature support for Gay's work, within the education institution, strength-based and student-centered culturally responsive teaching co-exist in parallel with deficit-based theory such as Payne's poverty theory and Lemov's classroom management guide. Pre-service teacher education and continuing professional development simultaneously promoted rigid behavior management strategies alongside culturally responsive practices (Ladson-Billings, 2007).

Science as a Culture

Common discourse perceived scientific thinking as objective knowledge; however the "culture of science" plays a significant role in how girls of color relate to it. There were intricate issues around engaging a non-dominant group into the norms of the dominant culture (Bell, Lewestein, Shouse, & Feder, 2009; Guimond, De Oliveira, Kamiesjki, & Sidanius, 2010; Ogbu, 1998; Sinnes & Loken, 2012). There must be deliberate and sustained changes to learning experiences and the accompanying power relationships between students and teachers (Gay, 2000). In the case of STEM education, the power must shift from the dominate group to value and celebrate the experiences of the non-dominate group. To emphasize: How can the white-male majority of STEM fields create a learning environment that feels inclusive to women and girls of color? Without this change, the STEM programs continue to unknowingly placing girls of color in a position of a stereotyped gender identity (Sinnes & Loken, 2012).

Philip Bell has led the current academic and policy dialogue on STEM education. Bell et al. (2009) explained that:

> . . . science equity has often resulted in attempts to provide equal access to opportunities already available to dominant groups, without consideration of cultural or contextual issues. Science instruction and learning experiences in informal environments often privilege the science-related practices of middle-class whites and may fail to recognize the science related practices associated with individuals from other groups. (p. 212)

Scholarship around Aboriginal Canadians have eloquently depicted the conflict between science cultures and students from marginalized cultural backgrounds. Aikenhead and Huntley (1999) illustrated that low participation of Aboriginal Canadians in science and technology careers struggle in “cultural crossing” with little support. STEM programs for girls of color needed to openly address the issues of gender stereotypes and systemic barriers. "The oppression is reinforced by cultural hegemony. We use the term cultural hegemony to refer to the valuing and dominance of one culture over another such that the valued culture becomes the norm" (Simpson & Parson, 2008, p. 297-298). Simpson (2002) suggested this leaves the youths in a very difficult bind. The expectation to assimilate was often threatening to the youth and community’s cultural survival. Hernandez, Schultz, Estrada, Woodcock, and Chance (2013) reported some girls of color weighted the effort necessary to combat a white male-dominant environment against the potential gains from the efforts, and decided it was not worth the investment, leading to a maladaptive trend for low persistence.

Instead of recruiting students to join a culture of science, Lee (1999) argued that it was more beneficial to develop supportive environments for "scientific biculturalism." STEM educators could promote students to have ownership over their science identity without threatening their personal identity. In other words, students are encouraged to cultivate multiple identities without social risks (Hernandez et al., 2013; Sinnes & Loken, 2012). Proper support could help students develop emotional safety in navigating within the culture of science and maintain their identity outside of science, much like a bilingual person who could be fluent in two languages (Lee, 1999). Skills in traversing between the cultures could be taught and valued.

Organizational Practices on STEM Education

Four decades ago, the landmark 1975 conference among thirty women of color scientists produced the report, *The Double Bind: The Price of Being a Minority Woman in Science*, and shed light on the struggles and isolation experienced by members of the group (Malcom, Hall, & Brown, 1976). Malcom and Malcom (2011) suggested there have been great strides in progress for women of color in STEM, however, the achievement was limited. Women of color continued to lack representation in leadership roles. The causes of low participation rates from women of color in the STEM workforce were immediately and repetitively described as both a shortcoming of the girl's self-esteem or a lack of interest in STEM as viewed through a deficit-based lens (Sinnes & Loken, 2012). The resulting solutions to focus on exposure, inspiration, and feeding the pipeline model reflected the deficit-based thinking.

For the last three decades the dominant view in STEM education efforts was the pipeline metaphor (Blickenstaff, 2005; Cannady et. al. 2014; Maltese & Tai, 2011). The pipeline model had become synonymous with education pathways. This was seen in the manifestation of national policies such as Co-STEM's STEM Education 5-Year Strategic Plan and the White

House's Educate to Innovate Initiative. The pipeline model prescribed a linear education path for students to display STEM aspirations in primary schools, continue STEM course work in secondary schools, enter higher education, and exit the pipeline into the STEM workforce.

Stemming the Tide: Why Women Leave Engineering, a 2012 report funded by the National Science Foundation, found that there was a significant attrition rate of women engineers after they successfully exited the academic STEM pipeline. This recent inquiry has led to the acknowledgment that the lack of women in science-related jobs was not due to the lack of girls entering the pipeline, but that they were being filtered out. The report found that one in five female engineers leave the industry, citing difficult workplace climate and lack of professional advancements compared to their male peers (Fouad et al., 2012). *Stemming the Tide* (2012) proposes that workplace climate was one of the causes why decades of efforts in the STEM education and workforce pipeline had not produced the desired or predicted results.

The environment and infrastructure made a significant difference in girls' and women's ability to be successful in STEM. Blickenstaff (2005) indicates that they were not leaking out of the pipeline, but were pushed out through sex-based filters. The filters were complex and resistant to change. The filters spanned across social environments, classrooms, gender role pressure, teaching pedagogy, role models, early life experiences, and academic access (Blickenstaff, 2005). This was an ongoing shift in how to view the STEM gender and race gap.

Recent debates (Blickenstaff, 2005; Cannady, Greenwald, & Harris, 2014; Espinosa, 2011) critiqued the pipeline model as outdated and incorrect. Operating under the pipeline metaphor, the evaluation metrics looked for "leak preventions" at academic benchmarks such as graduation and course selections (Cannady, et al., 2014). The pipeline assumption evaluation metrics were frequently limited to attendance and demographics. Utilizing the proper evaluation metrics to show program effectiveness has become an elusive goal in STEM education. There has been inadequate comprehensive support from academia to develop more in-depth evaluation strategies and methods for STEM education (Lawrenz, Huffman, & Thomas, 2006). Measuring persistence and interest levels in STEM topics from girls who were already attending STEM programs contains a hidden bias because youth who signed up for STEM activities typically self-select into such programs due to their predisposed interests (Chun & Harris, 2011; Weber, 2012).

The pipeline model assumed early interest in STEM and enrollment in secondary academic courses would automatically lead to a STEM career path (Maltese and Tai, 2011). The narrow view that there was only one path to a STEM career and it must be traveled in a sequential lockstep journey presented an oversimplified vision. The pipeline model failed to capture the reality that half of the current STEM work force did not follow the traditional pipeline path (Cannady, et al., 2014).

The pipeline view assumed lack of participation from low-SES and female students was purely caused by lack of access and exposure. This view veiled the bigger systemic problem of discriminatory practices. Espinosa (2011) found that women of color faced a significantly more hostile environment compared to their white counterparts. The hostility was even more pronounced toward women of color than for their white female peers (Fouad et al., 2012). More research would be needed to understand the nuances of experience for women and girls of color participating in STEM activities.

While there was a large body of literature exploring the STEM gender gap, it generalized the experiences of women in general. The experiences of girls and women of color in STEM were scarcely represented in the literature. Ong, Wright, Espinosa, and Orfield (2011) assessed that the unique position of women of color in the STEM fields was only addressed in a combined

116 unpublished and published empirical papers between the years 1970-2009. Of those 116 papers, 80% of those papers examined the undergraduate years. More specific to this research, there was a limited body of literature on STEM complementary learning programs and even fewer publications that studied only girls of color. This literature gap was a barrier to the development of meaningful evaluation metrics (Chun & Harris, 2011).

Efforts needed to focus on building experientially accessible STEM learning environments for girl of color. In other words, creating culturally responsive STEM learning environments. Changing away from the conventional teaching practices could not happen by chance and required intentional and sustained efforts (Gay, 2000). Long term changes required commitment from the organizational level through leadership and training.

CHAPTER IV

METHODS

Framework

This study followed an anti-deficit achievement framework modeled by Shaun Harper (2010) that redirected attention to the existing support system within the community and student knowledge as previously undervalued resources that could be leveraged. While Harper (2010) used this approach in a qualitative study of black male students in STEM undergraduate programs, this anti-deficit, or strength-based, framework provided an "instead of" line of queries that moved away from frequent examination of student deficits. The current research adjusted the framework to apply to the organizational practices of complementary learning programs in recognizing students as resources. This strength-based framework was applied here to capture the current field practices that lead to STEM program characteristics that were beneficial to girls of color. Categories of organizational practices categories were based on the framework outlined in Peter Drucker's (1990) Managing the Non-Profit Organization: Principles and Practices, which established the importance of the mission statement, communication, training, and community partnerships in effective social service organizations. This framework was chosen to examine the management strategies of STEM program providers. The instrument recorded results on mission statement, communication, training, and community partnership. However the scope of this analysis only included the results from the mission statement and training questions. The framework was adapted to focus organizations' reported practice around diversity and inclusion, where internal practices were treated as the “inputs” and the STEM programs produced by these organizations were the end product or “outputs” of the system. The types of inputs affected the quality and types of outputs from a system (Drucker, 1990). Mission statement and training were selected as the focus in of this study with the intention that the findings would provide recommendations for organization leadership on best practices. This analysis measured training and mission statements (inputs) against the culturally responsive elements of the programs (outputs). The measurements were analyzed for correlations between diversity inputs and diversity outputs to identify strength and weaknesses of the practices. Table 1 showed the mission statement and training indicators that were used as independent variables.

