

AFRICAN AMERICANS, STEM, AND ENTREPRENEURSHIP: A STUDY OF FACTORS  
THAT INFLUENCE AFRICAN AMERICANS TO PURSUE ENTREPRENEURSHIP IN  
STEM FIELDS

by

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Abstract

AN AMERICANS, STEM, AND ENTREPRENEURSHIP: A STUDY OF FACTORS THAT  
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FIELDS

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Minority business entrepreneurship, specifically in the areas of science, technology, engineering, and mathematics (STEM), provides multiple opportunities for innovation, job creation, high earning potential for underrepresented minorities, and for increasing the diversity of the U.S. workforce to reflect current population demographics. This study examines the educational backgrounds of high technology African American entrepreneurs and the factors of STEM programs that influence STEM-educated graduates to pursue high tech entrepreneurship. The research questions include, do STEM programs provide a link to high technology entrepreneurship? And, what STEM program factors are related to high technology entrepreneurship?

The theoretical framework that informs the study draws upon the social network and social capital literature. STEM programs are conceptualized as a social capital bridge that can

provide program participants access to economic opportunity. A program provides a bridge by enhancing the social network characteristics of program participants and connecting them to a future career opportunity or trajectory. Programs provide this bridge through the elements they offer, including the relational and structural supports that address historical deficits that have served as barriers in STEM programs and entrepreneurship. The STEM program elements related to social capital and social networks included role models, mentoring, and social networking.

Data were gathered from a variety of sources to identify and describe the patterns and trends in STEM programs and high technology entrepreneurship. Data sources included an existing entrepreneurship data set that includes information on business owner and enterprise characteristics, including race, education, and type of enterprises owned. This data set is used to determine if there is a relationship between type of education and high technology entrepreneurship. Surveys were also administered to program administrators of the Louis Stokes Alliance for Minority Participation (LSAMP) Alliances and STEM program graduates. Chi-square and Fisher's exact tests were used to analyze the data, as appropriate.

An association was found between African American entrepreneurs with STEM degrees and high tech entrepreneurship. This suggests that African American entrepreneurs that are participating in the workforce as high technology entrepreneurs are those obtaining educational degrees in STEM. However, a primary finding in the study is that STEM programs are not directly connecting program participants to the factors identified as important for high technology entrepreneurship. The review of STEM-support program elements included the components of social networks and social capital through mentoring, role models, and networking, with financial support. No significant association was found for the majority of the

program elements and high technology entrepreneurship. However, the exception is that STEM programs that include venture capitalists as role models have an association with high technology entrepreneurship.

The lack of association between the STEM-support program elements and high tech entrepreneurship can be partly attributed to the overall program goals and emphasis on education completion and less on employment pursuits. The program goals and emphasis on education completion results in a program structure that is void of access to the social capital resources that can facilitate high technology entrepreneurship as one path to the STEM workforce. Currently, program elements emphasize building the STEM workforce in the area of research and academia.

The analysis suggests, if high technology entrepreneurship is valued as a STEM sub workforce, the need to broaden program missions and include program supports that link STEM education and high tech entrepreneurship. Recommendations include the implementation of various initiatives such as the introduction of entrepreneurship into courses in the STEM curriculum; the creation of partnerships with other educational units such as business programs to provide training; the development of partnerships and internships among high tech industries; and the provision of increased access to entrepreneurs.

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## Chapter 1

### **Introduction to the Study**

The task of promoting STEM education and careers has quickly become a necessity not only for educators, but also for policymakers whose objectives are to align the goals of the education system with the needs of the 21<sup>st</sup> century workforce. The U.S. Department of Labor (2012) identifies the 21<sup>st</sup> century workforce as being larger and more diverse with overall growth projections of 10.5 million by 2020 and minorities making up about 40% of the workforce (Toossi, 2012). Employment is shifting from manufacturing to services and has an increased need for educational attainment; advancements in technology have led to the creation of high tech jobs and an increased demand of high skilled workers (Karoly & Panis, 2004). According to the National Science Foundation (NSF), building the “STEM workforce”, defined broadly as those who employ significant STEM knowledge and skills in their job, is critical to innovation, competitiveness and the 21<sup>st</sup> century workforce (p. 9, 2015). The STEM workforce includes a broad range of sub-workforces, one of which is high technology entrepreneurship. Given the broad diversity of the STEM workforce, NSF (2015) has identified it as critical “to devise policy solutions that address the specific and varied educational and training needs of our citizenry” (p. 9). The purpose of this dissertation research is to contribute knowledge on the relationship between STEM programming and one STEM sub-workforce group, high tech entrepreneurs. Specifically, this dissertation research focuses on one subgroup of the population, African Americans.

The research questions are as follows. Do STEM programs provide a link to high technology entrepreneurship? And, what STEM program factors are related to high technology entrepreneurship? Do African American’s that participate in STEM programs pursue high

technology entrepreneurship? The theoretical framework that informs the study draws upon the social network literature and social capital literature. Specifically, STEM programs are viewed as a social capital bridge that can provide program participants access to economic opportunity. A program provides a bridge by enhancing the social network characteristics of program participants. STEM program elements that can enhance participant's social capital and social networks include role models, mentoring, and access to social networking opportunities.

Likewise, programs can offer other structural supports, such as financial capital, that address historical deficits that have served as barriers in STEM programs and entrepreneurship. They also provide financial capital in the form of financial resources such as grants, stipends, travel funds, etc. to aid in education advancement and degree completion. These programs support human capital characteristics of obtaining the degree necessary to be qualified and prepared for this sub sector of the workforce, high tech entrepreneurship. However, the question is to what degree are STEM programs providing the link to entrepreneurship to realize the diverse needs of the 21<sup>st</sup> century workforce.

High tech entrepreneurship can be classified as one of the sub-workforce groups contributing to the 21<sup>st</sup> century workforce (National Science Board, 2015). Entrepreneurship has been identified as an important workforce group in the 21<sup>st</sup> economy for several reasons. High tech entrepreneurs tend to earn more than comparable paid workers (Braguinsky et al., 2012). These highly educated high tech entrepreneurs tend to create high tech, fast growing firms from ideas based on prior employment (Bhide, 2000; Braguinsky, Klepper, & Ohyama, 2012).

Boston and Boston (2007) state that, "entrepreneurs are conceptualized as agents of innovation" (p. 110), emphasizing the importance entrepreneurship provides to advancements of firms and the future of the workforce. Entrepreneurship is seen as a catalyst for economic growth

in its role of creating jobs (Audretsch, Keilbach, & Lehmann, 2006). Entrepreneurial firms often contribute to innovations in industry and promote economic growth (Audretsch, 1995; Blume-Kohout, 2014). Innovation occurs within businesses, but in order to truly advance the process of new ideas, the leaders of high technology firms have the opportunity to develop their company's products and ideas (Károly & Panis, 2004). Through contributions to innovation, economic growth, and workforce growth, entrepreneurship continues to be an important contribution to the 21<sup>st</sup> century workforce.

Education is not required to become an entrepreneur, but entrepreneurs tend to have more education than the general population, and the level of education achieved fluctuates based on the needs of the industry (Bates, 1995; Nair & Pandey, 2006). Entrepreneurs are often the leaders in these STEM fields that are responsible for creating the products and promoting innovation that drive advancements (Boston & Boston, 2007). Those often able to enter the workforce of tomorrow are those that possess a postsecondary degree that involves quality academic preparation, and science, technology, engineering, and mathematics (STEM) are the areas in education that are closely linked with high technology, high skill, and high salary positions (Chubin, May, & Babco, 2005). The education level for more than two-thirds of the STEM workforce is at least a college degree compared to one-third of workers not in STEM (Langdon, McKittrick, Beede, Khan, & Dhoms, 2011). However, there continue to be gaps in terms of who has access to STEM education as well as STEM occupations. Research has identified a lack of underrepresented minorities (URM) currently pursuing STEM education and employed in STEM professions, as described below (Chubin et al. 2005).

## **STEM Programs as a Bridge to the STEM Workforce for URM**

Educational support programs that promote STEM serve as a bridge and link allowing access to education among minority students, providing social resources and support to facilitate their entry into STEM careers. The U.S. education system continues to create and support STEM related programs to foster the STEM workforce (Anderson, 2010). The U.S. federal government allocates billions of dollars to increase funding for postsecondary STEM programs. One of the many goals of funding these programs is to assist with recruiting and academically preparing minority students to move into STEM careers (Crisp, Nora, & Taggert, 2009).

Many of the policies and programs that promote STEM education target minorities that have historically been underrepresented in these fields (George, Neale, Van Horne, & Malcom, 2001). Underrepresented minorities (URM) can be identified as Black/African American, Latino, and Native American/Hawaiian individuals (George et al., 2001). The percentages of URM in STEM professions are disproportionately lower than the numbers of URM in the U.S. workforce as well as in the U.S. population (Anderson, 2010). Whites make up approximately 77 % of those employed in science, technology, engineering and mathematics (STEM) occupations; Asians make up 12%, and African Americans, Latino, and American Indians make up a combined 11% (Chubin et al., 2005).

Research has identified various factors that influence why many underrepresented minorities (URM) do not pursue STEM education. These factors include, but are not limited to, personal influence from family and peers, poor pre-college preparation as evidenced by lack of rigor and resources in K-12 education, poor student achievement as evidenced by teacher effectiveness and the absence of advanced math and science classes, and a lack of available financial resources and relative debt which impact the student's ability to continue with STEM

education (Crisp et al., 2009; George et al., 2001). Factors related to minority success include but are not limited to a strong support system, perseverance, and obtaining advanced education, specifically related to business skills (Hisrich & Brush, 1986). Efforts can be made to reduce factors that impede URM advancement, while increasing those factors that promote minority success.

STEM support programs, if designed appropriately, may be able to provide a link to this segment of the STEM workforce. Although STEM programs have begun to diminish the education disparities among minorities, the lack of equal access to human and financial capital has been found to negatively impact African American entrepreneurship; social capital and social networks have been found to be equally important (Fairlie & Robb, 2010; Smith, 2005). A goal of this study is to understand how and if STEM-support programs are exposing African American students to social capital and social networks that may facilitate high tech entrepreneurship as a career pathway. There are a number of potential social and economic benefits to reducing this gap and by cultivating STEM education and high technology entrepreneurship among African Americans.

African Americans are the focus of the study because they have been historically underrepresented in STEM education and high technology entrepreneurship. Bridging this gap is important to foster a 21<sup>st</sup> century workforce that is diverse in both career pathways and representation. According to the Minority Business Development Agency (MBDA, 2010) African Americans have seen entrepreneurship firm growth at 60% between 2002 and 2007 compared to non-minority firm growth of 9%, and even with this firm growth, African Americans only make up about 7% of the total firms in the U.S. (MBDA, 2010). Perhaps more important, is that a closer look at the growth data reveals that only 9% of these firms are in the



high-tech sector, so African Americans are increasingly growing firms in the traditional sectors as opposed to high technology and in STEM professions. This is important because it suggests that existing disparities may be reproduced in this segment of the STEM workforce.

Secondly, the study limits its focus to African American entrepreneurs in order to focus on the educational and professional experiences that have led to the disparities that exist for African Americans, specifically in the areas of business ownership. Although URM are often researched as a unit, there are racial differences that exist when comparing factors such as education, wealth, and business ownership among African Americans, Hispanics and Asians (Fairlie & Robb, 2010). When comparing the race of business owners, Asian owners experience some of the best business outcomes while African American owners experience some of the worst business outcomes of major racial groups (Fairlie & Robb, 2010). This study aims to gain information that can be used to support the increase of business ownership among African Americans and to reduce the disparities that exist not only between African Americans and successful non-minority owners, but also among successful minority owners.

### **Research Questions**

These research questions include: how do education programs such as STEM-support programs influence African Americans to pursue entrepreneurship; what factors influence African Americans' decision to start businesses in the area of STEM or become STEM entrepreneurs; and what impact, if any, does STEM-support programs play in this decision among African Americans? Of particular interest is the question as to whether or not STEM programs provide the social capital and social network supports to make the bridge to high technology entrepreneurship. High tech entrepreneurs in this study are defined as individuals who identify as self-employed, owners of small businesses, or owners of start-up companies who

are highly skilled and have educational backgrounds in STEM and are primarily associated with STEM industries (Kauffman Foundation 2011).

There is little research that explores the relationship between STEM education and entrepreneurial outcomes. However, there are some anecdotal accounts that STEM programs are emphasizing entrepreneurship as a career path. An example of a program that puts an emphasis on entrepreneurship is DREAM STEM, which is the acronym for Driving Research, Entrepreneurship, and Academics through Mastering STEM. This program is located at North Carolina Central University. The goal of this program is to identify students early on as scientists and promote entrepreneurship in science education. Another initiative started and funded by the NSF to support STEM education and entrepreneurship is Innovation Corps (I-Corps), which provides resources and funding to researchers to encourage entrepreneurship. The goal of I-Corps is to foster entrepreneurship by turning science research into business ventures (Reich, 2011). An example of a STEM industry that is promoting entrepreneurship is the American Chemical Society (ACS). The ACS began an entrepreneur training program to encourage chemists to create new opportunities in the world (Reich, 2011). These programs and others like them are seen as a response to the needs of the 21<sup>st</sup> century workforce.