Table 1. Description of Independent Variables and Measures

Organizational practice indicators	Scale and Range
Mission Statement	
Mission statement includes diversity	Four-point scale: 1 = Strongly disagree; 4 = Strongly agree *
Mission statement includes education equality	Four-point scale: 1 = Strongly disagree; 4 = Strongly agree *
Training	
Provide staff racial equality training	Four-point scale: 1 = Strongly disagree; 4 = Strongly agree *
Provide staff gender equality training	Four-point scale: 1 = Strongly disagree; 4 = Strongly agree *
Provide staff cultural competency training	Four-point scale: 1 = Strongly disagree; 4 = Strongly agree *

* Due to the raw data distribution, the 4 level scales were recoded to 2 categories: 1 = Agree/Strongly agree; 2 = Disagree/Strongly Disagree.

Defining characteristics of the output were required to measure for cultural responsiveness. Culturally responsive indicators (CRI) were developed for this study. The indicators were created based on the descriptions from Geneva Gay's (2000) *Culturally Responsive Teaching: Theory, Research, and Practice* provided recommendations outlined as the "Pillars for Progress." The indicators selected for this study were not exhaustive, but rather provide a representation to fit the scope of the analysis. They should not be interpreted as comprehensive indicators of culturally responsive programs.

Table 2 showed the 16 culturally responsive indicators used for this study divided in four categories: Ethnic-centering, authentic choice making, varied instruction styles, and organizational practices. The four categories expressed the descriptive characteristics of culturally responsive teaching. Culturally responsive teaching is multidimensional, validating, empowering, transformative, emancipatory, and comprehensive (Gay, 2000).

The four ethnic-centering CRIs in this study were incorporate participant's cultural heritage, incorporate popular culture, build pride in students' racial and ethnic identities, and having over 50% girl participants (Table 2). Ethnic-centering indicators reflected a validating and affirming practices because it "acknowledges the legitimacy of the cultural heritages of different ethnic groups (Gay, 2000, p. 31). The ethnic-centering section was of particular benefit for youths from traditionally marginalized populations. The last indicator in the ethnic-centering section, i.e., "over 50% girls participation", is not part of Gay's framework, which did not specify whether the key factors include a shared identify among participants. Current studies are still inconclusive whether single sex or co-ed environment would be a more conducive learning environment for girls (Wang & Degol, 2013). Historically STEM programs have an over-representation of boys. Recording programs with over 50% girl participants served as a simplified indicator of gender equality by having equal gender ratio in participation. For the purpose of the current study, reports were treated as a positive sign of progress to correct the disproportionate gender ratio.

Authentic choice making indicators reflected learning experiences that were empowering and transformative by putting decision making power into the hand of the learners. The three authentic choice making CRIs in this study were small group work, students provide peer feedback to each other, and student-driven project goals (Table 2). Decentralizing the learning climate encouraged collaborative learning based on cooperation instead of as site for conflicts (Norman et al., 2001).

The four varied instruction style CRIs in this study were auditory learning, visual learning, movement-based activities, and tactile learning (Table 2). Varied instruction styles indicators reflected multidimensional ways for students to engage and demonstrate knowledge. Finally the organizational practices is outside of the experience of the learners. This category captured the training to help prepared STEM educators. The category was an extension of the culturally responsive teaching and served to measure correlation to the STEM educator’s experience in diversity.

Table 2. Description of Dependent Variables and Measures

Culturally Responsive Indicators (CRI)	Scale and Range
Ethnic-centering indicators	
Incorporate participant's cultural heritage	0 = no; 1 = yes
Incorporate popular culture	0 = no; 1 = yes
Build pride in students' racial and ethnic identities	0 = no; 1 = yes
Over 50% girl participants	Data collected in 0-100%. Recoded < or > 50%
Authentic choice making indicators	
Small group work	0 = no; 1 = yes
Student provide peer feedback to each other	0 = no; 1 = yes
Student-driven project goals	0 = no; 1 = yes
Varied instruction indicators	
Auditory learning	0 = no; 1 = yes
Visual learning	0 = no; 1 = yes
Movement-based activities	0 = no; 1 = yes
Tactile learning	0 = no; 1 = yes
Organizational Practices	
Provide staff racial equality training	Four-point scale: 1 = Strongly disagree; 4 = Strongly agree *
Provide staff gender equality training	Four-point scale: 1 = Strongly disagree; 4 = Strongly agree *
Provide staff cultural competency training	Four-point scale: 1 = Strongly disagree; 4 = Strongly agree *
Specifically hires diverse staff	Four-point scale: 1 = Strongly disagree; 4 = Strongly agree *
Actively recruits a diverse volunteer base **7**	Four-point scale: 1 = Strongly disagree; 4 = Strongly agree *

* Due to the raw data distribution, the 4 level scales were recoded to 2 categories: 1 = Agree/Strongly agree; 2 = Disagree/Strongly Disagree.

Participants

Participants were recruited electronically through the following associations: The Association of Science-Technology Center, Space Grant Affiliates, National Afterschool Association, Challenger Learning Centers, and STEM Learning and Research Center. The invitations were either distributed through these groups' mailing list or social media pages. In addition, STEM programs were identified through internet searches. Program with email addresses listed on their websites were contacted. Invitation recipients were encouraged to forward the survey link to their professional network with an aim to get cross-regional participation. The use of electronic communication could have introduced bias through selection. It was expected recruitment would miss smaller and offline programs. A total of 600 invitations were sent out with 94 surveys returned. Participants had the option to skip any questions. Some questions received less than 94 responses.

Table 3 described the respondent demographics. The majority population identified as white. The respondents were also predominantly female. The mean experience in a volunteer or staff role with the current organization is 7 years (M = 7.11, SD = 7.42) with a reported general experience in STEM education field that is twice as long (M= 14.14 years, SD = 11.71).

Table 3. Respondent Demographics

Identity	%
Gender (n=64)	
Female	69
Male	31
Respondent Race (n=63)	
White	76
Black or African American	10
Hispanic or Latino American	6
Asian American	6
Multiracial American	3
Native Hawaiian or Other Pacific Islanders American	2
Native American or Alaska Native American	2
Prefer not to disclose	2

Instrument

The quantitative questionnaire was conducted online using Qualtrics. The instrument received Institutional Review Board approval Project Number IRB-201504-

310. Participants answered twenty-seven multiple part questions. Question types were a combination of rank order, Likert scale, and nominal multiple choices. For the purpose of this thesis, the analysis examined questions pertaining to mission statements, training, and culturally responsive indicators.

Since there were a limited number of STEM programs that target services to girls of color only, the questionnaire was open to designers from any STEM education program. Limiting participation only to programs for girls of color would have risked anonymity of the study participants as well as limited the sample size significantly. It was also more beneficial to collect data from STEM programs open to all girls and boys, that may include girls of color within their participants. The participants' professional organizations were not be identified. Program descriptive and demographic questions were categorized broadly to prevent linkage to identities or institutions. Individual participant's demographic questions collected gender, race, role in program, years worked in the organization, and years worked in STEM education in general. Information such as age and education level were intentionally left out to prevent biased conclusions since the study's goal was to focus on systemic issues and not individual influences. The questionnaire did not distinguish volunteers and staff because Drucker (1990) advocated that volunteers be treated as "unpaid staff."

The purpose of the study was to gain participants' perceptions of effectiveness of certain STEM education strategies by ranking their level of agreement to statements. However, the questions were not intended to document the actual effectiveness of the programs and methods since no direct observation of the program was to take place. The culturally responsive data was treated as indicators. The quality and effectiveness of the actual implementation were beyond the scope of this study. Questionnaire responses would identify which organizational practices were conducive for culturally responsive programs

Instrument Choice

An online questionnaire was chosen as the research instrument. A questionnaire was appropriate for collecting descriptive data and perceptions from participants. It also served as an effective method to conduct an anonymous survey in a short time frame. This short format of a 10-15 minute questionnaire was expected to encourage a higher response rate compared to a longer qualitative approach. This method also provided a wider representation of program types and geographic regions.

Schedule

The survey used for this study was open from May 15 to July 15, 2015. The timing during late spring to early summer was intended to maximize contact with complementary STEM learning programs that operate during the school year, as well as summer programs that operate during summer break. Data analysis took place during the fall of 2015.

Data Analysis

The independent variables were whether training and mission statement key words are present (Table 1). The dependent variables consisted of culturally responsive indicators and organizational practices (Table 2). Three variables on training, i.e., provide staff racial equality training, provide staff gender equality training, provide staff cultural competency training, and were categorized as dependent variables (culturally responsive indicators).

In survey Q16 (Appendix A) respondents were asked to rate the level of agreement if their organization: 1) had a mission statement that includes diversity and education equality and 2) provides professional development on racial equality, gender equality, cultural competency, specifically hires diverse staff members, and actively recruits diverse volunteers base.

For culturally responsive indicators in Table 2, respondents were given the options to "check all that apply." Unchecked indicators were interpreted as the elements not used in the program. Question 9 provided a scale bar for respondents to "drag" the bar along a number line to indicate the approximate percentage of girl participants in the program. The returned data ranged from 0%-100% girl participation ($M = 17$, $SD = 8.27$, $n = 83$). The raw data were recoded into two categories, 0-49% and 50-100%. This was used as an indicator for programs that have more than half the participants being girls. While increasing participation with shared identity, i.e., identify as a girl, was not part of the original framework in Geneva Gay's (2000) culturally responsive teaching, this study extended the indicators to include higher girl participation.

Organizational practices on training and mission statement items asked respondents to self-report by selecting the level of agreement using a 4-point Likert-type scale – 1 (Strongly Disagree), 2 (Disagree), 3 (Agree), and 4(Strongly Agree). A large number of Chi-square test cells could not be supported by the number of observations, due to the data distribution. The sample size was not sufficient for the original four levels, data were collapsed into two levels and recoded as: 1 = Agree/Strongly Agree and

2 = Disagree/Strongly Disagree. After recoding, both independent and dependent variables were treated for correlation using the Chi-square test, with one degree of freedom through software program MiniTab Express.

CHAPTER V

RESULTS

Program Descriptive Statistics

The primary purpose of this study was to examine organization practices and shift the academic discourse away from perceived youth deficits to examining institutional strengths and systemic barriers. In addition, the collected data provided a secondary outcome by illustrating a representative sample of "typical" STEM programs on a national level. Participants had the option to skip any questions. The highest

Table 4 shows program and organization characteristics as reported by the respondents. Almost half of the respondent's organizations were based in urban areas (47%, *n* = 94). Just less than half are over 10 years old (41%, *n* = 92). Programs were offered to various age groups, with a higher concentration of programs reported for youth in middle childhood, ages 9-12, and young teens ages 12-15 (67% and 66%, respectively, *n* = 94).

Only 33% (n = 94) of programs took place inside a schoolhouse during weekends and after school hours. Almost half of the programs targeted low socioeconomic status populations (44%, *n* = 90), however this survey did not provide markers to define low-socioeconomic status. Just over half of the programs are free to participants (52%, *n* = 91). Of the programs with a fee, 51% (*n* = 93) offered scholarship assistance. The data skew toward older and more established programs because they are more likely to have established websites and through professional associations. Bias was introduced because the mailings were sent out to museums and programs with email contacts posted on websites. Less advertised programs may not be represented in this study. Organizations were mostly small operations where the majority only had 1-20 people, counting staff and volunteers (56%, *n* = 94).

Table 4. Profile of sample organizations.

Item	%
*Grade level served (n = 94)**	
K-3	47
4-6	67
7-9	66
10-12	53
General Public	36
Location (n = 94)	
Urban	47
Suburban	37
Rural	15
Online	1
Setting (n = 94)	
School house (weekend or afterschool)	33
Public spaces (e.g. museum, library)	35
Private spaces (e.g. scouts, religious center)	5
College or university	14
Online	1
Other	12
Program duration (n = 94)	
One time event	30
1-3 weeks	12
1-3 months	12
4-9 months	16
> 9 months	31

Table 4. cont.

Item	%
Time of Day (n= 78)	
Before school	6
Afterschool	41
Evening	4
Weekend	26
School breaks	23
Session Size (n =94)	
1-10 students	14
11-20 students	28
21-30	25
>30 students	28
Rolling audience (booth, online)	6
Program Maturity (n = 92)	
1st year	9
1-3 years	20
4-5 years	19
6-10 years	12
>10 years	41
Organization size (n = 94)	
1-20 people	56
21-50 people	17
51-100 people	6
>100 people	18
Organization Composition (n = 93)	
Mostly staff	47
Mostly unpaid volunteers	33
About equal volunteers and staff	19

*67% of respondents served more than one age categories.

Effects of Mission statement

Of the responding programs, 82% have a mission statement (*n* = 92). Table 5 displays the results of a chi-square analysis to determine the existence and strength of correlation between mission statements that contain diversity and education equality with the reported presence of four types of culturally responsive indicators. In response to hypothesis 1 (H_1): Organizations with mission statement keywords, diversity and education equality, will exhibit more culturally responsive indicators. Having diversity in an organization's mission statement showed a weak correlation with increased ethnic-centering, authentic choice making, and varied instruction style CRIs, but had a strong correlation with organizational practices.

In testing H_1, mission statement key words had a weak correlation with ethnic-centering CRIs. Only one positive correlation indicated more likelihood to incorporate popular culture in programs ($\chi 2$ (1, n = 65) = 5.00, p <.03). Mission statement key words had a weak correlation with authentic choices making CRIs. Only one positive correlation indicated more likelihood to include small group work ($\chi 2$ (1, n = 65) = 4.31, p < 04). Mission statement key words had no correlation with varied instruction style CRIs.

The existence of a mission statement with the diversity and education equality has a strong correlation with organizational practices. Mission statements that include diversity showed more likelihood of providing racial and gender equality training ($\chi 2$ (1, n = 58) = 9.91, p <.002); ($\chi 2$ (1, n = 56) = 4.49, p <.03, respectively). Mission statements that included education equality also showed an impact on the tendency to provide racial and gender equality training ($\chi 2$ (1, n = 57) = 4.68, p <.03); ($\chi 2$ (1, n = 55) = 4.91, p <.03, respectively).

The last section of Table 5 showed a higher rate of recruiting a diverse volunteer base aligned with both mission statement groups. The diversity statement group showed a slightly lower correlation than the education equality group ($\chi 2$ (1, n = 56) = 6.37, p <.01; $\chi 2$ (1, n = 56) = 8.76, p <.003, respectively).

Table 5. Mission Statement vs. Culturally Responsive Indicators

	Mission Statements Includes					
	Diversity			Education Equality		
Culturally Responsive Indicators	*n*=	χ^2	*p*-value	*n*=	χ^2	*p*-value
Ethnic-centering						
Incorporate participant's cultural heritage	65	2.75	0.10	65	0.03	0.86
Incorporate popular culture	65	5.00	0.03	65	0.08	0.78
Build pride in students' racial and ethnic identities	65	1.23	0.27	65	0.10	0.75
Participants > 50% girls	59	1.34	0.25	60	1.86	0.17
Authentic choice making						
Small group work	65	4.31	0.04*	65	0.34	0.56
Student provide peer feedback to each other	65	0.27	0.60	65	0.27	0.60
Student-driven project goals	65	0.38	0.54	65	0.27	0.60
Varied instruction style						
Auditory learning	65	0	0.99	65	0.17	0.68
Visual learning	65	0.7	0.40	65	0.09	0.76
Movement-based activities	65	0.29	0.59	65	1.40	0.24
Tactile learning	65	0.70	0.40	65	0.09	0.76
Organizational Practice						
Provide staff racial equality training	58	9.91	0.002*	57	4.68	0.03*
Provide staff gender equality training	56	4.49	0.03*	55	4.91	0.03*
Provide staff cultural competency training	47	0.18	0.68	47	0.34	0.56
Specifically hires diverse staff	54	5.21	0.02*	53	3.42	0.06
Actively recruits a diverse volunteer base	56	6.37	0.01*	56	8.76	0.003*

Note: Degree of Freedom = 1, Significant at $p < 0.05$ level
*Statistically significant correlation

Effects of Training

Of the responding organizations, 69% ($n = 94$) offered professional development to their staff and volunteers. In response to hypothesis 2 (H_2): Organizations that provide diversity training, will exhibit more culturally responsive indicators. Having diversity training showed a weak correlation with increased ethnic-centering, authentic choice making, and varied instruction style CRIs but showed a strong correlation with organizational practices.

In testing H_2, diversity training had a weak correlation with ethnic-centering CRIs. Only one positive correlation indicated more likelihood between offering gender equality training correlated with girls' participation rate of higher than 50% ($\chi2$ (1, n = 54) = 6.32, p <.01). Diversity training had no correlation with authentic choices making CRIs. Diversity training had a weak correlation with varied instruction style CRIs. Only two positive correlations appeared. Tactile learning was increased with racial equality training ($\chi2$ (1, n = 73) = 4.40, p <.04) and gender equality training ($\chi2$ (1, n = 61) = 4.46, p <.03).

The existence of a mission statement with the diversity and education equality had a strong correlation with organizational practices. The indicator of hiring diverse staff showed correlation with training for racial equality, gender equality, and cultural competency ($\chi2$ (1, n = 57) = 7.62, p <.006; $\chi2$ (1, n = 55) = 6.34, p <.01; $\chi2$ (1, n = 55) = 11.68, p <.001, respectively). Parallel findings were displayed in the last indicator on Table 6. Actively recruiting a diverse volunteer base had a positive relationship with racial equality, gender equality, and cultural competency training ($\chi2$ (1, n = 58) = 6.12, p <.01; ($\chi2$ (1, n = 57) = 4.41, p <.04; ($\chi2$ (1, n = 57) = 7.59, p <.006, respectively).