The research is characterized as a descriptive study because it aims to find out ‘what is’ and ‘how’ STEM programs provide a bridge to entrepreneurship (Glass & Hopkins, 1996). ‘What is’ refers to what is occurring in STEM programs related to entrepreneurship and ‘how’ refers to the connection between program elements and entrepreneurial outcomes. A major contribution of the research is that it collects data not previously available in order to demonstrate the patterns in STEM programming and their relationship to entrepreneurial outcomes. The data is organized and tabulated in a manner to depict the relationships.

Associations are determined using the chi-square test and Fisher's Exact Test. However, descriptive studies are limited in that they cannot detect causality of relationships. Hence, this study does not control or account for factors that influence a student's choice to pursue a STEM degree nor does it control or account for any factors that uniquely influence future career paths. Despite this, it still provides useful information on the potential for STEM programs to facilitate access to this segment of the workforce. It also provides a foundation from which future longitudinal studies can be established.

Three phases of research were conducted to answer the research questions. The first phase of research utilized the Kauffman Firm Survey (KFS) to determine if a relationship exists among STEM education and high tech entrepreneurship among African Americans. Several hypotheses were presented to analyze the relationship between STEM program supports related to human, financial, and social capital.

*Hypothesis 1.* A positive association will exist between African American entrepreneurs with STEM degrees (undergraduate or graduate) and high tech entrepreneurship.

Support is found for the association between STEM degrees and high tech entrepreneurship among African American entrepreneurs. While the study is not causal in nature, and it does not control for other factors influencing this relationship, it does show a relationship exists between having a STEM education and high tech entrepreneurship. The findings from H1 add to the literature that supports the link between STEM education and the pursuit of high tech entrepreneurship. STEM degrees are now a requirement for many high-skilled technology jobs (Chubin et al., 2005; Langdon et al., 2011).

The second phase of research utilized surveys to gather data from STEM program administrators and alumni from a STEM program. A total of 18 out of 46 program administrators

completed the survey; a response rate of 39% was achieved. The 18 program administrators represent 13 of the 34 states that have alliances, thus providing data from approximately 175 institutions. A total of 38 out of 428 alumni completed the survey; a response rate of 9%. Out of the 38 participants, 12 identified as African American.

A series of hypotheses were generated based on a review of the literature and expectations of how the structural and social capital supports in STEM programs might influence entrepreneurship outcomes. Specifically, the hypotheses addressed the program elements of formal mentoring, role models, and social networking and their relationship to high tech entrepreneurship. These program elements are considered and classified as the social capital and social network resources programs provide to participants. Access to formal mentors (assigned mentors with requirements to meet), access to role models, and access to other social networking opportunities can enhance the social capital resources of program participants and expand their social network connections.

*Hypothesis 2a.* STEM-support programs that include formal mentoring are more likely to be associated with higher rates of high tech entrepreneurship.

When looking at specific program elements there were no relationships found between mentoring and the rate of entrepreneurship.

*Hypothesis 2b.* STEM-support programs that include role models are more likely to be associated with higher rates of high tech entrepreneurship.

There was a relationship found between offering venture capitalist role models and rate of entrepreneurship among the small number of programs with a high rate of entrepreneurship. This finding is also supported in the literature, including the work of Buunk, Peiro, and Griffioen

(2007), that exposure to role models who have proven to be successful in their careers stimulates proactive career behavior.

*Hypothesis 2c.* STEM-support programs that include social networking (among cohorts, faculty, industry professionals, and financial capital providers) will be associated with higher rates of high tech entrepreneurship.

There were no relationships found between social networking and the rate of entrepreneurship. The current structure of the STEM-support program does not include opportunities for students to network and interact with venture capitalists or financial institutions that could ultimately aid in business formation. In the area of entrepreneurship, social networks have been identified as providing an important role in assisting entrepreneurial success.

The next hypothesis addressed the program element financial support (scholarships, stipends, grants, travel funds, competitive awards, and research funds) as financial capital and its relationship to high tech entrepreneurship. Financial support can attribute to STEM degree completion and to aid in asset and equity building that can provide the support for business startup success.

*Hypothesis 2d.* STEM-support programs that include financial support will be associated with higher rates of high tech entrepreneurship.

When looking at specific program elements there were no relationships found between financial resources and the rate of entrepreneurship. All programs do provide financial support to assist with degree completion.

The final hypothesis addressed the human capital characteristic of obtaining advanced education in STEM through STEM programs and its relationship with high tech entrepreneurship.

*Hypothesis 3.* African American graduates of STEM programs that pursue entrepreneurship will be associated with high tech entrepreneurship.

Though this association exists and STEM-support programs provide access and opportunities to African Americans to gain the education most associated with high-tech firms, STEM-support programs are not promoting a link to high-tech entrepreneurship. There is some evidence that African American STEM program graduates are pursuing high tech entrepreneurship, one of the sub-workforce groups in the 21<sup>st</sup> century; however, the alumni survey sample yielded numbers too small for statistical analysis.

The third phase of the research consulted three experts who are administrators in the Louis Stokes Midwest Center for Excellence for additional insight on the trends present in the program survey data. The lack of support of H2 a-d regarding program factors association with the likely pursuit of entrepreneurship can be partially explained from the discussion with the experts who provided insight about the overall goals of the programs and how they are achieved. The primary goals of most of the programs are to increase graduation rates, encourage research, and promote graduate education for their program participants. Some programs introduce entrepreneurial opportunities and have had increased percentages of students pursuing entrepreneurship compared to other programs, but entrepreneurship is not the primary goal of most STEM-support programs.

The STEM support programs included elements to enhance social capital and social networks as well as provided structural support through providing financial capital to assist

participants to successfully complete their STEM education. Financial capital was provided as financial resources in the form of scholarships, stipends, grants, travel funds, competitive awards, and research funds. Human capital support was provided through the STEM degree offerings, which prepared the participants for careers in STEM fields.

However, the STEM programs lack the specific social capital supports to make the bridge to this sub sector of the workforce, high tech entrepreneurship. This research helps to identify key policy and programmatic elements needed to promote equal or improved access to high tech entrepreneurship via STEM programming. The findings provide supportive data to guide policies and programs that encourage and support entrepreneurship among African Americans in the areas of STEM. It also supports the continued efforts of educational programming that promotes STEM education to URM. This dissertation also brings attention to current programs and initiatives that promote entrepreneurship, thus prompting researchers to look into the makeup and outcomes of these programs and their effects on high tech STEM entrepreneurship.

## Chapter 2

### Literature Review

#### 21<sup>st</sup> century workforce

As the U.S. continues to support the 21<sup>st</sup> century workforce, the U.S. government looks to invest in policy solutions to address and support the educational needs required for future employment (National Science Board, 2015). The 21<sup>st</sup> century workforce is defined as the people who are engaging or that are available to work in this current century (Toossi, 2012). The American workforce has begun to change making STEM knowledge and skills vital to an increased number of workers, thus prompting government, employers, and educational institutions to provide solutions to best support these workers as they prepare to meet future workforce requirements (National Science Board, 2015).

The workforce is changing in terms of diversity of participants and the nature of work. The factors driving the change in the U.S. workforce are demographic changes, growth, globalization, and advances in technology (Karoly & Panis, 2004; US 21<sup>st</sup> Century Workforce Commission, 2000). A report by the U.S. Department of Labor (1999) has stated that by the year 2050, half the U.S. population will be made up of minority groups with the population expected to increase by 50%. The growth of the U.S. workforce is fueled by immigration and diversity, as well as an increase of women workers (Herman, 1999). Economic globalization continues to impact growth in trade and capital flows, its impact on the workforce has seen benefits and losses to the economy through increased trade, increased immigration, and in some markets job loss (Karoly & Panis, 2004).

As the workforce diversifies and changes, so does the nature of work. The new economy is information, technology and knowledge driven, prompting the growth of high-tech industries



and the need to create new high-skilled jobs (Herman, 1999; Karoly & Panis, 2004; Pantazis, 2002). Positively impacted by globalization and technological changes, an increase in small and medium firms contribute to a more competitive and rapidly changing entrepreneurial economy, as smaller firms account for a larger share of production and employment (Judy & D'Amico, 1997). These entrepreneurial firms contribute to innovations in industry and impact economic growth through creating jobs (Audretsch, 1995; Audretsch, Keilbach, & Lehmann, 2006; Blume-Kohout, 2014). More specifically, high tech entrepreneurs tend to generate high tech firms and industries that contribute to the technological advancements in the workforce (Braguinsky et al., 2012). High tech entrepreneurship can be classified as one of the sub-workforce groups contributing to the 21<sup>st</sup> century workforce (National Science Board, 2015).

The purpose of this dissertation is not to study whether or not the workforce is changing or the nature of work is changing. Rather, the purpose of this dissertation research is to explore and describe how existing STEM program efforts are preparing minority students for high technology entrepreneurship. The specific research questions include: Do African American's that participate in STEM programs pursue high technology entrepreneurship? And, what STEM program factors are related to the pursuit of high technology entrepreneurship? In essence, the research is starting from the point that high technology entrepreneurship is an important subsector of the STEM workforce and that minority participation in this subsector is important. The contribution it aims to make is to explore and describe how existing efforts are creating opportunities to facilitate diversity in this subsector. It particularly focuses on creating opportunities for African American high technology entrepreneurship. In this section, the theoretical framework that informs the research design is explained, followed by a review of the literature on the 21<sup>st</sup> century workforce, STEM programs and education, and the role of human,

social and financial capital in developing the 21<sup>st</sup> century workforce. The section concludes with a series of hypotheses used to analyze the data and answer the research questions.

### **Theoretical Framework**

Social network theory is used in this dissertation research to better understand the program elements incorporated in STEM programs that potentially connect students to one sector of the STEM workforce, high technology entrepreneurship. Social network theory is used to understand and explore how and if STEM programs are linking program participants to high technology entrepreneurship as a career option.

Social network theory (SNT), also known as network theory, discusses the connections and relationships between people, groups, and organizations. Within this theory, networks can be described as a set of relationships (Jaafar, Abdul-Aziz, & Sahari, 2009; Kadushin, 2004). Social network theory tends to focus on interactions in these networks and provides various analyses of the relationships. Granovetter (1983) views social relationships as nodes and ties, nodes are the individuals in networks and ties as the relationships between the individuals. Social networks consist of all the ties in social networks that contain information, career support, emotional, support, friendship, and motivation; these are often referred to as strong ties (Granovetter, 1983; Jaafar et al., 2009; Kadushin, 2004). According to Granovetter (1983), ties can be strong or weak. Strong ties are defined as those that are among friends who are motivated to assist; these ties are easily accessible as the relationships tend to be close (Granovetter 1983). Weak ties are defined as acquaintances that provide access to information and resources outside of social circles. Granovetter (1983) suggests that strong ties are limited, as those are inside your network that ties you to people much like you and their circles (parents, siblings, uncles/aunts, neighborhood friends). They are limited because they do not produce any new information about

opportunities or exposure to new knowledge. Weak ties are more valuable as they are those that are outside your network (professional connections) that can provide you with valuable information and new knowledge.

This is important when thinking about STEM because most opportunities to gain education and employment in these areas are presented through weak ties or connections made outside of close networks. These connections for the sake of education and employment are created through educational ties, STEM colleagues, and industry professionals. As with many opportunities, the opportunity to succeed in STEM is going to be impacted by the ability to obtain information and knowledge through weak ties.

Social capital is defined as productive relationships among persons as a basis for action (Coleman, 1988). Social capital consists of social structures that facilitate actions to achieve certain outcomes among individuals (Coleman, 1988). Examples of social capital include but are not limited to the relationship between family, peers, and social contacts (Coleman, 1988).

Lin (2008) defines social capital as resources that can be accessed through network ties. Lin (2008) views social capital through the lens of social resource theory. Social capital is the access to and use of resources embedded in social networks to facilitate the flow of information, influence individuals, and the use of social ties for resources (Lin, 1999). Thus, social capital does not automatically result in more favorable action, but rather, it depends upon the social resources contained in one's network (Lin, 1999). It is contingent on social networks, and these networks provide the conditions for access and use of resources (Lin, 2008). One definition has an emphasis on the relationships between person and the other puts a bigger emphasis on the resources as a result of the networks, but both views of social capital identify the relationships or network ties as the bridge or catalyst of resources that produce results.

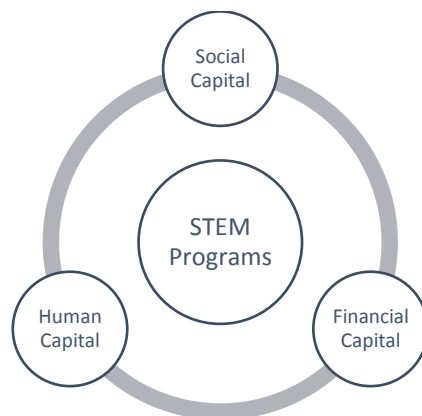
Hence, social capital can be understood and distinguished from social networks in the following manner. Social networks are a key component to one's overall social capital. Social capital is conceptualized as one's stock of resources of ties and is contingent on social networks; networks provide the conditions for access and the use of resources, they can increase the sharing of resources, and they can facilitate access to varied resources (Lin, 2008). According to Lin (2008), social capital is contingent on social networks; these networks provide the conditions for access and use of resources.

The differences between social capital and social networks is that social capital focuses on resources of ties and is contingent on social networks; networks provide the conditions for access and the use of resources, they can increase the sharing of resources, and they can facilitate access to varied resources (Lin, 2008)

Social capital is considered in this dissertation as equally important as human and financial capital. It is viewed as having a relationship with both and important in developing human capital and facilitating access to financial resources. Human capital is the skills, knowledge and experience that is possessed by individuals or populations that create economic value (Coleman, 1988). Examples of human capital include but are not limited to education, and work experience (Cooper, Gimeno-Gascon, & Woo, 1994). Human capital and social capital have a relationship where social capital, through networks and relations, can provide access to human capital such as education (Coleman, 1988). Financial capital comes in the form of funding, debt, and/or equity acquired from external sources (Coleman 2007). Resources obtained from social capital gained through networks can be combined with other resources (human and financial capital) to produce desired outcomes for individuals (Coleman, 1988).

Social network theory and social capital focuses on access to individuals and networks to gain resources that link to high tech entrepreneurship, whereas human capital and financial capital focuses on the structural support through education attainment and financial resources to advance entrepreneurship. To address the importance of social capital and social networks programs often include elements such as mentoring and role models that aim to change the nature and structure of participants' existing set of social relationships. STEM programs often contain a strong social network element with access to mentoring, social networks, and role models from a variety of sources. One program that presents several opportunities to support students through social networks and relationships is the MESA program, which provides year-round mentoring, student cohorts, and programming that allow for parent and family involvement. These elements can create rich social networks for URM that allow access to information and resources to aid in the pursuit of high tech entrepreneurship.

Figure 2- 1 below shows social capital, human capital, and financial capital as they are associated with STEM-support programs.



*Figure 2-1 Social, Human, and Financial Capital and STEM Programs*

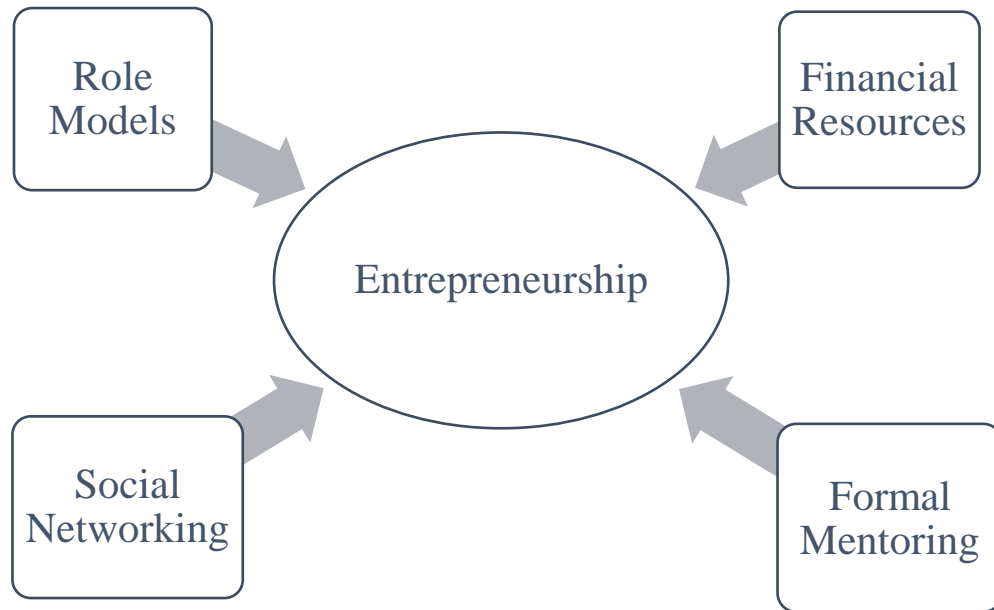
Social network theory implies that social networks are relatively important to entrepreneurs as they provide the relationships and environments necessary for business

formation. The network relationship refers to the establishing and maintaining a lasting connection between the entrepreneurs and their networks (Aldrich & Zimmer, 1986; Jaafar et al., 2009). Entrepreneurship is embedded in networks of social relations, that entrepreneurship is either enhanced or constrained by the resources and opportunities afforded by these relationships (Aldrich & Zimmer, 1986). With a lack of social networks—specifically weak ties--, it can be difficult for entrepreneurs to gain access to resources, and the economic and social infrastructure needed to promote self-employment (Smith 2005). This speaks to the importance of social networks in the success of entrepreneurs. More dense networks of strong collaborative ties enable individuals to obtain necessary information and resources that lead to success and leadership in STEM fields (Parker & Welch, 2013).

STEM-support programs can provide various information and resources necessary to facilitate entrepreneurship and assist individuals in making decisions concerning their future endeavors. These programs are designed to provide educational influences to promote interest in STEM. Their educational influences occur as curricula that focus on learning opportunities and interactions with educators and experts in STEM fields, and an introduction to the variety of career opportunities in STEM (Anderson, 2010). These career opportunities could include entrepreneurship in STEM. Creators of STEM initiatives hope that the continuous exposure and promotion of STEM will positively influence students to choose educational and career options that many believe will provide benefits for the future (Anderson, 2010). Many of these programs provide various opportunities to students, thus creating a need to determine which opportunities are most likely to lead to entrepreneurship.

STEM programs that facilitate a connection to entrepreneurship are those that include elements that produce the types of social network connections that are associated with high

technology entrepreneurship. Figure 2- 2 shows the STEM program elements classified as either social networking or structural support that can bridge the gap to entrepreneurship.



*Figure 2-2 STEM Program Elements and Entrepreneurship*

In the next sections, a review of the literature on the STEM workforce, STEM programs, and high entrepreneurship is reviewed with a particular focus on the social, human and financial capital factors associated with each.

### **STEM Workforce**

According to the National Science Foundation (NSF), building the “STEM workforce”, defined broadly as those who employ significant STEM knowledge and skills in their job, is critical to innovation, competitiveness and the 21<sup>st</sup> century workforce (p. 9, 2015). Global and domestic employment projections predict continuous growth in the areas of STEM (National Science Board, 2015). Science, technology, engineering, and mathematics (STEM) are the areas in education that are closely linked with high technology, high skill, and high salary positions

(Chubin, May, & Babco, 2005). Careers in STEM have been recognized as positions that are difficult to fill (Anderson, 2010; Karoly & Panis, 2004). Many of these positions require college or advanced degrees that involve quality academic preparation, hands-on training, and successful completion of challenging majors such as biology, chemistry, computer science, and engineering (Chubin, May & Babco, 2005).

Degrees in STEM are now a basic requirement for high-skilled technology “jobs of the future” (Chubin, May, & Babco, 2005). As the pace of technological needs increases, so does the demand for high-skilled workers who can create and advance new technologies, especially as the global demand for goods and services increase (Karoly & Panis, 2004). An added benefit is the earning potential and job growth opportunities for those that pursue careers in STEM. Melguizo and Wolniak (2012) confirmed that students in STEM fields reported earnings anywhere from 26 to 40% more than their counterparts who majored in areas of humanities or education. The study which reviewed earnings, fields of study, and the congruence between majors and occupation fields, revealed that skills associated with certain majors can be more valuable in the labor market, leading to higher economic rewards (Melguizo & Wolniak, 2012).

### **Racial Makeup of STEM Workforce**

The percentages of underrepresented minorities (URM) in STEM professions are disproportionately lower than the numbers of URM in the U.S. workforce as well as in the U.S. population (Anderson, 2010). White Americans make up about 77 % of those who work in science, technology, engineering and mathematics (STEM) occupations (Chubin et al., 2005). Asians make up 12 % and African Americans, Latinos, and American Indians make up a combined 11 % (Chubin et al., 2005). These numbers do not reflect the demographic make-up of the U.S. Increasing the number of URM who meet the STEM needs of the U.S. workforce would



create a changing workforce more diverse than before (Chubin et al., 2005). Diversity is recognized as an asset in the global economy that allows teams to be more creative, solutions to be more practical, products more usable, and employees more knowledgeable (Chubin et al., 2005; Fine, 1996).

In order for the U.S to sustain its economic strength, it has begun to look at URM as an untapped pool of talent, as businesses bring in guest workers from other countries to fill employment gaps in technical jobs (George et al., 2001). Guest workers under the H-1B visa are college-educated, many of them STEM workers, who are brought to the U.S. to be employed in STEM occupations that are unfilled by U.S. workers, roughly 65,000 immigrants receive these visas each year (Peri, Shih, & Sparber, 2015).

The 1987 Characteristics of Business Owners Survey (CBO) conducted by the U.S. Census Bureau provided a public database that included information on women, minority, and non-minority male business owners and their businesses, but unlike similar surveys this one captured the education of the entrepreneurs and specifics such as area of concentration in college. Information gained from the survey revealed that black-owned business owners are less likely to have completed a Bachelor's degree compared to women who own businesses and non-minority male business owners. The survey also supported previous reports that non-minority male owners are more likely to have an engineering degree than black males and women. Lastly, it can be noted that women and non-minority male owners were more likely to complete an unspecified degree than black male owners. The findings from this survey identified the education disparities among black, women, and non-minority male owners, thus supporting current efforts to promote STEM education and promote business ownership in STEM. This information provided additional support to the study, which identifies an association between

STEM education and high tech entrepreneurship as well as program factors that have a positive association with African American entrepreneurs.

The U.S. federal government allocates billions of dollars to increase funding for postsecondary STEM programs (Breiner, Harkness, Johnson, & Koehler, 2012). One of the many goals of funding these programs is to assist with recruiting and academically preparing minority students to move into STEM careers (Crisp et al., 2009). One population that can be targeted are minority students who excel academically but may not consider STEM, for example many African American students who are skilled in math and science, tend to choose non-STEM fields (Fields, 1998). The funding of these programs is supported by various studies representing data on URM in STEM. In reviewing the numbers of school-aged students who are interested in STEM, approximately one-third of the population consists of African American, Latino, and Native American students but they collectively make up only 11% of those who are in STEM occupations (Chubin, May, & Babco, 2005). Griffith (2010) stated fewer women and students of color receive their degrees in STEM fields compared to their white male counterparts, often due to the lack of support from their faculty and the lack of diversity regarding the racial and gender makeup of the college STEM field departments; but educational STEM programs which promote diversity have made a difference in URM pursuing these disciplines (George et al., 2001). These efforts aim to foster human capital development in the form of preparation and knowledge for the STEM workforce.

### **STEM Program Initiatives**

Currently there are educational programs in the U.S. with the specific goal of increasing the number of students pursuing and graduating with STEM degrees and entering STEM-related occupations. These programs aim to bridge the gap in human capital development by increasing

the rates of STEM education among URM. Numerous educational institutions throughout the U.S. provide instruction and encouragement for students to adequately prepare and promote STEM education and careers (Breiner et al., 2012). In 2011 the federal government allocated 3.7 billion dollars in its budget, funding the creation of education programs and centers with a STEM focus (Breiner et al., 2012). The U.S. has promoted STEM-support programs to assist in increasing the recruitment and retention of African Americans and women to avoid a shortfall of scientists and engineers in the future (Tsui, 2007). These programs also have an emphasis on encouraging STEM undergraduates to pursue graduate education (Merolla & Serpe, 2013). However, less certain is how STEM education translates into an African American's choice to pursue entrepreneurial activities post-graduation.

Science, technology, engineering, and mathematics (STEM) programs often include several elements that are considered to be keys to educational success and to build the human capital necessary for the 21<sup>st</sup> century workforce. STEM programs often include social capital elements such as mentoring and role models in the form of grad students, faculty, staff, and industry professionals, financial capital elements that provides financial assistance for education, and human capital elements such as enrichment opportunities in STEM involving education and industry partnerships. These program elements use social capital to increase access and build relationships and provide structural support in the form of human and financial capital. These programs use social and financial capitals to facilitate human capital development through the encouragement of STEM education. In the next paragraphs, the effectiveness of these components is discussed as well as examples of how these elements have been included in various STEM initiatives.

Campbell, Jolly, Hoey, and Perlman (2002) revealed that the inclusion of several program components can impact students continued educational pursuits in STEM areas. These components include but are not limited to adding a provision of role models through mentoring, providing diverse role models, having programs that not only work with the students but the teachers and parents, and encouraging teachers to raise their expectations for students. Other factors that can impact an individual's decision include social capital characteristics of networking, mentoring, and strong family support, financial capital in the form of financial resources, and personal characteristics such as self-confidence and persistence, (Chapman, 1981; Crisp et al., 2009; Flint, 1992).

### **STEM Program Elements and the 21<sup>st</sup> Century Workforce**

Enrichment opportunities and programs in STEM were created to increase student interest in STEM as well as improve student outcomes, with many programs targeting minorities, women, and economically disadvantaged students (Merolla & Serpe, 2013). Evidence suggests that enrichment programs have positive effects for students in areas such as academic performance, degree completion, encouraging and continuing an interest in science, enrollment in graduate programs, and maintaining an interest in STEM careers (Maton & Hrabowski, 2004; Merolla & Serpe, 2013). Access to enrichment opportunities and participating in enrichment programs may encourage individuals to consider STEM graduate education and ultimately influence individuals to seek entrepreneurship in STEM as they have more opportunities to learn and have experiences related to STEM.

Programs that provide degree offerings in the areas of STEM have been created to encourage more URM to pursue STEM education and to build the 21<sup>st</sup> century workforce. The education gained from program participation can increase knowledge and skills and combine

human and social capital to build up the workforce (Coleman, 1998). This investment in human resources can generate future economic returns as these individuals take the information gained from their education and join the workforce (Lin, 1999).