Table 6. Training vs. Culturally Responsive Indicators

Culturally Responsive Indicators	Training Type: Racial Equality			Training Type: Gender Equality			Training Type: Cultural Competency		
	n=	χ^2	*p*-value	*n*=	χ^2	*p*-value	*n*=	χ^2	*p*-value
Ethnic-centering									
Incorporate participant's cultural heritage	63	1.57	0.21	61	0.20	0.65	59	0.30	0.58
Incorporate popular culture	63	0.45	0.50	61	0.16	0.69	59	0.03	0.87
Build pride in students' racial and ethnic identities	63	3.58	0.06	61	2.44	0.12	59	0.97	0.32
Participants > 50% girls	56	3.36	0.07	54	6.32	0.01*	52	1.30	0.25
Authentic choice making									
Small group work	63	0.14	0.71	61	0.20	0.65	59	0.39	0.54
Student provide peer feedback to each other	63	0.00	1	61	0.55	0.46	59	0.33	0.57
Student-driven project goals	63	1.01	0.32	61	1.20	0.27	59	0.05	0.82
Varied instruction style									
Auditory learning	73	1.22	0.27	61	0.55	0.46	72	0.06	0.81
Visual learning	73	1.69	0.19	61	1.09	0.30	72	0.97	0.33
Movement-based activities	73	0.07	0.79	61	0.87	0.35	72	0.16	0.69
Tactile learning	73	4.40	0.04*	61	4.46	0.03*	72	0.20	0.65
Organizational Practice									
Provide staff racial equality training	-	-	-	-	-	-	-	-	-
Provide staff gender equality training	-	-	-	-	-	-	-	-	-
Provide staff cultural competency training	-	-	-	-	-	-	-	-	-
Specifically hires diverse staff	57	7.62	0.006*	55	6.34	0.01*	55	11.68	0.001*
Actively recruits a diverse volunteer base	58	6.12	0.01*	57	4.41	0.04*	57	7.59	0.006*

Note: Degree of Freedom = 1, Significant at $p < 0.05$ level
*Statistically significant correlation

CHAPTER VI

DISCUSSION

Culturally responsive pedagogy provides more structured opportunities for students to participate in learning experiences that center their autonomy and sense of identity (Gay, 2000). Answering the two hypotheses provides insight to the practices organizations can take to improve cultural responsiveness within their programs.

H_1: Organizations with mission statement keywords, diversity and education equality, will exhibit more culturally responsive indicators.

H_2: Organizations that provide diversity training, will exhibit more culturally responsive indicators.

Ethnic-Centering

Mission statement key word education equality in the mission statement do not enhance ethnic-centering. There is a weak correlation indicating more likelihood to incorporate popular culture in programs ($\chi 2$ (1, n = 65) = 5.00, p <.03). No other correlations are observed based on mission statements. This weak correlation in the results does not support H_1. Mission statement key words do not have a significant impact to increase ethnic centering CRIs. The existence of various kinds of diversity trainings also do not show correlation with ethnic-centering CRIs, with the exception that gender equality training correlates with higher than 50% girls' participation rate ($\chi 2$ (1, n = 54) = 6.32, p <.01).

Neither professional development nor inclusive language in the mission statements make a difference to increasing ethnic centering elements for students' experiences. It should be noted that 74% of programs surveyed are either free of charge or charged under $100 (Table 4). One explanation of this observation is that organizations expressed education equality by reducing financial barriers to their programs. The current findings reveal that the ethnic-centering experience for girls of color in STEM program may not be improved by training and inclusive language mission statements.

Incorporating participants' cultural heritage and building students' racial and ethnic identity are only present in a small number of programs (19%; $n = 94$, for both). STEM fields are traditionally presented as a completely objective discipline that exists in a vacuum sealed from societal cultural factors (Bell et. al., 2009). The low rate of ethnic-centering indicators may be due to this common perception which perpetuates the idea that cultural elements are irrelevant to STEM programs. The reluctance can be further amplified by the popular STEM education rhetoric which aims to fix the perceived deficit in students and focuses on inspiration and exposure to new activities. This view can be oppressive toward historically non-dominant groups and female students with prior knowledge gained from their families and communities (Bell et. al., 2009).

Including activities or perspectives that build students' ethnic and gender identities is crucial to the emotional well-being and academic success of students from historically marginalized groups (Gay, 2000). Educators may not be well equipped with teaching tools that can embrace student ethnic and gender identity within the STEM contexts. Such activities can include learning about historic and current role models from marginalized groups, and more powerfully through STEM activities that address issues related to students in the context of their home community. Intentionally including students' interest and community relevance as part of the learning structure is beneficial because when teachers actively engage students' prior knowledge and treat student's cultural capital as assets instead of deficits (Medin & Bang, 2014; Parson et al., 2005).

Authentic Choice Making

Including authentic choice making as part of the curriculum design ensures that programs are inclusive and provide students real autonomy throughout the learning experience. The indicators show weak correlation with both training and mission statement with diversity and education equality. The only positive correlation is between mission statements containing diversity with presence of small group work ($\chi 2$ (1, n = 65) = 4.31, p < 04). The solitary correlation should be not interpreted as a key finding because small group work is a common best practice among STEM education practitioners as indicated by the majority of respondent organizations that already use it (80%, n = 75).

Learners are more engaged when their prior knowledge gain validity in the learning environment (Gay, 2000; Medin & Bang, 2014). One strategy to embody this value in programs is to structure lessons to include many opportunities for students to practice authentic decision-making in their own learning. This practice places value to the learning process over emphasis on creating a final product (Vossoughi, Escudé, Kong, and Hooper, 2013).

Varied Instruction Style

The existence of a mission statement with the diversity and education equality exhibit no correlation with varied instruction style CRIs. Dominate and non-dominate populations all thrive with varied instruction options. Racial equality and gender equality professional development show positive correlations with increased incidence of tactile learning ($\chi 2$ (1, n = 73) = 4.40, p <.04) and ($\chi 2$ (1, n = 61) = 4.46, p <.03), respectively. This outcome is consistent with STEM programs focusing on providing access to "hands-on" experiences and increasing "exposure" STEM work environments.

Racial and gender training show no correlation with other CRIs in this section. Cultural competency training do not have any correlation with an increase in any varied instruction style CRIs. Furthermore, a majority of the programs are already using visual learning (87%, n = 82) and tactile learning (88%, n = 83) in their programs regardless of the presence of mission statement or training. The outcome suggests that current organizational practices do not have a strong influence on increasing varied instruction style. The results are similar to the previous two sections and indicate that the presence of diversity training and inclusive wording in mission statements do not translate strongly into culturally responsive practices in STEM programs.

Presenting STEM learning in a mixture of learning styles creates more channels for students to "access" or connect with the material. Offering various ways for students to receive and produce knowledge through different forms of expression. Multidimensional access to information benefits all ethnic groups and all levels of learners (Gay, 2000). Curriculum that connect newly introduced information and with students' prior knowledge allow students to engage from a diversity of standpoints based on their personal background (Xu, Coats, and Davidson, 2012). For example, auditory and kinesthetic learning styles are communication styles that Black students typically respond well to and have been shown to improve learning (Gay, 2000; Ladson-Billings, 1995). However, evidence in this study points to a lack of varied instruction styles, with a particularly lower occurrence of auditory learning and movement-based activities (39%, 57%, n = 94, respectively).

Hypothesis 2 expected organizations that provide diversity training will exhibit more culturally responsive indicators. The observations do not support hypothesis 2. In the nature suggested by Gay (2000), there is a gap between the instruction style used and student needs. Organizations that value diversity are providing diversity professional development, but the trainings are not translating into their STEM programs (product). One explanation of this observation is that the trainings do not provide specific strategies to culturally responsive STEM practices. This disconnect demonstrates the necessity for more applicable professional development to support culturally responsive STEM program designs.

Organizational Practices

The results in this section contrasted with the previous three sections. Organizational practices show the most correlation with both training and mission statement. Having the keyword “diversity” in the mission statement correlated strongly to organizations providing racial and gender equality training. The observations support hypothesis 1 and 2 in the organizational practices section. Offering diversity training and having mission statement keywords correlate strongly with an organization’s internal diversity practices. This section shows the highest number of positive correlations in the study. The multiple correlations between mission statement and training to organizational practices suggest that diversity trainings lead to an inclusive environment inside the organization. This conclusion is supported by the strong correlations between having diversity in the mission statement with increased cultural responsiveness e.g. providing diversity training, specifically hire diverse staff, and actively recruiting a diverse volunteer base. However, note that the improvements are limited to internal practices that are experienced by the staff and volunteers within the organizations. The improvements do not appear to extend out to the program experiences for girls of color, since mission statement and training only showed weak correlations with CRIs that take place in the learning programs. Mission statements and training made a difference for the adults involved in the STEM programs, but do not make a significant different for the programing experienced by the youth.

The differences may be due to different accountability metrics. Workplace climates are measured by factors such as staff satisfaction and morale. Student identity formation and learning experiences in complementary education settings are not typically measured in program performance evaluations. STEM evaluation metrics focus on graduation rates, program participation rates, and student interest in STEM careers (Cannady, et al., 2014; Lawrenz, Huffman, & Thomas, 2006). Metrics that detect attrition and participation rates stem from the assumptions that pipeline leakage is the primary problem. Acknowledgement of the lived experience of marginalized students in STEM programs will move away from these “cosmetic” measurements of success (Sinnes & Loken, 2012).

The positive correlation on hiring and recruitment of diverse adults to work in STEM programs actively places adults from traditionally non-dominant population to be decision makers in STEM programs. Diverse staff and volunteer base has the potential opportunity to develop programs that will benefit youth who share their identity. The study’s stated focus on girls of color may have influenced higher respond rates from educators of color and created a bias in the results. Even with this progress, people of color representation is still less than a quarter of the respondent.

A staff and volunteer who “match” the gender and ethnicity of participants can become positive role-model for students to identify with (Gay, 2000). However, care must be taken not to put too much pressure on this strategy as the primary indicator of cultural responsiveness. It is dangerous to expect that "teachers of color should assume the primary responsibility (and, by extension, blame) for the achievement of students of their own ethnic groups" (Gay, 2000, p. 241).

The current education profession is dominated by college-educated White females. This distribution was reflected in the demographics of the survey respondents 69% female, n = 64; 76% White, n = 63). It is unrealistic to expect only people of color to occupy every STEM education position. An assumption that the white educators are operating on a cultural deficit simplifies that matter and can end up displacing the deficit on to the individual educators (Settlage, 2011). Instead, a more realistic approach would be to design culturally responsive STEM programs that do not rely on the educators' ethnicity identity for success.