STEM-support programs often provide its participants with access and resources by using social capital such as mentoring, role models, and various social networks. Enrichment opportunities and programs often allow students to develop social relationships and interactions with mentors. Interactions can include participation in laboratory research, which enables students to experience and conduct research. Students are often provided opportunities to attend supplemental educational workshops, tutorials, career advising, and encouraged to develop peer relationships with other science students for support (Barlow & Villarejo, 2004; Maton & Hrabowski, 2004; Merolla & Serpe, 2013; Stake & Mares, 2001). These elements create relationships and gain networks among student cohorts, faculty/staff, industry professionals, and venture capitalist to connect students with information and resources that assist individuals' introduction to STEM industry and business ventures.

Networking is another social capital component of many STEM-support programs; these programs provide opportunities for students to form social networks with other STEM students and faculty through formal and informal events (Windsor et al., 2015). Based on Granovetter's definition of ties, the networks provided through STEM-support programs are weak ties. A recent study that evaluated the MemphiSTEP program, a STEM Talent Evaluation Program located at the University of Memphis, found that networking had a significant impact on retention and improved academic performance, specifically among African American students (Windsor et al., 2015). This positive impact is a step in encouraging students to continue and excel in STEM.

Program elements often include financial supports to address structural barriers to education and building the necessary human capital. Financial capital in the form of stipends, scholarships, research funds, and travel dollars are provided to students. Access to financial resources reduces the challenges and barriers that come with having poor or inadequate funding for education (Crisp et al., 2009; George et al., 2001).

One of the pre-college STEM initiatives is the Mathematics Engineering Science Achievement (MESA) program, which provides enrichment opportunities in areas of STEM for URM students. Through tutoring and year-round mentoring, this program improves students' academic performance, builds confidence, and provides awareness of careers in STEM. The MESA program also incorporates parents and families through education and support for college planning. By involving the parents and families in the process, students receive support and encouragement from influential individuals as they make their educational choices (Chapman, 1981). Evaluation of these programs suggest that their success in increasing college attendance rates is related to these key components, academic planning, enrichment opportunities, study skills training, career and college preparation, and parent involvement. The MESA program has a strong presence in 11 states and has a heavy emphasis on pre-college preparation. The MESA program has a long history of promoting STEM education to primarily K-12 educationally disadvantaged students.

Other STEM initiative programs primarily work within institutions of higher learning and have more of a national presence with programs existing in many states. The Louis Stokes Alliances for Minority Participation is one such program. The National Science Foundation (NSF) funds the Louis Stokes Alliances for Minority Participation (LSAMP) program. The LSAMP program, which was established in 1991, has a 25-year history and is present in 34

states including the District of Columbia. The LSAMP program implements programs to offer early research and enrichment experiences (NSF, 2003). The goal of this and similar programs is to improve students' performance in the areas of science, mathematics, engineering, and technology and increase the number of underrepresented minorities earning degrees in STEM (Clewell, Cosentino de Cohen, Tsui, & Deterding, 2006; Crisp et al., 2009). The primary goal is to encourage students from underrepresented communities to earn baccalaureate degrees in STEM and increase the students' interest in graduate education in STEM fields, with the long-term objective of diversifying the STEM workforce. The program has partnered with academic institutions, government agencies and laboratories, industries, and professional organizations throughout the U.S. LSAMP programs commonly offer research and enrichment opportunities, provide teaching and mentoring opportunities, encourage one-on-one interactions with graduate students and faculty mentors, and offer professional and personal development opportunities (Chubin, May & Babco, 2005; Clewell et al., 2006; NSF, 2003).

The LSAMPs are divided into three types of programs, Alliances, Bridge to Baccalaureate (B2B), and Bridge to Doctorate (BD). The alliances focus on undergraduate and graduate recruitment and retention activities of URM, the bridge to baccalaureate alliances focus on educational preparation activities to transition URM community college students to pursue STEM degrees at 4-year institutions, lastly the bridge to doctorate program provides fellowships and academic and research skills to support LSAMP students to successfully earn STEM doctoral degrees.

Another STEM initiative is the doctoral preparation program for college students, the Meyerhoff Scholars Program at the University of Maryland, Baltimore County (UMBC). The Meyerhoff Scholars program was founded in 1988 as an educational support program to promote

achievement for African Americans in areas of science (Maton, Pollard, McDougall Weise, & Hrabowski, 2012). The purpose of this program is to increase the representation of minorities in science and engineering by providing financial assistance, mentoring, advising, and research experience to undergraduate students of all backgrounds who plan to pursue doctoral study (Maton et al., 2012). The key points of success for the Meyerhoff Scholars Program include requiring all incoming scholars to attend a summer program that provides them with tools to acclimate to the rigors of college. Another point is to encourage students to form small study groups within their major that creates mutual support along with positive peer pressure. Lastly, it requires regularly scheduled meetings with program staff all four years of college to conduct academic advising and graduate and professional school preparation.

These STEM programs collectively provide social capital, human capital, and financial capital elements in various forms. Examples of social capital provided in these STEM programs include year round mentoring, programs that facilitate parent and family support, networking, role models, and student cohorts. Examples of human capital provided in these STEM programs include education courses, study skills training, enrichment opportunities, tutoring, college planning, research, and summer programs focused on academic preparation. Financial capital was provided through fellowships and financial assistance.

### **STEM Program Elements and High Technology Entrepreneurship**

Social, financial, and human capital are also important factors that influence entrepreneurial pursuits and success. Previous research in the area of STEM entrepreneurship focuses on access through social capital, educational advantages through human capital, and barriers such as lack of financial capital, as factors that impact the pursuit of entrepreneurship. However, it is important to note that there are also innate personal factors, beyond these capitals,



that can influence entrepreneurship such as drive and motivation (Campbell, Jolly, Hoey, & Perlman, 2002; Tsui, 2007). However, without the social, financial and human capital to pursue entrepreneurship, drive and motivation alone is rarely sufficient. A new focus on social characteristics that influence entrepreneurship has emerged and much data has identified the important role of social networks, including family, relatives, friends, and social groups, on entrepreneurial activities (Djankov et al., 2008). Social networks can connect entrepreneurs with others who have access to information or knowledge, which can assist them in overcoming challenges such as social structural barriers they may face as they grow their business. Recent studies have shown that the social environment has a direct effect on the decision to become an entrepreneur. Figure 2-3 classifies the different factors that influence entrepreneurship.

<b>Factors that Influence Entrepreneurship</b>	
<b>Personal Factors</b>	<b>-Drive and Motivation</b>
<b>Human Capital</b>	<b>-Family history -Education -Work experience</b>
<b>Financial Capital</b>	<b>-Financial support</b>
<b>Social Capital</b>	<b>-Networking -Mentoring -Role models</b>

*Figure 2-3 Entrepreneur Attributes*

In the review of literature, several studies were found that suggest some of the personal factors and characteristics entrepreneurs possess include, but are not limited to, the need for achievement, self-confidence, ready to take a risk, tolerance of ambiguity and decisiveness (Bhide, 2000; Djankov, Qian, Roland, & Zhuravskaya, 2008; McClelland, 1961). In the next section the relationship between the different types of capitals and entrepreneurial pursuits are presented.

## **Human Capital and Entrepreneurship (Family History, Work Experience, and Education)**

Several attributes of entrepreneurs can be classified as being human capital characteristics, attributes that are often associated with an individual and in many cases, are unchanged, and these include but are not limited to family history, and work experience.

### **Family History**

Various business surveys report that as many as 90% of small and medium enterprises are family businesses. Researchers have identified parents as an important factor in influencing the pursuit of entrepreneurship in children (Hisrich, 1990; Hoffman, Junge, & Malchow-Møller, 2015; Lumpkin, Steier, & Wright, 2011). Children of entrepreneurs are more likely to become entrepreneurs, the independence and flexibility associated with self-employment is often ingrained in these individuals as they witness the process of maintaining a business first hand (Hisrich, 1990; Hoffman et al., 2015; Lumpkin et al., 2011). Family history is a factor explained by the gaining of relevant work experience in the family firm, through inherited preferences and/or abilities to being an entrepreneur, and access to family funds to help fund their venture (Hoffman et al., 2015).

### **Work Experience**

Work experience can be defined as either the amount of time spent on a job or the amount of times a task has been completed (Quinones, Ford, & Teachout, 1995). In this study, work experience is skill and knowledge acquired so it is associated with the human capital attribute. Previous business and work experience can be an aiding factor in an individual deciding to pursue entrepreneurship as many individuals will often create ventures in the industry in which they have previously worked (Hisrich, 1990). There is a positive relationship between having work experience and self-employment, but a stronger likelihood of success

exists when education and work experience are combined (Bates, 1995; Robinson & Sexton, 1994). The number of years of work experience has an impact when looking at self-employment in areas such as manufacturing and wholesaling, but is less important in skilled services that require educational attainment (Bates, 1995). Through industry internships offered through STEM programs, individuals can gain work experience in STEM areas.

## **Education**

The role of education in entrepreneurship presents conflicting arguments, with many entrepreneurs emphasizing the importance of prior knowledge and work experience on achieving success over obtaining education (Simpson, Tuck, & Bellamy, 2004). Formal education is not a requirement for becoming an entrepreneur but education can provide a solid background when the knowledge gained specifically relates to the field of the venture (Hisrich, 1990; Nair & Pandey, 2006). This formal education, specifically as it relates to technical and scientific knowledge is something that must be acquired through external means, and results in certifications and/or degrees from technical schools, colleges and universities. Self-employment and success increase with higher levels of education (Robinson & Sexton, 1994). Although education is not required, entrepreneurs tend to be more educated than the general salary and wage population (Robinson & Sexton, 1994). Technical education and training can favorably affect entrepreneurship as the level of education can vary depending on the industry, example High tech (Bates, 1995; Nair & Pandey, 2006). Gaining education in the areas of finance, strategic planning, marketing and management can strengthen the ability of new entrepreneurs to be competitive (Hisrich, 1990).

According to the Association to Advance Collegiate Schools of Business (AACSB), there are 520 accredited business programs in the U.S., with many of them providing programs and

courses on entrepreneurial management. For minority entrepreneurs, particularly African Americans there are 107 HBCUs (US Department of Education, 2015) and of those, 79 business programs specific to their group. Within these business programs there is a continued call for these institutions to help develop and promote minority business through the development of entrepreneurship specific programs as many of these schools have traditional business programs that do not emphasize entrepreneurship (Adebayo, Adekoya, & Ayadi, 2001). In 2014, an initiative called the HBCU Innovation and Entrepreneurship Collaborative began as a cohort of 15 public and private HBCU's committed to fostering innovation, commercialization, and entrepreneurship on their campuses. Participating institutions include Clark Atlanta University, Fayetteville State University, Florida A&M University, Hampton University, Howard University, Jackson State University, Morehouse College, Morgan State University, North Carolina Agricultural and Technical State University, Prairie View A&M University, Tuskegee University, University of Maryland Eastern Shore, University of the Virgin Islands, Virginia State University, and Xavier University of Louisiana. Per the Association of Public and Land-Grant Universities (APLU), these institutions will have the opportunity to collaborate among institutions, federal government, and private industries to increase innovation and entrepreneurship across many disciplines including STEM and business (APLU).

HBCU's have begun to create and participate in competitions similar to the Venture Lab Investment Competition (VLIC), formerly known as the MOOT Corp competition, to encourage entrepreneurship and provide necessary skills needed to manage businesses. This competition takes place annually at the University of Texas at Austin and focuses on business competing in teams to conceive a business idea, create a written business plan, and present their plan to a panel of judges made up of entrepreneurs, accountants, lawyers, and venture capitalists. The winners

receive cash prizes that the students can use to finance their business startups. In addition to the opportunity of financial awards, students are able to network with other students from the many different schools represented, improve their business plans, gain feedback from the panels, as well as make contacts with potential investors. These competitions have helped students hone their skills for developing sustainable business ventures (Anderson, 2010).

### **Financial Capital and Entrepreneurship (Financial Support)**

Financial capital in the form of assets and financial support are associated with entrepreneurs. Financial resources are classified as structural supports as these are characteristics that when needed, are often acquired from external sources (financial institutions, venture capitalists) to gain support for entrepreneurship. Unlike social networking financial capital does not necessarily require or occur as a result of relationships or networks.

### **Funding**

Funding is classified as financial capital. It is often sought out from external sources such as financial institutions and/or venture capitalists. A key characteristic of successful startups is sufficient financing from either the entrepreneur themselves through savings or assets, loans from banks or family members, or equity financing from venture capitalist to maintain the endeavor's existence in the market and profit earning (Basu & Parker, 2001; Marlow & Patton, 2005). Access to finances is an important component of start-ups that directly affects business performance (Marlow & Patton, 2005). For example, lack of funding through discriminatory practices that include denying credit and charging higher interest rates for approved loans to African American business owners versus comparable non-African American owners has had a negative impact on African American business success, thus eliminating the discriminatory

practices can allow for increased funding opportunities which can positively impact businesses (Blanchflower, Levine, & Zimmerman, 2003).

Funding for new businesses comes from various sources such as personal savings, loans from family members, venture capitalists' investments, and bank loans (Basu & Parker, 2001; Staniewski, Szopinski, & Awruk, 2016). External financing for new entrepreneurs is usually in the form of loans provided by financial institutions (De Meza & Southey, 1996; Berger & Udell, 1998). Research on entrepreneurs and start-ups suggest that bank loans are more desirable because the borrower maintains full ownership of the firm, which is not the case with venture capitalist, who in addition to providing managerial contributions to the venture, also require part ownership of the firm (de Bettignies & Brander, 2007). Although financial institutions such as banks provide 61% of the external funding for new businesses, bank loans are often competitive to receive and at times lend a lesser amount of funding needed to finance the business (De Meza & Southey, 1996; De Meza, 2002).