CHAPTER VII

CONCLUSION

The problem of girls of color's low participation in STEM activity is complex. One of the barriers is STEM program participation experience for traditionally marginalized girls. STEM programs that offer culturally responsive learning experiences can positively engage more girls of color. By examining two organizational practices, mission statements wording and training, for correlation with programs exhibiting culturally responsive characteristics, this study provides a better understanding of the relationship between organizational practices used by STEM education organizations and the programs they create.

This study asks: Do organizational practices in STEM education programs positively affect the program's cultural responsiveness for girls of color? The research predicted that (H_1) organizations with mission statement keywords, diversity and education equality, will exhibit more culturally responsive indicators and that (H_2) organizations that provide diversity training, will exhibit more culturally responsive indicators. The data collected suggest that there are weak correlations between organizational practices and cultural responsiveness of their STEM programs. The weak indications are not strong enough to fully support the hypotheses.

Racial equality, gender equality, and cultural competency of training also do not show strong correlation to indicators. Regardless of stated intentions in mission statements and providing diversity training, there is little correlation to indicate changes in organizations' STEM programs (external products) experienced by students. In other words, the external products from these organizations remains unchanged. The existence of a mission statement with the diversity and education equality exhibit a weak association with increasing culturally responsive indicators.

The findings do not support H_1 nor H_2 with the exception of strong correlations in the experiences for the organizations' staff and volunteers when provided with diversity training (internal practices). In contrast, these mission statement key words showed a clear influence on ensuring an organization provides racial and gender equality training. An expressed commitment through inclusive language in mission statements and training led to efforts in cultivating a diverse staff and volunteer base.

These practices to increase diversity affect the experience of staff and volunteers for an organization, and only had a weak impact on the power dynamic and pedagogy of the STEM programs. Ethnic-centering, authentic choice making, and varied instruction style are supportive strategies that increase positive student experiences. Increasing these practices in STEM education is critical to ensure equitable experiences for girls of color. Making this shift must be "deliberate and explicit, systematic and sustained" and cannot depend "happenstance, sporadic, or fragmentary" unsubstantial efforts (Gay, 2000).

Recommendation

Research

This study only investigated reported perceptions of diversity training and mission statement of organizations. Future research is require to establish the validity of the claim that H_1 and H_2 are not supported. Given the quantitative scope of the current study, it is recommended that the next step include mixed method research that include direct observations and interviews.

In addition, this report recommends future research to qualify what types of professional development will lead to cultural responsiveness in STEM complimentary learning spaces. Near future research can establish the impact of current practices of STEM educators, to create a baseline to compare the impact of new STEM education trainings that are based on cultural responsiveness. Since half of the respondents reported on the practices of smaller organizations consisting of 1-20 people, future research should examine potential differences between smaller and large organizations.

Practice

Dominate culture influence how STEM knowledge are passed on to youth (Aikenhead & Huntley, 1999; Bell et al., 2009). Organizations need be held accountable for the quality of deliberate and systematic efforts to increase culturally diverse practices. This approach requires STEM educators to explicitly address the hidden implicit role of culture in teaching and learning. This is a drastic but essential approach and is expected to encounter initial resistance.

It is recommended that organizations place intentional effort to provide training on *how* to create culturally responsive programs. STEM education organizations must invest in anti-racism professional development to support educators to be successful "cultural and ethnic border crosser" from their own ethnic or academic culture into the youths' cultures to undo systemic biases. Resources should include explicit examples of culturally responsive strategies for STEM education. Organizations need to address the systemic barriers presented by the power dynamics in learning spaces as well as STEM content knowledge.

APPENDIX A

Survey Instrument

Introduction to study: Thank you for taking the time to participate in this 10-15 minute multiple choice questionnaire. You were invited because you are involved in the planning of K-12 science, technology, engineering, and math (STEM) informal education programs that take place outside of the standard school day. The study will explore the relationship between organization practices and STEM program cultural relevancy for girls of color. In this study, girls of color is defined as any youth who identify herself as a girl and as a non-white person. You may skip any questions that you do not wish to answer. You must be 18 or older to participate. This research study will measure the relationship between organizational practices and the program cultural relevancy for girls of colors. The results will identify program planning practices that are beneficial for girls of color. Thank you in advance for your time! Please select "CONTINUE" to start.

#	Answer		Response	%
1	Continue		127	96%
2	No thanks		5	4%
	Total		132	100%

By clicking YES at the bottom the page, you are indicating that you have reviewed the informed consent for and agree to participate in this study.

UNIVERSITY OF NORTH DAKOTA Institutional Review Board Informed Consent Statement

Title of Project: STEM education for girls of color: Organizational practices and cultural responsiveness Principal Investigator: Kam Yee, 206-972-2609, kamyee@ymail.com Advisor: Dr. James Casler, 701-777-3462, casler@space.edu Purpose of the Study: You are invited to be in a research study about the relationship between organization practices and the cultural relevancy for girls of color in science, technology, engineering, and math (STEM) programs because you are involved in the planning of a K-12 STEM informal education program that takes place out of the standard school day (e.g. after school program, summer camps, internship, mentoring program, science expo) The purpose of this research study is to test the hypothesis: Strength-based organizational practices in informal STEM education programs positively affect the program's cultural responsiveness for girls of color. The results will provide a better understanding of organizational practices behind STEM programs and how to improve recruitment, services, and retention of girls of color in STEM education paths. Procedures to be followed: You will be asked 27 multiple part questions about a STEM program you work with and organizational practices. A special focus will be paid to program alignment to the needs of girls of color. You are free to skip any questions that you would prefer not to answer. The survey will be open from May 1, 2015 to July 15, 2015

Risks: There are no risks in participating in this research beyond those experienced in everyday life.

Benefits: You will not benefit personally from being in this study. However, we hope that, in the future, other people might benefit from this study because the results may be used to help organizations to improve their STEM education programs and work environment. STEM education professionals can use the results to guide organization practices that foster culturally responsive programing.

Duration: It will take 10-15 minutes to complete the questions.

Statement of Confidentiality: The questionnaire does not ask for any information that would identify who the responses belong to. Therefore, your responses are recorded anonymously. If this research is published, no information that would identify you will be included since your name is in no way linked to your responses. All survey responses that we receive will be treated confidentially and stored on a secure server. However, given that the surveys can be completed from any computer (e.g., personal, work, school), we are unable to guarantee the security of the computer on which you choose to enter your responses. As a participant in our study, we want you to be aware that certain logging; software programs exist that can be used to track or capture data that you enter and/or websites that you visit.

Right to Ask Questions: The researcher conducting this study is Kam Yee. You may ask any questions you have now. If you later have questions, concerns, or complaints about the research please contact Kam Yee at kam.yee@my.und.edu or Dr. James Casler at (701)777-3462 during the day. If you have questions regarding your rights as a research subject, you may contact The University of North Dakota Institutional Review Board at (701) 777-4279. You may also call this number with problems, complaints, or concerns about the research. Please call this number if you cannot reach research staff, or you wish to talk with someone who is an informed individual who is independent of the research team. General information about being a research subject can be found on the Institutional Review Board website "Information for Research Participants" http://und.edu/research/resources/human-subjects/research-participants.cfm

Compensation: You will not receive compensation for your participation.

Voluntary Participation: You do not have to participate in this research. You can stop your participation at any time. You may refuse to participate or choose to discontinue participation at any time without losing any benefits to which you are otherwise entitled. You do not have to answer any questions you do not want to answer. You must be 18 years of age older to consent to participate in this research study. Completion the survey implies that you have read the information in this form and consent to participate in the research. Please print a copy of this form for your records or future reference.

#	Answer		Response	%
1	Yes, I agree to take part in this study.		112	97%
2	No thanks. I am not interested in continuing.		3	3%
	Total		115	100%

Q1. This section will focus on the components of the STEM program. If you work or volunteer on multiple STEM programs, choose ONE program you are most familiar with while you answer the following questions. What age range does this program serve? (check all that apply)

#	Answer		Response	%
1	Grades K-3 (~ages 5-9)		44	47%
2	Grades 4-6 (~ages 9-12)		63	67%
3	Grades 7-9 (~ages 12-15)		62	66%
4	Grades 10-12 (~ages 15-19)		50	53%
5	General public		34	36%

Q2. What region is the program primarily based in? Pick one answer from the drop down menu below the map. If the program is online, please select the region where the organization is primarily based in.

#	Answer		Response	%
1	Zone 1		32	39%
2	Zone 2		10	12%
3	Zone 3		11	13%
4	Zone 4		8	10%
5	Zone 5		21	25%
6	US territories		0	0%
7	Outside of USA		1	1%
	Total		83	100%

Q3. Select the characteristics from the drop down menu that best describe the program most of the time.

													%	Total
1	Location	Urban	46.81 %	Suburban	37.23 %	Rural	14.89 %	Online	1.06%	Other	0.00%			
2	Setting	Inside school house (Weekend or afterschool)	32.98 %	At a public space such as museum, science center, or library	35.11 %	At a private space, such as Girls Scouts or religious center	5.32%	On a college or university campus	13.83 %	Online	1.06%	Other	0.00 %	94
v	Program duration	One-time only event (one day or multi-day seminar)	29.79 %	1-3 weeks (such as camps)	11.70 %	1-3 months	11.70 %	4-9 months	15.96 %	Longer than 9 months	30.85 %		11.70%	94
4	Time of Day	Before school (AM)	6.41 %	After school (PM)	41.03 %	Evening	3.85%	Weekend	25.64 %	During school breaks	23.08 %		0.00 %	94
5	Frequency	One-time only event	11.70 %	2-6 times a year	14.89 %	7-12 times a year	14.89 %	Weekly	23.40 %	Daily	10.64 %	Ongoing/No end date	0.00 %	78

6	Typical session size	1-10 students	13.83%	11-20 students	27.66%	21-30 students	24.47%	more than 30 students	27.66%	Rolling audience (i.e. event booths, online, meet and greet)	6.38%		24.47%	94
7	Transportation (to/from program)	Program provides transportation	4.71%	Families arrange transportation	68.24%	Program takes place in school	25.88%	Online	1.18%		0.00%		0.00%	94
8	Cost	$1-100	21.98%	$101-200	12.09%	$200-400	7.69%	Above $400	6.59%	No Cost/Free	51.65%		0.00%	85
9	Scholarship Available?	Yes	26.88%	No	25.81%	N/A	47.31%		0.00%		0.00%		0.00%	91
10	How long has this program been offered?	1st year	8.70%	1-3 years	19.57%	4-5 years	18.48%	6-10 years	11.96%	over 10 years	41.30%		0.00%	93
													0.00%	92

Q4. Select the characteristics from the drop down menu that best describe the organization:

#	Question	Label 1	Count 1	Label 2	Count 2	Label 3	Count 3	Label 4	Count 4	Total Responses	Mean
1	Organization size (staff and volunteers combined)	1-20 people	53	21-50 people	16	51-100 people	8	more than 100 people	17	94	1.88
2	Composition	Mostly paid staff	44	Mostly unpaid volunteers	31	About equal volunteers and staff	18		0	93	1.72

Q5. In the text box below, please write down what STEM topic(s) the program focus on? Examples: Aerospace, computer science, medical science, robotics.

Text Response
computer science
Math, physics, chemistry, electronics, aerospace, aviation, geology, water science
robotics, science, math- serving children 3 to 12 years old we incorporate math and science into hands-on activities
Astronomy, Weather, Physical, Earth and Life Sciences
engineering design, physical science (energy conservation, matter, waves, magnetism), biology, general inquiry/problem solving
Aerospace, robotics, rockets
aerospace
communicating science
Human space flight, atmosphere, stars and planets, weather, space weather, telescopes and astronomy
Each event has a different STEM topic
Science process skills, engineering, creative problem solving, communication, astronomy, biology, chemistry, physics
Code, Robotics
STEAM - aeronautics, aerospace, flight, nanotechnology, materials science, engineering and making
Aerospace, robotics, medical science
computer science, cybersecurity, STEM careers, STEM at colleges
Astronomy, celestial mechanics, optics
Aerospace, Robotics, Planetary science
engineering and general science
wide variety of topics attempting to represent the breadth of STEM
all aspects of STEM are offered
Energy production, wind, geology, engineering
Engineering
Aerospace, Robotics, Basic Science
All forms of Engineering.
engineering, robotics, biological sciences, mixed STEM areas, STEM careers
robotics, computer science with 3D imaging, nanoscience, mechanical engineering
aerospace, physics, experimentation
Math, Science, Civil , Aerospace, Microcontrollers, Biomedical, Construction Mgmt, Mechanical, Architecture, Electrical
Astronomy
pre-engineering, robotics
Statistics, Environmental science, biotechnology, independent research
Simple physics, space flight, astronomy
robotics
General Focus on STEM, try to incorporate all aspects of science, math, and engineering, with a Tech focus of basic copmuter sciece and computer programming
computer science, robotics, web design, game design, forensics, engineering
Aerospace, engineering, robotics
Aerospace, robotics, computer science, space science, math, engineering, rocketry, flight, astronomy, planetary science, propulson

Engineering, city management
Aerospace including astronomy, aeronautics, astronautics and atmospherology
VARIOUS STEM FIELDS
Space Science, Aerospace
Computer science
Aerospace, Computer Science, Robotics, Engineering, etc.
Local research in all STEM
Engineering fields
Engineering
Electricity and Magnetism; Nature of science; Optics
Robotics 3D Printing Coding
Aerospace
Medical Science, Computer, Environmental, Automotive, Civil, Math, MicroBiology
electrical engineering, computer science, game design, mechanical engineering, structural engineering, various engineering, digital medial
Space, earth science
chemistry, physics, electricity, weather, astronomy, math, etc.
Natural history topics including biology, earth/planetary science, anthropology, astrophysics.
Engineering, atmospheric studies, space science
STEM Writing and basic research skills
engineering, environmental science, geoscience, physics, atmospherics, ecology, robotics, etc.
Aerospace, rocket science, programing, electronics, design
Aerospace, robotics, material sciences, mechanical, electrical, and system engineering
space science, general physical science; human body/health
chemistry, geology, astronomy, biology, physics
Any STEM topics- new one every month
Basic science, computer programming, robotics, astronomy, etc.
Advanced environmental physics and mathematics
biology, paleontology, physics, math, engineering, chemistry, robotics, aerodynamics, rocketry, taxonomy, astronomy, etc.
As wide a variety of STEM topics as possible, and depends on which experts I can get from year to year
environmental science, broadly defined -- projects depend on individual interests of kid/mentor
Program explores a range of topics related to life sciences, aerospace, environmental science, technology
Aerospace, Computer science, Bio science, robotics, mathematics, Engineering
All STEM Components, Science, Technology, Engineering & Math, oh also Aerospace and robotics
all areas of STEM
Nanotechnology, Robotics, Geology, Chemistry, Physics
structural, electrical, mechanical engineering; computer science
All
Any and all science themes. Past themes include robotics, space/rockets, computer science, physics, forensics, food science, engineering
Bioenergy and bioproducts
Science, astronomy, mathematics,
All STEM topics are fair game.
All fields of STEM
Aerospace

space related STEM items
Because we meet weekly through the entire school year, our scientific topics vary.
Aerospace
Robotics, computer science, mathematics, biology, physics, engineering, nursing, etc.
green energy technology
Building Solar Cars
Natural Sciences, Astronomy, Technology, Engineering, Chemistry
agriculture science and natural resources
Engineering (type varies by week)
physical science, anatomy, aerospace, math, environmental science,
Engineering and math
Plant Science, genomics, bioinformatics, plant biology

Statistic	Value
Total Responses	92

Q6. Select which of the following elements are present in the program (check all that apply)

#	Answer		Response	%
1	Auditory learning (i.e. music, songs, story-telling, rhymes)		37	39%
2	Visual learning (i.e. graphical representations, videos)		82	87%
4	Tactile learning (i.e. hands-on with tools, lab equipment, computers)		83	88%
9	Incorporated popular culture		34	36%
3	Movement-based activities (i.e. acting out concepts, physical activities)		54	57%
5	Small group work		75	80%
6	Student provide peer feedback to each other		54	57%
7	Student-driven project goals		54	57%
8	Incorporated participants' cultural heritage		18	19%
10	Build pride in student's racial and ethnic identities		18	19%

Q7. Does the program target any special population? (check all that apply)

#	Answer		Response	%
1	Black or African American		22	24%
2	Hispanic or Latino American		21	23%
3	Asian American		7	8%
5	Native Hawaiian or Other Pacific Islanders American		9	10%
6	Native American or Alaska Native American		17	19%
7	Low socioeconomic status population		40	44%
8	Don't know		2	2%
9	None		44	49%
4	Middle Eastern and North African American		9	10%

Q8. Is the program exclusively for...

#	Question	Yes	No	Total Responses	Mean
2	Girls only?	12	82	94	1.87
3	Girls of color only?	1	89	90	1.99

Q9. Change the percentage bar below to represent approximately what percentage of program participants are?

#	Answer	Min Value	Max Value	Average Value	Standard Deviation	Responses
1	Girls	5.00	100.00	53.05	20.26	83
2	Girls of color	0.00	100.00	32.86	28.51	81

Q10. This section will focus on the program's interactions with the participants' families. By moving the numbers on the right hand side, please rank the following types of family involvement in the order of importance for girls of color to succeed in STEM education in general. (drag most important item at the top)

#	Answer											Total Responses
1	Encouragement	41	11	9	3	5	2	0	0	3	1	75
2	Parent-instructor communication	5	10	17	10	7	10	6	5	4	1	75
3	Attendance at celebratory events (e.g. graduation, competition, showcase)	1	6	2	12	7	6	11	10	7	13	75
4	Daily homework support	5	9	14	7	7	4	9	2	10	8	75
5	Use of libraries, museums, and other institutions	4	5	9	6	7	12	9	8	7	8	75
6	Help girls in long term academic planning	6	11	3	12	11	6	9	5	9	3	75
7	Attendance at parent workshops	2	5	4	6	8	6	8	15	11	10	75
8	Volunteer with schools	2	7	2	5	4	6	5	17	14	13	75
9	Instill cultural values	3	5	4	8	8	9	9	9	7	13	75
10	Encourage enrollment in rigorous academic courses	6	6	11	6	11	14	9	4	3	5	75
	Total	75	75	75	75	75	75	75	75	75	75	-

Q11. Enter the number of family engagement events the program host for each group of youth participants.