### **Social Capital and Entrepreneurship (Networking, Mentoring, Role models)**

Several attributes associated with entrepreneurs can be classified as being social network characteristics. Social networks can be described as the relationships made up of family, friends, mentors, and teachers who indirectly influence the choice of others specifically through various educational influences. Their method of influence includes but is not limited to offering incentives, providing feedback to improve performance, and making sure information is comprehensible to the decision maker (Chapman, 1981; Ginorio & Grignon, 2000; Kadushin, 2004). Family history is a human capital characteristic, but also has social capital components by providing access to resources such as goodwill and economic stability that increases the

likelihood of children of entrepreneurs embarking on entrepreneurial ventures with success (Lumpkin et al., 2011; Nair & Pandey, 2006).

These attributes, which are often present in STEM programs to create human capital, are classified as social networking based on the relationships and connections they provide in the form of support, information, guidance, and inspiration that is provided to the entrepreneur. These characteristics include but are not limited to mentoring, role models, and social networking.

### **Mentoring**

Mentors play a very important role for entrepreneurs as they can help them avoid pitfalls and assist them with knowledge and skill acquisition (Ozgen & Baron, 2007; Wilbur, 2013). Mentoring can be classified as a social networking attribute based on the role it plays in providing information, connections and support for entrepreneurship. Furthermore, mentors can facilitate awareness of opportunities for new ventures and introduce them to entrepreneurial opportunities and are often part of their support networks (Ozgen & Baron, 2007; Wilbur, 2013). There is evidence that those who have mentors advance more quickly in their career and earn greater salaries and recognition than entrepreneurs who do not have mentors (Ozgen & Baron, 2007). Additionally, the relationships they have with mentors often provide useful information that expands throughout their careers (Ozgen & Baron, 2007).

Mentoring allows for the one-on-one interaction that helps to build confidence, provides positive pressure for them to succeed, and provides them with information (Chubin et al., 2005; Clewell et al, 2006). Mentors can serve as someone who provides necessary information and support for their mentee when they are faced with choices (Ginorio & Grignon, 2000; Tsui,

2007). Evidence suggests mentoring is one of the key factors that can lead to an individual pursuing entrepreneurship (Wilbanks, 2013).

Mentoring programs have been a widely-accepted approach in intervention programs for minorities, and students report the critical role their mentors play in their progress toward their career (Tsui, 2007). In STEM programs, mentors and teachers can educate and encourage students to advance their education in the areas of STEM. They can influence these students by creating positive learning experiences, giving encouraging words and advice, and providing access to information regarding STEM (Tsui, 2007). The literature recognizes a distinction between formal and informal mentoring (Lee, 1999; Tsui, 2007). Formal mentoring is planned mentoring which consists of strategic pairing of individuals that may have set times for interactions. Informal mentoring or natural mentoring is a relationship that tends to form naturally and voluntarily (Lee, 1999; Tsui, 2007). Some intervention programs encourage informal matching by setting up interactions that occur through cohort or community building activities; research suggests that informal mentoring is more likely to be successful and result in greater outcomes than formal mentoring (Tsui, 2007).

Many minority students have stated that mentors have been influential in helping them make decisions regarding their progress toward graduate education and career choices (Freeman, 1999; Tsui, 2007). Mentees often report that they value their mentoring relationship because it can provide trust, encouragement, support, and the needed challenge to push them beyond their current boundaries and level of comfort (Freeman, 1999). In STEM programs, mentors and teachers can educate and encourage students to advance their education in the areas of STEM. They can influence these students by creating positive learning experiences, giving encouraging words and advice, and providing access to information regarding STEM (Tsui, 2007).



Mentorship that promotes STEM education and promotes high technology entrepreneurship plays a role in creating human capital for the STEM workforce.

### **Role Models**

Role models as defined by Mertz (2004) “is a person from whom one seeks social or emotional support to learn more about what it means to be like that person” (p. 552). Another way to describe a role model is a person who possesses qualities or has reached a level of achievement that an individual would like to imitate; the role model is seen as motivation for future endeavors and achievements (Ware & Stein, 2013). This relationship that is formed with the entrepreneur is the reason role models are considered a social capital characteristic.

Studies have confirmed that exposure to successful role models creates motivation and inspiration which stimulates more proactive career behavior (Buunk, Peiró, & Griffioen, 2007). Many entrepreneurs contend that others outside their family influenced their idea to start a business as well as the development of the business, and in many instances these other individuals were entrepreneurs themselves and can often be described as role models (Verheul, Praag, Hessels, Bosma, & Schutjens, 2012). Other examples of role models can be parents, siblings, relatives, as well as successful entrepreneurs within a community (Hisrich, 1990). For African Americans, lower probabilities of self-employed parents explain lower rates of self-employment among blacks, creating the need to look beyond family (Fairlie, 1999). Role models, as it relates to entrepreneurship, are individuals who set examples that can be followed by others and who inspire or motivate individuals to choices pertaining to their careers and goals (Verheul et al., 2012).

STEM-support programs often recruit STEM professionals from various fields as role models to interact with student participants and provide information about their educational path

and their current career (Ware & Stein, 2013). One reason often cited for minority and female underrepresentation in STEM fields is the lack of minority and female role models in traditionally white male dominated disciplines (Merolla & Serpe, 2013; Xu & Martin, 2011). Although, there is evidence that students attending predominately white institutions felt having faculty versed on their career field was more important than having a faculty member of color (Lee, 1999; Tsui, 2007). The interaction with role models, particularly those versed in STEM and high technology entrepreneurship, can be an influence on future human capital as it enters the workforce.

### **Networking**

Networking is described as formal or informal, with formal networking typically consisting of required tasks and specific relationship requirements, and informal networking as broad and social in nature (Ibarra, 1993; Xu & Martin, 2011). A benefit to networking, specifically informal, is social support along with access to information, advice, guidance, and resources that can aid in the advancement of the individual (Hisrich, 1990; Ibarra, 1993).

In the area of entrepreneurship, social networks have been identified as providing a critical role in facilitating entrepreneurial success (Casey, 2014; Greve & Salaff, 2003; Zimmer, 1986). In social networks, relationships become critical because they can serve as pivotal links to institutional supports, connections to others with additional information and resources, and facilitate access to financial resources necessary to enable entrepreneurship (Casey, 2014).

Moral support networks often provided by friends and family can offer encouragement, understanding, and assistance but offer limited and similar types of contacts (Granovetter, 1983; Hisrich, 1990). Professional support networks can allow the opportunity to gain information and resources with other self-employed business associates, clients or buyers of products and

services, supplies, and connection to professionals needed in business such as lawyers, financiers, accountants, and marketing experts, in fact maximizing the “strength of weak ties,” (Granovetter, 1983). The social networks that are most associated with entrepreneurs are those that are classified as weak ties, these are networks of acquaintances that allow for the exchange of information and resources that can aid in business startups as well as create new connections (Granovetter, 1983).

Networking is a social capital component that is present in many STEM-support programs; networking provides students opportunities to connect and form social networks with other STEM students, with faculty, and with career professionals through formal and informal events (Windsor et al., 2015). Social networks can promote STEM education and promote high technology entrepreneurship to students, influencing future human capital for the STEM workforce.

### **Overview of African American Entrepreneurial Activities**

Historically, racial discrimination has made an impact on the diversity of the U. S. workforce as discriminatory hiring practices created obstacles for minorities who sought employment (Coleman, 2004). Racial structures existed to create a distinction between impoverished whites and non-whites who often considered themselves better than minorities despite their shared economic status (Brooks & Clunis, 2007). Also, the lack of public policies to protect the rights of minorities have made it more difficult for them to purchase property, obtain employment opportunities, and attain human capital (Bogan & Darity Jr., 2008). Because of discriminatory practices in the workforce against individuals based on race, color, religion, sex, and national origin, Congress implemented the Civil Rights Act of 1964 and prohibited employers from continuing discriminatory practices (Coleman, 2004).

Minorities, specifically African Americans and Latinos, are far less likely to begin a business than their white counterparts (Bates, Jackson, & Johnson, 2007). In reviewing U.S. Census Bureau (2010) data from the Survey of Business Owners, the U.S. has just over 27 million firms, with African Americans and Latinos making up approximately 7.1% and 8.3% of business ownership, respectively Whites make up approximately 77.9%. Per the Minority Business Development Agency (MBDA) preliminary 2012 SBO results, the number of minority-owned firms has increased by 38% with non-minority firms decreasing by 5% since 2007. According to the recent 2013 population information provided by the U.S. Census Bureau, whites constitute about 62.6% of the U.S population, African Americans are 13.2%, with Latinos increasing to 17.1% of the population. When comparing the population data with the percentage of business ownership, there is quite a disparity in the representation of URM in comparison to their representation of the total population. The data indicates that whites are represented at a higher rate in establishing businesses, at 124%, whereas African Americans and Latinos are underrepresented at 53.7% and 48.5%. These numbers have led to the U.S. putting measures in place to promote and support minority business ownership.

Entrepreneurship continues to be a means for the economic advancement of ethnic and racial groups; self-employment is seen as an alternative to unemployment and a way to alleviate poverty (Bogan & Darity Jr., 2008). Although Black and Latino owners have seen an increase in the number of firms, disparities among races still exist, which can be attributed to lack of access to financial and human capital (Fairlie & Robb, 2007). It has been determined that African Americans and Latinos have less rates of self-employment than other ethnic groups (Ahn, 2011; Koellinger & Minniti, 2006). Social capital bridges and links have been found to be important in reducing some of the barriers that minority entrepreneurs face (Casey, 2014). African American

entrepreneurship has been found to play a pivotal role in enhancing the economic status of the United States and reducing racial disparity in economic well-being through economic development, employment creation, and hiring of minority workers (Bates, 2007; Bogan & Darity Jr., 2008; Smith, 2005).

Throughout history there have been low rates of entrepreneurship among URM, specifically African Americans (Fairlie & Robb, 2007; Koellinger & Minniti, 2006). African Americans exhibit more optimism about business ownership and are more likely to attempt to start a business than others; this suggests that constraints and not preferences are behind racial differences in business ownership (Koellinger & Minniti, 2006). According to Koellinger and Minniti (2006) a lack of participation in business ownership among African Americans is due to the existence of uneven barriers to entry across races along with increased failure rates among minorities, not because of a lack of entrepreneurial propensity.

In the past, early minority entrepreneurs had businesses concentrated in the areas of personal services and trades, areas that tended to be less desirable to whites (Bogan & Darity Jr., 2008). These occupations included areas such as restaurantship, hotel keeping, mechanics, hauling and moving, and were concentrated in responding to specific needs of minority communities such as barbershops and beauty parlors along with retail. Many view these areas as businesses that are less profitable (Bates, Jackson, & Johnson, 2007; Bogan & Darity Jr., 2008). Business owners were also limited in the clientele that they served, typically providing services for their own or similar ethnic/racial groups, thus limiting their opportunity to develop and grow their businesses (Bates, Jackson, & Johnson, 2007). Concentrated efforts on certain services and clientele cannot necessarily provide the needed business experience to continue to develop and expand minority businesses (Bates, Jackson, & Johnson, 2007).

## **Social Capital**

In many urban communities, African American business owners often provide jobs for local youth and serve as role models for aspiring African American entrepreneurs in the community (Smith, 2005). African American entrepreneurs have the opportunity to not only serve their minority clientele, but they often hire youth from their communities (Smith, 2005). The focus on community allows African American entrepreneurs to provide social capital in the form of community support, role modeling, and mentoring.

The concentration of minority businesses in minority communities is not always the desired intent of minority entrepreneurs. Racial tensions often lead to minority business owners being confined to their communities and having less access to more affluent white consumers (Bogan & Darity Jr. 2008). Additional barriers include lack of access to mentors and networks that guide entrepreneurs through the process of starting a business (Casey, 2012). Social, professional, and financial networks are often mentioned as important components that aid in inventive and business activities but are often missing among African American entrepreneurs (Cook & Kongcharoen, 2010). Social network characteristics can reduce the negative factors of limited access through efforts to link African Americans to role models, mentoring, and networking, social capital attributes associated with entrepreneurial career opportunities.

## **Human Capital**

Human capital is associated with entrepreneurship (Bates, 1995). Researchers have cited that human capital characteristics such as low levels of education, fewer self-employed parents, demographic trends, and discrimination are some of the reasons for lower levels of entrepreneurship in minority communities (Bogan & Darity, Jr., 2008). Discriminatory barriers have prevented many minority business owners from obtaining the human capital associated with

successful, growing businesses, such as education, business training, and business experience (Bates, Jackson, & Johnson, 2007; Bogan & Darity, Jr., 2008).

Blacks and Hispanics are less likely than whites to be self-employed due to lack of human capital factors such as prior industry and self-employment experience, but programs can be created that improve early career employment and provide experience in preparation for self-employment (Ahn, 2011). The keys to successful business ownership include human capital characteristics, such as management skills and knowledge (Bates, Jackson, & Johnson, 2007). Efforts have been made to create structural supports in the form of education to address deficits that have served as barriers for minorities' pursuit of entrepreneurship.