Text Response
All
3-4 per year
4
2
1
1
3
10
0
2
53
1
2
4
2
2
some
doesn't make sense
1
16
0
4 per year
0
0
4
4
1
0
2
8
2
3
family camps
2
150
2
6
unknown
12
2
1
0
0
2

2
2 per year
3 - 5 annually (7 year program)
0
2
0
10
1
100s
0
0
1
1-2
0
0
3+
0
n/a
5
25
2
80%
2
5
0
1
4
1

Statistic	Value
Total Responses	72

Q12. What is the most effective way to communicate with families in your program?

#	Question	Not used	Very Ineffective	Ineffective	Effective	Very Effective	Total Responses	Mean
1	Family engagement events	21	4	3	26	19	73	1.96
2	In-person conversations	11	1	4	29	30	75	2.73
4	Emails	13	3	8	45	8	77	2.25
5	Newsletters	26	3	15	29	3	76	1.39
6	Snail mail	43	5	10	14	3	75	0.48
7	Notes sent home with student	36	4	10	22	2	74	0.84
8	Texting	46	2	9	13	4	74	0.39
9	Phone calls	30	1	6	28	10	75	1.43
10	Word-of-mouth	9	4	9	35	20	77	2.57
11	Community networks	18	2	9	33	13	75	2.04
12	Fliers	15	0	17	37	5	74	2.03
13	Others? Please specify	19	0	1	6	3	29	0.45

Others? Please specify
school staff
Invite to attend Open House
STEM Teachers
website
Special events
take home activities
Social Media
Teacher tells students

Q13. Does the program provide family communications in languages other than English?

#	Answer		Response	%
1	Yes		18	23%
2	No		59	77%
	Total		77	100%

Q14. This section will focus on information flow in the organization. Which of the following best describes the organization's structure?

#	Answer		Response	%
1	Work is divided by many layers of management.		8	10%
2	Work is divided by few layers of management.		27	33%
3	Work is crossed managed by multiple managers.		21	26%
4	Entrepreneur. Only 1-3 people running the whole organization.		25	31%
	Total		81	100%

Q15. Does the organization have a mission statement?

#	Answer		Response	%
1	Yes		70	92%
2	No		6	8%
	Total		76	100%

Q16. Rate the following statements about the organization's MISSION STATEMENT.

#	Question	Strongly Disagree	Disagree	Agree	Strongly Agree	Total Responses	Mean
4	Mission statement that includes diversity.	4	14	30	17	65	2.92
5	Mission statement that includes education equality.	4	8	28	25	65	3.14
8	Organization regularly discuss the mission statement.	4	14	32	17	67	2.93
16	I understand the organization's mission.	2	1	24	40	67	3.52
17	Mission statement feels relevant to my day-to-day work.	2	2	29	34	67	3.42

Q17. If yes, how was it communicated?

#	Question	Formal Channels	Informal Channels	Total Responses	Mean
1	I usually find out about organization news.	53	13	66	1.20
2	Organization goals are usually communicated clearly.	55	6	61	1.10
3	My responsibilities are usually explained to me.	47	13	60	1.22
4	I usually get feedback on my work from my supervisor.	37	16	53	1.30
5	I usually get feedback on my work from my peers.	15	42	57	1.74
6	I usually get feedback on my work from the community.	14	42	56	1.75

Q18. Do you agree?

#	Question	Yes	No	Not applicable	Total Responses	Mean
1	I usually find out about organization news.	64	4	4	72	1.17
2	Organization goals are usually communicated clearly.	58	8	5	71	1.25
3	My responsibilities are usually explained to me.	56	7	7	70	1.30
4	I usually get feedback on my work from my supervisor.	51	10	9	70	1.40
5	I usually get feedback on my work from my peers.	52	14	4	70	1.31
6	I usually get feedback on my work from the community.	51	13	6	70	1.36

Q19. Do you agree?

#	Question	Yes	No	Not applicable	Total Responses	Mean
1	Important information usually reaches my leadership quickly.	63	4	6	73	1.22
2	I can usually reach out to my supervisor when needed.	63	0	9	72	1.25
3	I can usually reach out to my peers on my team when needed.	64	4	4	72	1.17
4	I can usually reach out to other teams when needed.	57	7	8	72	1.32
5	Information usually flows freely between teams.	49	18	4	71	1.37

Q20. If yes, how was it communicated?

#	Question	Formal Channels	Informal Channels	Total Responses	Mean
1	Important information usually reaches my leadership quickly.	45	19	64	1.30
2	I can usually reach out to my supervisor when needed.	37	26	63	1.41
3	I can usually reach out to my peers on my team when needed.	33	33	66	1.50
4	I can usually reach out to other teams when needed.	35	25	60	1.42
5	Information usually flows freely between teams.	27	30	57	1.53

Q21. Rate the following statements about the organization's TRAINING. The organization . . .

#	Question	Strongly Disagree	Disagree	Agree	Strongly Agree	Total Responses	Mean
1	Provides professional development on racial equality.	6	18	26	13	63	2.73
2	Provides professional development on gender equality.	6	16	21	18	61	2.84
3	Provides professional development on cultural competency.	6	16	25	12	59	2.73
4	Provides professional development on STEM knowledge.	4	8	22	31	65	3.23
5	Actively recruits a diverse volunteer base.	5	8	28	23	64	3.08
6	Specifically hires diverse staff members.	4	17	24	14	59	2.81

Q22. This section will focus on organization's collaborations. Rate the following statements about the organization's COLLABORATION.

#	Question	Strongly Disagree	Disagree	Agree	Strongly Agree	Total Responses	Mean
4	My decisions are valued by my peers.	0	3	33	29	65	3.40
5	My team encourages collaborations with other teams within the organization.	1	5	31	28	65	3.32
6	I usually trust decisions made by organization leaders.	1	6	38	21	66	3.20
7	Volunteers and staff work together smoothly.	0	5	35	26	66	3.32
8	My decisions are valued by my supervisors.	1	2	30	28	61	3.39
9	My team encourages collaborations with outside institutions.	2	2	34	29	67	3.34
10	Staff members are treated as valued members of the organization.	2	3	32	27	64	3.31
11	Volunteers are treated as valued members of the organization.	1	4	32	28	65	3.34

Q23. When developing a STEM program, to what extent do you consult the following during the planning?

#	Question	None	Very Little	Some	Very Much	Total Responses	Mean
1	Academic publications	7	14	32	18	71	2.86
2	Feedback from past participants	1	1	30	36	68	3.49
3	Staff ideas	1	3	14	50	68	3.66
4	Volunteer ideas	4	7	30	27	68	3.18
5	Parent input	9	16	28	15	68	2.72
6	Civic leaders input	14	18	27	7	66	2.41
7	Youth idea	7	7	30	23	67	3.03
8	Funder input	11	13	28	15	67	2.70
9	Teacher input	3	5	28	34	70	3.33
10	Other community-based organization input	8	12	36	14	70	2.80
11	STEM professionals	4	4	25	37	70	3.36

Q24. What is the program's quality of collaboration with the following?

#	Question	None	Low	Moderate	High	Total Responses	Mean
1	School administrators	4	16	29	23	72	2.99
2	Teachers	3	6	26	36	71	3.34
3	Families	8	12	31	19	70	2.87
4	Other community-based organizations	5	13	34	19	71	2.94
5	Government agencies	12	25	21	13	71	2.49
6	Private industry partners	10	18	21	22	71	2.77
7	Colleagues within your organization	1	6	20	43	70	3.50
8	Academic institutions	5	10	31	24	70	3.06
9	Youth	5	8	29	28	70	3.14
10	Other? Please specify	13	1	3	4	21	1.90

Other? Please specify
NGSS
Engineering Societies
STEM Professionals
churches
We do not limit input from any source

Q25. Final section: Questions about you. What is your role in this program? (Check all that apply)

#	Answer		Response	%
1	Work directly with the youth		45	61%
2	I run the day-to-day operation of program.		44	59%
3	I designed the program.		42	57%
4	I serve on the leadership level.		48	65%
5	Other		6	8%

Other
Help modify program to better suit needs of community and meet institutional goals
Executive Director
Curriculum design
donor
consultation
Work with entire public

Q26. How long have you been working or volunteering with this organization? Combine time if you have both volunteered and worked as paid staff. Please write the number of years and months in the text boxes below.

#	Answer	Min Value	Max Value	Average Value	Standard Deviation
1	Years	0.00	29.00	6.96	7.45
2	Months	0.00	11.00	3.12	3.71

Q27. How long have you been working or volunteering in the STEM education field in general? Combine time if you have both volunteered and worked as paid staff. Please write the number of years and months in the text boxes below.

#	Answer	Min Value	Max Value	Average Value	Standard Deviation
1	Years	0.00	50.00	13.60	11.37
2	Months	0.00	11.00	0.87	2.18

Q28. How do you identify your gender as?

#	Answer		Response	%
1	Male		23	32%
0	Female		50	68%
2	I would prefer not to disclose		0	0%
	Total		73	100%

Q29. How do you identify yourself? (Check all that apply.)

#	Answer		Response	%
1	Black or African American		8	11%
2	Hispanic or Latino American		5	7%
3	Asian American		5	7%
5	Native Hawaiian or Other Pacific Islanders American		1	1%
6	Native American or Alaska Native American		2	3%
7	Multiracial American		3	4%
8	White		54	75%
9	I would prefer not to disclose		1	1%
4	Middle Eastern and North African American		0	0%

REFERENCES

Aikenhead G. & Huntley, B. (1999). Teachers' views on Aboriginal students learning western and Aboriginal science. *Canadian Journal of Native Education*, *23*(2), 159-75.