When comparing Black entrepreneurs with their white counterparts, established business ownership is less prevalent among Blacks than among whites (Ahn, 2011; Koellinger & Minniti, 2006). Blacks are more likely than whites to participate in start-up ventures but are significantly less likely to own an established business. Thus a lack of human capital in the form of inadequate knowledge, low likelihood of working for a family owned business, and lack of prior self-employment experience, account for higher exit rates of Blacks from self-employment (Ahn, 2011; Fairlie & Robb, 2007, Koellinger & Minniti, 2006). Education programs that focus on the promotion of STEM careers often provide lots of resources in the form of knowledge of the profession and connections with individuals who work in these various professions, thus providing some of the keys that can lead to successful business ownership.

### **Financial Capital**

A shortage of financial capital can also be a barrier to business success (Coleman, 2007). The keys to successful business ownership include access to product markets and financial capital needed to produce a viable business (Bates, Jackson, & Johnson, 2007). Major barriers

primarily include racial disparities when it comes to the ability to obtain sources of capital and access to credit, two essential variables needed to finance a startup business (Bates, Jackson, & Johnson, 2007). Even when venture capitalist funds have been committed to investing in minority businesses, they invest selectively instead of broadly, focusing on specific businesses who have perceived higher return on investment (Bates & Bradford, 2009).

Other barriers that impact minority businesses include poverty in their communities which makes it difficult to generate necessary cash-flow to stimulate business growth, limited access to capital due to discrimination in lending with white banks and underdevelopment of minority banks, and the inability to obtain desirable business locations in main business areas (Bogan & Darity Jr., 2008).

The concentration of services in predominately minority neighborhoods led to additional barriers when it came to seeking out funding for businesses. Despite policies such as the Community Reinvestment Act of 1977, which was created to address the credit needs of low and moderate incomes as well as minority residential areas, there is still evidence of inequality in minority access to loans (Bates & Robb, 2015). Examples of inequality include minority neighborhood firms being treated differently than white firms during the application phase, inconsistency in criteria for small business loan applications, and minority owners receiving smaller loans (Bates, & Robb, 2015). Minorities with businesses in all minority neighborhoods are being evaluated differently by banks compared to equally credit worthy minorities located in different neighborhoods (Bates, & Robb, 2015). White business owners with businesses in all white neighborhoods who possess similar factors such as family income and business scores receive more loans than their Black counterparts in all Black neighborhoods (Bates & Robb 2015).



Entrepreneurs who lack formal financial support to develop a business may face structural barriers when linking to institutional support (Casey, 2014). African Americans and Hispanics continue to have difficulty obtaining funds from formal financial resources such as bank loans, finance companies, etc., in comparison to their white counterparts (Casey, 2012). Financial-capital barriers, such as household net worth and borrowing constraints can limit minority-owned businesses' access to capital and credit. This statement is consistent with continuing discrimination against minorities, specifically African Americans who pursue business lending (Bates, Jackson, & Johnson 2007). Prejudicial type discrimination and credit rationing, a practice where lenders limit the supply of credit even when borrowers are willing to pay higher interest rates, have led to disparities in the access to capital for minority business owners (Craig, Jackson, & Thomson, 2007).

### **STEM Programs and Factors that Influence Minority Entrepreneurship**

STEM programs can serve as an important social capital bridge and link that reduces information uncertainties among minority students, providing social resources and supports to facilitate their entry into STEM careers, including one subsector of the workforce, high tech entrepreneurship. Science, technology, engineering, and mathematics programs are increasingly including components that facilitate and reduce the barriers for STEM majors to pursue entrepreneurship. Science, technology, engineering, and mathematics support programs can provide various information and resources necessary to facilitate entrepreneurship and assist minorities in making decisions concerning their future endeavors.

These programs are designed to provide educational influences to promote interest in STEM. Their educational impacts occur as curricula that focus on learning opportunities and interactions with educators and experts in STEM fields, and an introduction to the variety of

career opportunities in STEM; these career opportunities could include entrepreneurship in STEM (Anderson, 2010). Many of these programs provide various opportunities to students, thus creating a need to determine which opportunities are most likely to lead to entrepreneurship; an example of such a program is DREAM STEM, which is the acronym for Driving Research, Entrepreneurship, and Academics through Mastering STEM, a program at North Carolina Central University. The goal of this program is early identification of students as scientists and to promote entrepreneurship within science education. The program provides learning cohorts with other students, faculty mentors, financial support through scholarships, access to resources that promote research along with opportunities to give presentations with travel funds, and networking opportunities with graduate students. Several factors present in this program such as mentoring, networking, financial support, and access to resources have been shown to influence minority entrepreneurship and may also be present in many STEM-support programs.

STEM programs also have the potential to facilitate connections to high technology entrepreneurship. In 2011 the US National Science Foundation (NSF) began Innovation Corps or I-Corps with the goal of fostering entrepreneurship by turning science research into business ventures (Reich, 2011). Innovation-Corps has the intended outcome of promoting innovation along with entrepreneurship, and teach individuals how to identify product opportunities that can be generated from academic research. In 2013, the NSF launched a curriculum called the I-Corps for learning that encourages NSF researchers to come up with innovative ways to take practices into the classroom that are based on STEM research. In August of 2015, NSF announced the expansion of the I-Corps program by forming new private and public partnerships to expand the access of the I-Corps program. Currently there are 37 I-Corp grants that have been awarded which fund programs being represented in 24 states and the District of Columbia. Several of

these programs are being conducted at historically Black colleges and universities (HBCUs) such as Howard University and Hampton University, and many others are at schools that are focused on working with URMs and first generation students; these include schools such as the University of North Carolina at Charlotte and the New Jersey Institute of Technology. One potential to promote entrepreneurship among STEM is to introduce the I-Corp grant to the LSAMP alliances, I-Corp offers a curriculum that provides training and guidance from experienced entrepreneurs.

This review of literature and of existing STEM program efforts to educate and cultivate minorities for the 21<sup>st</sup> century workforce provides a foundation for further exploration of how these programs are preparing minority students for high technology entrepreneurship; specifically focusing on the role of human, social and financial capital in the development of creating opportunities for African American high technology entrepreneurship. A series of hypotheses are presented below to answer the research questions.

### **Hypotheses**

The following hypotheses have been established to answer what STEM program factors are related to high technology entrepreneurship and do African Americans' that participate in STEM programs pursue high technology entrepreneurship?

*Hypothesis 1.* A positive association will exist between African American entrepreneurs with STEM degrees (undergraduate or graduate) and high tech entrepreneurship

*Hypothesis 2a.* STEM-support programs that include formal mentoring are more likely to be associated with higher rates of high tech entrepreneurship.

*Hypothesis 2b.* STEM-support programs that include role models are more likely to be associated with higher rates of high tech entrepreneurship.

*Hypothesis 2c.* STEM-support programs that include social networking (among cohorts, faculty, industry professionals, and capital providers) will be associated with higher rates of high tech entrepreneurship.

*Hypothesis 2d.* STEM-support programs that include financial support will be associated with higher rates of high tech entrepreneurship.

*Hypothesis 3.* African American graduates of STEM programs that pursue entrepreneurship will be associated with high tech entrepreneurship.

Many programs and resources have been dedicated to the promotion of STEM and an additional emphasis has been placed on encouraging URM to pursue STEM careers. The disparity between African American entrepreneurs who own firms in the areas of STEM compared to their white counterparts raises questions. Pinpointing the characteristics present in African American entrepreneurs along with ascertaining how STEM-support programs can bridge the gap between STEM education and high tech entrepreneurship and influence these individuals to pursue entrepreneurship to decrease the disparity among these populations.

The data gained from the quantitative analysis using existing databases and data from two surveys promotes the need to continue to support URM in STEM and it identifies the link between STEM education and high tech entrepreneurship. With this link to STEM education and entrepreneurship, programs can be created that promote entrepreneurship among URM and provide support for URM entrepreneurs in their pursuit of business ownership. It can also be used to modify or re-evaluate existing programs. This information can influence policy formation to limit allow equal or improved access to the much-needed financial capital and credit for business startups and success.

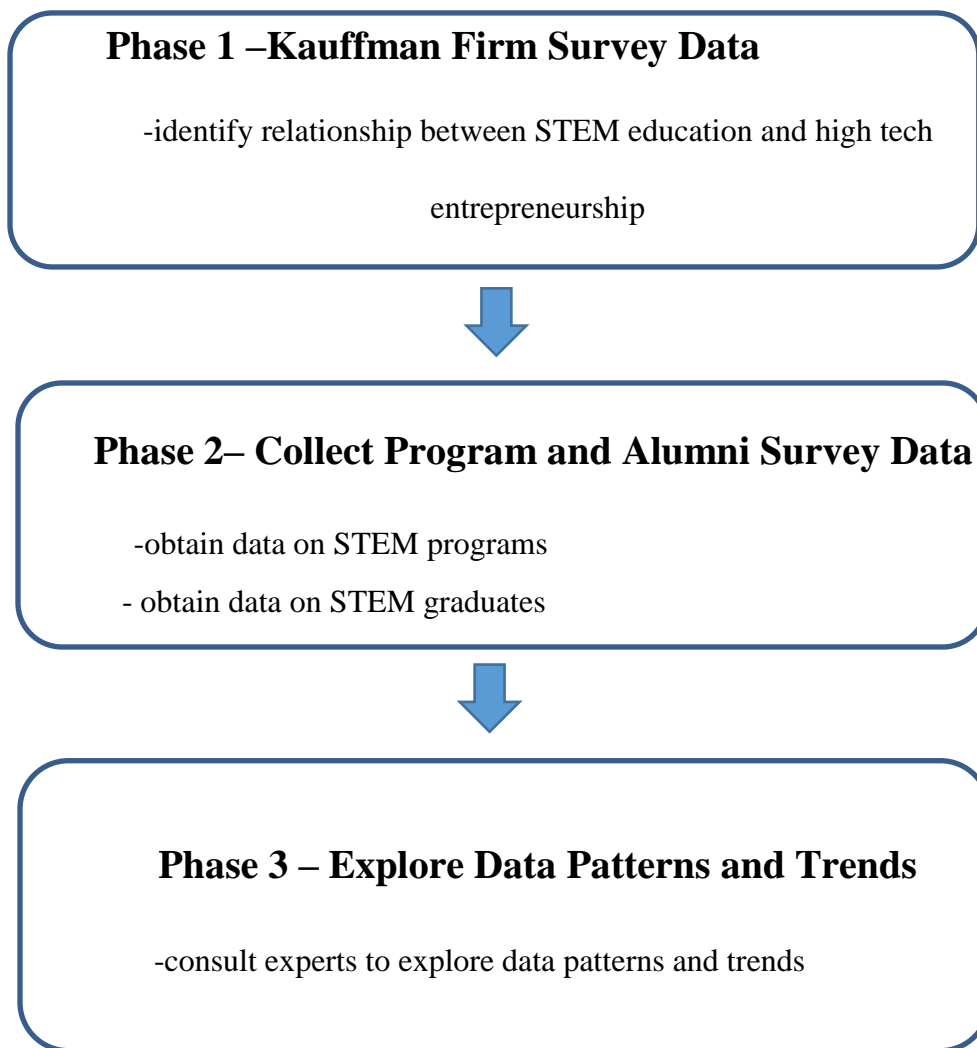
## Chapter 3

### **Methodology**

This study methodology employs a descriptive design to answer the research questions. Key concepts in this study include entrepreneurs, high tech firms, and STEM education. Entrepreneurs are defined using the definition provided by the Kaufman Foundation Survey (2011), which defines entrepreneurs as individuals who identify as self-employed, owners of small businesses, and/or owners of start-up companies. High tech firms are defined as firms that have science and engineering intensive occupations. Farhat and Robb's (2013) approach to identifying high tech firms is used in this study. High tech firms are identified in the KFS using the six-digit 2010 North American Industry Classification System (NAICS) codes that have science- and engineering-intensive occupations, whose shares of employment in those occupations were three times the national average, or industries that exceeded the U.S. average for both research and development expenditures per employee and for the proportion of full-time-equivalent R&D scientists and engineers in the industry workforce (Farhat & Robb, 2013). As stated previously in the paper, the acronym STEM stands for science, technology, engineering, and mathematics.

The study is divided into three phases of data collection and analysis. The phases are designed to understand what type of human capital associated with high tech entrepreneurship (measured by type of education) and the social and financial capital factors present in STEM programs to support STEM participants. The first phase of the study utilizes secondary, quantitative data on entrepreneurship from the Kauffman Firm Survey (KFS) dataset to identify the education of African American entrepreneurs. The second phase of the study utilizes researcher designed survey instruments to collect data from two populations – LSAMP program

administrators and a subgroup of LSAMP program alumni. The original plan was to submit a Freedom of Information Act (FOIA) to NSF to collect data on individual program outcomes, however the FOIA request was never granted. This lack of data prompted the creation of the LSAMP program alumni survey. The final phase of the study collects feedback from LSAMP program experts to explore the patterns and trends identified in the previous findings. Figure 3-1 explains each of the phases of data collection below. A description of each phase is described below including the respective methods, sample and data analysis plan.