American Camping Association. (2012). *ACA Camp Business Operations Report: 2012.*

Anderson, J. D. (1988). *The Education of Blacks in the South, 1860-1935.* Chapel Hill, NC: The University of North Carolina Press.

Bell, P., Lewestein, B., Shouse, A. W., & Feder, M. A. (Eds.). (2009). *Learning science in informal environments: People, places, and pursuits.* Washington, D. C.: National Academies Press.

Blickenstaff, J. C. (2005). Women and science careers: leaky pipeline or gender filter? *Gender and Education, 17*(4), 369-386.

Bomer, R., Doworin, J.E., May, L., & Semingson, P. (2008). Miseducating teachers about the poor: A critical analysis of Ruby Payne's claims about poverty. *Teachers College Records, 110*(12), 2497-2531.

Cannady, M. A., Greenwald, E., Harris, K. N. (2014). Problematizing the STEM pipeline metaphor: Is the STEM pipeline metaphor serving our students and the STEM workforce? *Science Education, 98*(3), 443-460.Chin, T. & Phillips, M. (2004). Social reproduction and child-rearing practices: social class, children's agency, and the summer activity gap. *Sociology of Education, 77*(3), 185-210.

Chun, K. & Harris, E. (2011). *STEM out-of-school time program for girls* (Research update No. 5. Cambridge, MA: Harvard Family Research Project.

Committee on STEM Education. (2013). *Federal science, technology, engineering, and mathematics (STEM) education 5-year strategic plan*. (National Science and Technology Council Report 17 U.S.C. 105. Washington, DC: Government Printing Office.

Drucker, P. F. (1990). *Managing the non-profit organization: Principles and practices.* New York, NY: HarperCollins Publishers.

Eglash, R., Gilbert, J. E., Taylor, V., & Geier, S. R. (2013). Culturally responsive computing in urban, after-school contexts: Two approaches. *Urban Education, 48*(5), 629-656.

Espinosa, L. L. (2011). Pipelines and pathways: Women of color in undergraduate STEM majors and the college experiences that contribute to persistence. *Harvard Educational Review*, *81*(2), 209-241.

Fanon, F. (1965). The wretched of the Earth. New York, NY: Grove Press.

Fouad, N. A., Singh, R., Fitzpatrick, M. E., & Liu, J. P. (2012). *Stemming the tide: Why women leave engineering.* Milwaukee, WI: University of Wisconsin-Milwaukee.

Freire, P. (1970). *Pedagogy of the oppressed*. New York, NY: Herder and Herder.

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

Gay, G. (2002). Preparing for culturally responsive teaching. *Journal of Teacher Education, 53*(2), 106-16.

Government Accountability Office. (2004). *Gender Issues: Women's Participation in the Sciences has Increased, but Agencies Need to do More to Ensure Compliance with Title IX*. Washington, DC: U.S. Government Printing Office.

Guimond, S., De Oliveira, P,. Kamiesjki, R., & Sidanius, J. (2010). The trouble with assimilation: Social dominance and the emergence of hostility against immigrants. *International Journal of Intercultural Relations, 34*(6), 642-650.

Harper, S. R. (2010). An anti-deficit achievement framework for research on students of color in STEM. In S. R. Harper & C. B. Newman (Eds.), *Students of color in STEM: Engineering a new research agenda. New Directions for Institutional Research* (pp. 63-74). San Francisco: Jossey-Bass.

Harvard Family Research Project. (2008). *What is complementary learning?* [Fact sheet]. Retrieved from http://www.hfrp.org/publications-resources/browse-our-publications/what-is-complementary-learning

Hernandez, P.R, Schultz, P. W., Estrada, M., Woodcock, A. & Chance, R. C. (2013). Sustaining optimal motivation: A longitudinal analysis of interventions to broaden participation of underrepresented students in STEM. *Journal of Educational Psychology, 105*(1), 89-107.

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

Ladson-Billings, G. (2007). Pushing past the achievement gap: and essay on the language of deficit. *Journal of Negro Education, 76*(3), 316-323.

Landivar, L. C. (2013). *American Community Survey Reports: Disparities in STEM Employment by Sex, Race, and Hispanic Origin.* Washington D.C.: U.S. Census Bureau.

Lawrenz, F., Huffman, D., & Thomas, K. (2006). Synthesis of STEM education evaluation ideas *New Directions for Evaluation*, *2006*(109), 105-108.

Lee, O. (1999). Equity implications based on the conceptions of science achievement in major reform documents. *Review of Educational Research, 69*(1), 83-115.

Lemov, D. (2010). *Teach like a champion: 49 techniques that put students on the path to college*. San Francisco, CA: Jossey-Bass.

Malcom, L. E. & Malcom, S. M. (2011). The double bind: The next generation. *Harvard Educational Review, 81*(2), 162-172.

Malcom, S. M., Hall, P. Q., & Brown, J. W. (1976). *The Double Bind: The Price of Being a Minority Woman in Science.* Washington, DC: American Association for the Advancement of Science.

Maltese, A. V. & Tai, R. H. (2011). Pipeline persistence: Examining the association of educational experiences with earned degrees in STEM amount US students. *Science Education, 95*(5), 877-907.

Medin, D. L. & Bang, M. (2014). *Who's Asking?: Native Science, Western Science, and Science Education.* Cambridge, MA: The MIT Press.

National Science Foundation. (2014). *Improving Undergraduate STEM Education.* (2014) Retrieved from http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505082

Norman, O., Ault, C. R., Bentz, B. and Meskimen, L. (2001). The black–white "achievement gap" as a perennial challenge of urban science education: A sociocultural and historical overview with implications for research and practice. *Journal of Research in Science Teaching, 38*(10): 1101–1114.

Ogbu, J. U., 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.

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

Parsons, E. C., Travis, C., Simpson, J. S. (2005). The Black Cultural Ethos, Students' Instructional Context Preferences, and Student Achievement: An Examination of Culturally Congruent Science Instruction in the Eighth Grade Classes of One African American and One Euro-American Teacher. *The Negro Educational Review, 56*(2-3), 183-203.

Payne, R. K. (2001). *A framework for understanding poverty.* Highlands, TX: aha! Process.

President's Council of Advisors on Science and Technology. (2010). *Prepare and inspire: K-12 education in science technology, engineering, and math (STEM) for America's future.* (Executive Office of the President Report) Washington, DC: Government Printing Office.

Rahm, J. (2007). Urban youths' hybrid positioning in science practices at the margin: a look inside a school-museum-scientist partnership project and an after-school science program. *Cultural Studies of Science Education, 3*(1), 97-121.

Simpson, J. S. & Parsons, E. C. (2008). African American perspectives and informal science educational experiences. *Science Education, 93*(2), 293-321.

Simpson, L. (2002). Indigenous environmental education for cultural survival. *Canadian Journal of Environmental Education, 7*(1), 13-25.

Sinnes, A. T. & Loken, M. (2012). Gendered education in a gendered world: looking beyond cosmetic solutions to the gender gap in science. *Cultural Studies of Science Education, 2*(9) 343-64.

Smith-Evans, George, Graves, Kaufmann, & Frohlich. (2014). *Unlocking opportunity for African-American girls: A call for action for educational equity.* New York: The NAACP Legal Defense and Educational Fund and The National Women's Law Center.

Tan, E., Calabrese Barton, A., Kang, H. and O'Neill, T. (2013), Desiring a career in STEM-related fields: How middle school girls articulate and negotiate identities-in-practice in science. *Journal of Research in Science Teaching, 50*: 1143–1179.

The Department of Justice. (2014). *Overview of Title IX of the Education Amendments of 1972.* Retrieved from http://www.justice.gov/crt/about/cor/coord/titleix.php

The National Women's Law Center. (2012). *The Next Generation of Title IX: STEM - science, technology, engineering, and math* [Fact sheet]. Retrieved from http://www.nwlc.org/sites/default/files/pdfs/nwlcstem_titleixfactsheet.pdf

The White House Council on Women and Girls. (2014). *Women and girls of color: Addressing challenges and expanding opportunity.* Washington, DC: U.S. Government Printing Office.

U.S. Department of Education. (2008). *Public school data file, 2007-08.* National Center for Education Statistics, Schools and Staffing Survey (SASS). Retrieved from: https://nces.ed.gov/surveys/sass/tables/sass0708_035_s1s.asp

Valencia, R. R. (1997). *The evolution of deficit thinking: Educational thought and practice.* London: The Falmer Press.

Valencia, R. R. (2010). *Dismantling contemporary deficit thinking: Educational thought and practice.* New York, NY: Routledge.

Vossoughi, S., Escudé, M., Kong, F. & Hooper, P. (2013). Tinkering, learning & equity in the after- school setting. paper published as a part of FabLearn Conference proceedings. Stanford University.

Watkins, W. H. (2001). *The White Architects of Black Education: Ideology and Power in America, 1865-1954.* New York, NY: Teachers College Press.

Weber, K. (2012). Gender differences in interest, perceived personal capacity, and participation in STEM-related activities. *Journal of Technology Education, 24*(1), 18-33.

Xu, J., Coats, L., & Davidson, M. (2012). Promoting student interest in science: The perspectives of exemplary African American teachers. *American Educational Research Journal, 49*(1), 124–154.

Zaff, J. F., Moore, K. A., Papillo,A. R., & Williams, S. (2003). Implications of extracurricular activity participation during adolescence on positive outcomes. *Journal of Adolescent Research, 18*(6), 599-630.