*Figure 3- 1 Three Phases of Data Collection*

## **Phase 1. Establish the Relationship between the Education of African American Entrepreneurs and High Tech Entrepreneurship**

In the first phase, data from the Kauffman Firm Survey (KFS) is analyzed to determine if a relationship exists among STEM education and high tech entrepreneurship among African American entrepreneurs. This is important to provide a descriptive, associational account of the type of human capital possessed by this sub sector of the STEM workforce—entrepreneurs. Researchers lack a national, publicly available database that includes information on the education of entrepreneurs, and thus the association between STEM education and high tech entrepreneurship and African Americans has not been established. It could be that type of college education does not matter to high tech entrepreneurship in the 21<sup>st</sup> century workforce and entrepreneurs are gaining access to this subsector via other channels. The last data set that captured the type of degree an entrepreneur earned was the 1987 Characteristics of Business Owners Survey (CBO) conducted by the U.S. Census Bureau. The purpose of this phase is to establish the type of education associated with high tech entrepreneurship and to determine if STEM education appears to be important among African American high tech entrepreneurs.

**Data Collection.** The Kaufman Firm Survey (KFS) is a panel data set, which includes data on the education level and type of education of entrepreneurs. The KFS is an annual survey of businesses and the characteristics of those who own and operate them, sponsored by the Ewing Marion Kauffman Foundation. The KFS (2011) gives an overview of identified startups in the US from 2004 - 2011. The KFS data contains data on individual attributes of entrepreneurs, including race, gender, education level, and degree type. The STEM variable was created by the researcher by comparing the field of study variable to the 2010 Classification of Instructional Programs (CIP) codes on the National Center for Education Statistics (NCES)

website. If the field of study for a response was designated as a STEM field based on the CIP code, the STEM variable values were coded with a 1, while those without a STEM CIP were coded with a 0. The KFS variables of interest are described in Table 3-1 below. The primary variables of interest in Phase 1 are level of education, field of study, race and high-tech entrepreneurship.

Table 3- 1 Kauffman Firm Survey (KFS) Variables of Interest

<b>Characteristics of Entrepreneurs</b>	<b>Description</b>
Level of education	Undergraduate or graduate degree
Years of experience	# of years of work experience
Field of Study	STEM or non-STEM
Gender	Male or Female
Race	African American
High-Tech Entrepreneurship	Self-employed, owners of small businesses, or owners of start-up companies

**Sample.** The KFS dataset includes 4,928 businesses tracked over the stated timeframe. The dataset was reduced to focus on the relationship between STEM education, entrepreneurship and African American firms. The sample includes 233 African American firms; thus, the 4,928 firms were reduced to 233. Criteria for inclusion in the sample includes African American firm owners, both male and female, age (18 & up), level of education, years of experience, type of education and industry types (science, professional, high tech).

**Data Analysis.** Hypothesis 1 ( $H_1$ ) was established in order to analyze the existence of an association between STEM education, a human capital factor, and high tech entrepreneurship.  $H_1$  states that a positive association will exist between African American entrepreneurs with STEM degrees (undergraduate or graduate) and high tech entrepreneurship. A chi-square test was used



to analyze the relationship. SPSS 22 was used for the analysis. A p value of .05 level or less was deemed significant.

## **Phase 2: Identify the Social Capital and Entrepreneurial Elements of STEM Programs and Outcomes**

The second phase of the study is divided into two parts. Part A aims to identify patterns and trends in STEM programming and a relationship to entrepreneurship. Part B aims to identify the relationship between participation in a STEM program and entrepreneurship among a subgroup of LSAMP participants. Specific STEM program elements included those related to social and financial capital, including mentoring, role models, social networking (among cohorts, faculty, industry professionals, and capital providers), and financial resources. These program factors are selected for the analysis based on the literature review presented in Chapter 2, which suggests that STEM programs can include the structural and social capital supports to promote access to this sub group of the STEM workforce – entrepreneurship.

In Part A, LSAMP program administrators were selected for the survey. LSAMP program administrators were selected based on their status as lead administrators for their alliance and access to program data. As lead administrators, they submit annual reports to NSF comprised of consolidated program data for the alliance for which they are lead. Each alliance is comprised of programs held at various institutions; the number of programs that comprise an alliance range from as few as one to as many as 22. The program administrators were surveyed to obtain data on the characteristics of STEM programs, student characteristics, and high tech entrepreneurship. The LSAMP program was selected based on its 25-year history of promoting STEM education to URM, the inclusion of program factors – social networking, mentoring, role models, and financial resources, and its presence in 34 states.

**Data Collection.** A cross-sectional descriptive survey was used to collect the data. The researcher developed a 28-item questionnaire survey to identify trends in LSAMP programs and entrepreneurial outcomes. The survey was administered using Qualtrics, sent via email from a list acquired from the NSF website of grant funded LSAMP programs for 2012 – 2014 (see Appendix A). Data were collected on program demographics, program offerings, program characteristics, and post education and employment outcomes of program graduates. Data were also collected on the social and financial resources provided to program participants. The independent and dependent variables are described in Table 3-2 below.

Table 3- 2 LSAMP Program Survey Variables (2016)

<b>Independent Variable</b>	<b>Description</b>
Social Capital Factors	
Mentoring (categorical)	Structured, non-structured mentoring
Mentoring (numerical)	Students take advantage of mentoring opportunities
Role Models (categorical)	Access to role models provided, not provided
Role Models (numerical)	Students take advantage of role modeling opportunities
Social Networking (categorical)	Social networking provided, not provided
Social Networking (numerical)	Students take advantage of social networking opportunities
Venture Capitalists (numerical)	Connect students with venture capitalists
Promote Entrepreneurship (numerical)	Promote entrepreneurship among students
Financial Capital	
Financial Resources (categorical)	Financial resources provided, not provided
Financial Resources (numerical)	Students take advantage of financial resources opportunities
<b>Dependent Variable</b>	<b>Description</b>
High-Tech Entrepreneurship	Self-employed, owners of small businesses, or owners of start-up companies in high-tech industries

The survey was designed to obtain information about STEM programs, such as type of program (pre-college, college, summer, and/or graduate prep), the primary function of the program, whether formal mentorship was provided, were role models available, were social networks encouraged, did students have financial support and access to resources such as enrichment opportunities, and was entrepreneurship promoted in the program. The questionnaire contained a variety of question types, dichotomous, Likert and level of importance, to measure both the presence of the element and the degree to which program participants utilized the element. Information obtained from the questionnaire identifies which variables are present in STEM programs and which variables are associated with programs that produce entrepreneurs.

As illustrated in Table 3-2 above, the social capital elements in this study include mentorship, role models, and social networking. The questionnaire asked questions about mentoring opportunities provided to students. Mentoring was measured in two ways in this study: a) availability of mentors and/or structured mentoring program which aid in program completion and provide advice and support for career exploration and b) students taking advantage of the mentoring opportunities provided by the program. Two types of mentorship are distinguished in this research: general mentorship opportunities versus structured, or mandatory, mentorship. Structured mentorship is defined as approaches in which students are assigned mentors and are required to meet. Unstructured mentoring is informal and does not have meeting requirements, these relationships often occur naturally. The questionnaire contained dichotomous and Likert questions to determine if mentorship programs were structured or unstructured, whether they were conducted using peers, faculty/staff, industry professionals or venture capitalists, and measure students' level of participation in mentoring opportunities.

Networking is also considered as a social capital factor. The questionnaire asked questions about networking opportunities provided to the students. Networking was measured in two ways in this study: a) availability of networking opportunities among various groups such as cohorts, faculty, industry professionals, and capital providers that can expose students to individuals and resources that could aid in future entrepreneurial ventures and b) students taking advantage of the networking opportunities provided by the program. The questionnaire contained dichotomous, Likert, and level of importance questions to program administrators to measure whether program participants had access to peers, faculty/staff, industry professionals or capitalist providers and students level of participation in social networking opportunities. The questionnaire also asked questions to determine if students had access to resources and enrichment opportunities such as participating in research, STEM-related projects, internships, and/or visits with industry representatives to gain information and exposure to STEM careers.

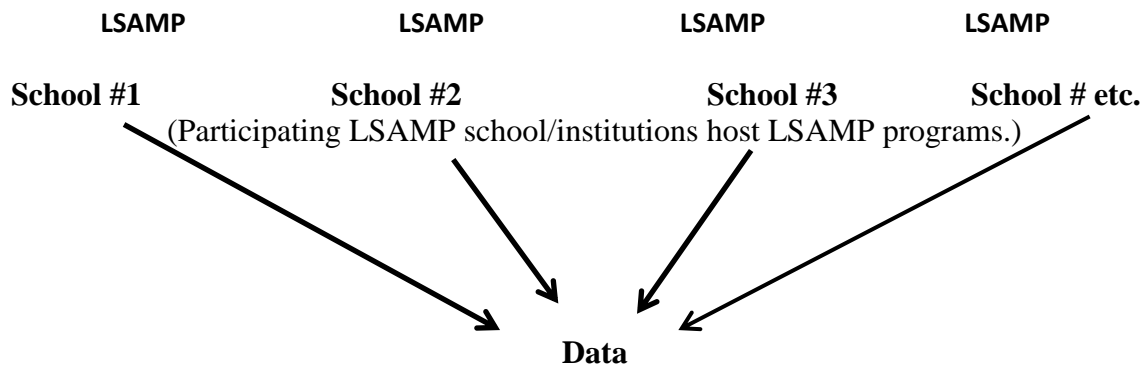
Access to role models is another social capital factor associated with entrepreneurship and falls under the social network characteristics. Program administrators were asked to respond to questions regarding if role models were provided through the STEM-support programs or via industry professionals. The presence of role models were measured in two ways in this study: a) availability of roles models such as faculty, staff, graduate students, industry professionals, and venture capitalist/investors that provide motivation and representations of success that aids in students' career exploration and exposure to successful entrepreneurial ventures and b) students taking advantage of the role model opportunities provided by the program. The questionnaire contained dichotomous, Likert, and level of importance questions.

Program administrators were also asked about the financial resources – financial capital- provided to program participants. Financial resources are measured in two ways in this study: a)

availability of resources to reduce student debt burden/costs of program completion and b) knowledge and exposure to financial resources to pursue entrepreneurial ventures. The questionnaire contained dichotomous, Likert, and level of importance questions.

**Sample population.** The sampling frame includes all 46 program administrators from state LSAMP Alliances representing 34 states including the District of Columbia nationwide. To date, there are over 400,000 LSAMP participants enrolled in the 40 alliances with over 600 institutions and partners (NSF 2016). Program administrators of LSAMP Alliances are targeted because they are identified as important stakeholders with access to alliance data and those that are responsible for generating annual program outcome reports for all LSAMP participants. LSAMP program administrators were selected as it allows for the recruitment of an institutionally diverse mixture of programs—some have affiliations with Hispanic Serving Institutions, HBCU, public universities, and community colleges. See Appendix B for the current list of the alliances and the states represented.

Criteria for inclusion in the sample include LSAMP program administrators who are responsible for submitting their alliance annual report to NSF. A flowchart of the LSAMP program and the process of gathering data are described below in Figure 3 – 2.



Data from each school/institution is collected by LSAMP program directors which includes student demographic profiles, degrees earned, student follow-up (ex. Transfers, drop outs, grad school acceptance) and program activities. This information is used to

generate year-end reports that are submitted to the LSAMP Alliance program administrator.



**LSAMP Alliance Program Administrator**

The LSAMP alliance program administrator collects the data/reports from the schools/institutions in their region, compiles it and submits this information to NSF via web portal. The alliance administrator is also responsible for creating a publication (ex. Journal, newsletter) periodically made available to the public that highlights the specific LSAMP alliance and its accomplishments.



**National Science Foundation (NSF)**

NSF collects the data from each LSAMP alliance and uses it for program evaluation and to determine continued funding for the LSAMP programs. NSF has shared the data with the Urban Institute, a nonprofit policy research and educational organization to conduct a process and summative evaluation of the LSAMP program. Through analysis of LSAMP data, the Urban Institute determined that the program not only met but exceeded its goals, and provides a model that can and should be replicated. Data is collected on approximately 450 institutions from 46 alliances that include student demographics and degree completion. No standardization of data is required and the data is the property of NSF therefore not available to the public.

*Figure 3- 2 Flowchart of LSAMP Program*

This research targets LSAMP program administrators at 4-year institutions and graduate institutions. The program was selected based on its history of supporting and increasing the percentage of URM completing STEM degrees, also it covers most of the United States, as there are alliances in 68% of the states. To provide context for the LSAMP alliances a summary of the LSAMP Alliance Partnerships from 2010 – 2011 are described in Table 3-3 below. See Appendix C for the name of the alliance and the states represented.

Table 3-3 LSAMP Partnership Summary

Alliance	Majority Institutions	HBCU's	HSI's	NASI's	Community Colleges	Other Partners	Total
Alabama	5	7	0	0	9	1	22
Alaska	3	0	0	0	16	0	19
All Nations	11	0	0	27	0	3	41

Arkansas	4	2	0	0	2	1	9
California	7	0	1	0	35	0	43
California State	8	0	14	0	0	0	22
Colorado	6	0	3	1	2	0	12
Florida-Georgia	4	4	4	0	3	0	15
Garden State	9	0	0	0	0	0	9
Georgia	1	3	0	0	1	0	5
Houston	2	1	2	0	2	0	7
Illinois	9	0	0	0	5	0	14
Indiana	8	0	0	0	0	0	8
Island of Opp.	6	0	0	0	12	0	18
Kentucky – W. V.	6	2	0	0	2	0	10
Louisiana	6	4	0	0	2	1	13
Michigan	4	0	0	0	9	0	13
Mississippi	3	4	0	0	0	1	8
New Mexico	0	0	5	1	20	2	28
New York City	7	2	3	0	5	1	18
North Carolina	3	4	0	1	7	1	16
North Star	11	0	0	1	4	2	18
Northeast	5	0	0	0	0	0	5
Oklahoma	10	1	0	4	3	0	18
Pacific Northwest	5	0	0	0	7	7	19
Peach State	2	2	0	0	1	0	5
Philadelphia	5	3	0	0	1	1	10
Puerto Rico	11	0	0	0	0	0	11
South Carolina	9	0	0	0	3	0	12
State Univ. of NY	6	0	0	0	10	3	19
Tennessee	4	2	0	0	0	3	9
Texas A&M	1	1	1	0	8	0	11
Univ. of TX System	4	0	5	0	5	0	14
Univ. Syst. of MD	2	1	0	0	22	0	25
Upstate	5	0	0	0	2	0	7
Urban Massachusetts	4	0	0	0	4	0	8
Virginia-North	4	4	0	0	0	0	8
Washington/Baltimor	0	7	0	0	10	1	18
WAESO	12	0	10	2	10	21	55
Wisconsin	17	0	0	1	4	0	22
<b>TOTAL</b>	<b>229</b>	<b>54</b>	<b>48</b>	<b>38</b>	<b>196</b>	<b>79</b>	<b>644</b>

Key: HBCU's Historically Black Colleges and Universities  
HSI's Hispanic Serving Institutions  
NASI's Native American Serving Institutions

There are three types of LSAMP programs, Alliances, Bridge to Baccalaureate, and Bridge to Doctorate. In this study the focus is on Alliances, which promote undergraduate degree completion, and Bridge to Doctorate programs, which promotes graduate education.

1. Alliances (multi-institutional partnerships) – focus on undergraduate recruitment and retention activities
2. Bridge to the Doctorate (BD) - focus on providing post-baccalaureate fellowship support to LSAMP students pursuing graduate studies

These two types of programs represent 111 colleges and universities; program participation by URM ranges from fewer than 75 to greater than 300 in each alliance. The justification to include these two types of programs is that they provide the educational requirements often associated with high-tech jobs. The selected programs receive grant funding to support the LSAMP program at their academic institution. Degrees awarded can include associates, bachelors, masters, and some doctorates.

**Participant recruitment.** Study participants were identified by searching the NSF website and through contacts at the Louis Stokes Midwest Center for Excellence (LSMCE). The names of participating state alliances, schools, and contacts for program administrators were obtained from the NSF website which provided alliance names and contacts for principal investigators. Alliances were also identified through the Louis Stokes Midwest Center for Excellence (LSMCE), which has a map that lists alliances locations, name, and contact information. The LSMCE is the pilot program of LSAMP that serves as a national hub of information for scholars to access data, models, and funding opportunities in broadening participation of URM students in STEM. Once the contacts were identified, a review of school websites was conducted to locate contact information such as phone and email for program



administrators. The Qualtrics survey was sent to the emails acquired through the process described above.

The goal was a 35% response rate (n=16 completed questionnaires, representing 12 of the 34 states, with each alliance representing on average 9 institutions, providing data from approximately 144 institutions). To gain the desired response rate the survey was open for 7 weeks, with email reminders going out weekly and just prior to closing the survey; phone calls were made to remind participants of the survey and to collect survey results via phone. No one elected to conduct the survey via phone.

**Data Analysis.** Hypotheses 2a-d (H2a, H2b, H2c, H2d) were established to analyze the association between the program factors' formal mentoring, role models, social networking, and financial support and the pursuit of high tech entrepreneurship among program participants. H2a states STEM-support programs that include formal mentoring are more likely to be associated with higher rates of high tech entrepreneurship. H2b states participants in STEM-support programs that include role models are more likely to be associated with higher rates of high tech entrepreneurship. H2c states participants in STEM-support programs that include social networking (among cohorts, faculty, industry professionals, and capital providers) will be associated with higher rates of high tech entrepreneurship. H2d states participants in STEM-support programs that include financial support will be associated with higher rates of high tech entrepreneurship. Several different sources of financial support were considered. Fisher's Exact Test was used to analyze the relationships in H2a – 2d; SPSS 22 was used for statistical analysis. The use of Fisher's Exact Test is appropriate as there is no minimum sample size or cell size required; this test often is used with small samples because it is more accurate than the chi-square test which requires a larger sample (Connelly, 2016).

## **Phase 2b: STEM Program Participants Workforce Outcomes**

In Part B, LSAMP program alumni were selected for an in-depth analysis of one of the LSAMP alliances. This survey was not part of the original research design, but was later implemented when it was determined that data on individual program outcomes would not be obtained from a FOIA request. The alumni were selected based on their participation in the Oklahoma LSAMP. The alumni were surveyed to gather data on program participant outcomes and to inquire about post-graduation employment and entrepreneurial pursuits to determine if a link exists between education type, level, and entrepreneurship in STEM fields. The importance of conducting this additional survey is to see if STEM program graduates engaged in entrepreneurship years after completing a STEM degree. Survey of all STEM program alumni was not possible due to a lack of a comprehensive database; however, this alliance provided a source of direct access to this population. The OK-LSAMP alliance was selected due to an ability to gain access to program alumni and because it includes an institutionally diverse mixture of programs, with some having affiliations with HBCU, majority universities, large and small institutions, as well as public and private. The OK-LSAMP alliance includes 11 institutions and has 10 majority universities, 1 HBCU, 10 public universities, and 1 private.

**Data Collection.** Data was collected from a 16-item survey adapted from the Panel Survey of Entrepreneurial Dynamics (PSED) questionnaire. The PSED is designed to gain information on business owner characteristics, business industry type, and startup information; it is conducted by the Institute for Social Research at the University of Michigan Retrieved December 4, 2016, from <http://www.psed.isr.umich.edu/psed/home>. The modified survey included questions regarding business startup such as were actions taken to start a business, when was the businesses started, business classification, and how the businesses emerged, and

additional questions were added to gain data including degree type, level of degree, institution name, individual demographics (race, gender, age), and high tech entrepreneurial status. The survey was administered using Qualtrics, sent via email to a protected and monitored OK-LSAMP alumni listserv (see Appendix D). This is a protected listserv maintained by the LSAMP program administrator for graduates of OK-LSAMP program alliance members. Access was not given to the listserv but per university protocol the survey was administered to the alumni per the listserv administrator. The independent and dependent variables are described in Table 3-4 below.

Table 3- 4 LSAMP Alumni Survey – Key Variables (2016)

<b>Independent Variable</b>	<b>Description</b>
Gender	Male or Female
African American	African American or not African American
Hispanic	Hispanic or not Hispanic
Age	Age category
<b>Dependent Variable</b>	<b>Description</b>
High-Tech Entrepreneurship	Self-employed, owners of small businesses, or owners of start-up companies in high-tech industries

The survey obtained information such as current occupation, business ownership, and if so, its classification as a high-tech business. Information obtained from the questionnaire determines which variables are associated with high tech entrepreneurship. A questionnaire consisting of 16 questions using various question types such as dichotomous, level of measurement, and contingency questions were provided to alumni to determine their occupation and their pursuit of entrepreneurship.

The questionnaire contained dichotomous questions to measure whether they have taken actions to startup a business, to determine entrepreneurial status. The survey uses skip-logic and contingency questions, so if the participant answers positively to the question, several levels of measurement questions are presented to determine how the business emerged to identify influences to the startup, and the classification of the business (retail, manufacturing, consumer services, etc.). The participant is also provided a definition of high-tech firms prior to a dichotomous question to collect data on if the respondent has a high-tech business and thus would be a high-tech entrepreneur. Additional questions to determine demographic data are included; this helps to identify African American program alumni.

**Sample Population and Participant Recruitment.** The sampling frame includes 428 alumni who completed a degree or degrees in STEM from the 11 different institutions that make up the OK-LSAMP alliances in the state of Oklahoma. The schools represented include Cameron University, East Central University, Langston University (HBCU), Northeastern State University, Northwestern Oklahoma State University, Oklahoma State University (Lead Institution), Southeastern Oklahoma State University, Southwestern Oklahoma State University, University of Central Oklahoma, University of Oklahoma, University of Tulsa (Private). The OK-LSAMP has been in existence for 21 years. This alliance consists of one historically black university, 3 comprehensive research institutions with 10 public institutions and one private institution. Study recipients were identified through the OK-LSAMP alumni listserv.

**Data Analysis.** Hypothesis 3 was also established to analyze the potential association between STEM support programs and the pursuit of high tech entrepreneurship among African Americans. H3 states African American high tech entrepreneurship in STEM programs will be associated with high tech entrepreneurship. The data allows the opportunity to gather additional

individual program participant level data on the educational background and entrepreneurial pursuits of African American STEM program graduates, program characteristics and its relation to high tech entrepreneurship. A Fisher's Exact Test was conducted to analyze if there was a relationship between African American alumni of STEM programs and high tech entrepreneurship. SPSS 22 was used for the statistical analysis.

### **Phase 3: Explore Data Trends and Patterns with Program Experts**

The third phase of the research is for verification of accuracy and trends present in the survey data. Seven experts in the field were recruited for this phase. A group interview was conducted with three of the seven experts from the Louis Stokes Midwest Center for Excellence (LSMCE). Additional information was received from the NSF LSAMP Program office, an interview was not conducted but my findings were shared with program officers and more information was received regarding the LSAMP program and its goals.

**Data Collection – Interview Protocol** An interview was conducted using an interview guide approach (Turner, 2010). This type of interview is more structured than informal conversation, with initial questions to prompt a response, but follow-up questions can be adapted based on the respondent (Turner, 2010). I proceeded to present to them my findings and ask for feedback regarding the results and their experiences with LSAMP. The interview lasted approximately one hour and was conducted as a group interview with all three participants. The interview was recorded and later transcribed for analysis.

**Sample and Participant Recruitment.** Four out of seven LSMCE administrators were invited to be interviewed and based on the availability of the participants a group interview was arranged. Three of the four could meet at the scheduled time. The individuals who were

interviewed are long standing leaders of the LSAMP program and organizers of the current LSAMP annual conference.

The individuals who were interviewed were identified from the LSMCE website, which lists various administrators and contributors to LSAMP. Those who participated from LSMCE were selected based on their roles within the center, their tenure with LSAMP, and their availability to meet during my visit to LSMCE in Indianapolis, IN. Two were chosen based on their role as Co-Principal Investigators of the LSAMP program and the LSMCE, a third was recruited based on their role as Director of Faculty Outreach and extensive background and accomplishments as a mentor. The last person was chosen based on their role with day-to-day operations with the LSMCE and LSAMP program and extensive interactions with LSAMP students.

Those recruited for the interview included Dr. Kim Nguyen who is a Co- Principal Investigator of the Pilot Regional Louis Stokes Center: Midwest Center of Excellence. She has also coordinated the Louis Stokes Alliances for Minority Participation (LSAMP) Indiana on the campus of Indiana University-Purdue University Indianapolis (IUPUI) since 2002 and is the founding and current director for operations of the Urban Center for the Advancement of STEM Education (UCASE) in the Indiana University School of Education since 2006. Her educational background is in higher education leadership with a long history of mentoring URM college students in STEM careers. Dr. Pamella Shaw is a Co-Principal Investigator and current Associate Dean of Diversity, Equity, and Inclusion at Indiana University School of Dentistry. She previously served as the Assistant Provost at Purdue University where she directed and managed two multi-campus LSAMP alliances. Her educational background is in biology, dental medicine and public health. Dr. Rafael Bahomonde currently serves as Associate Dean of the School of

Physical Education since 2012 and as director of faculty outreach for the LSMCE since 2013; he was previously the Director of the Diversity Scholars Research Program at IUPUI (DSRP) and is involved as a mentor in LSAMP as well as several other minority education support programs. His educational background is in biomechanics, anatomy, and physical education. Also present in the interview was Deb Cole who is the Academic Specialist-Programming Associate for the Louis Stokes Midwest Center of Excellence since 2014. Her educational background is in chemistry.

**Data Analysis.** Research findings from the LSAMP program administrator survey were presented to LSAMP program experts to explore the patterns and trends identified based on their experiences with LSAMP. They were also asked about employment goals and outcomes of LSAMP. The results were related to H2a – d, which were established to analyze the existence of an association between the program factors, formal mentoring, role models, social networking, and financial support and the pursuit of high tech entrepreneurship among program participants. The responses were recorded and transcribed and were analyzed to identify themes among experts regarding LSAMP and STEM program priorities, high tech entrepreneurship as a career pathway for African American students, and the role of STEM programming as a bridge to high tech entrepreneurship.

### **Study Limitations**

There are often trade-offs that must be made and considered when selecting an appropriate research design and methods to answer the research question of interest. The research design limitations encountered in this study are as follows: limitations of only survey program administrators and not program participants' data, reliance on a second survey to collect outcome data due to inability to gain FOIA data, reliance on survey and interview data and low

response rates, and cross-sectional data collection. These are discussed below as well as steps taken to mitigate these concerns. A complete list of limitations will be discussed in Chapter 5.

Collecting data at the level of the program administrator is a limitation because it results in data aggregated to an alliance of institutions rather than data directly from representatives at each institution or from individual program participants. Looking at just LSAMP STEM programs does not account for the differences that may exist when comparing them to non-LSAMP STEM programs and STEM program graduates. However, this is still the most efficient and effective way identified to gather the data as these programs do represent a heterogeneous mix of institutions.

The original research design planned to incorporate individual level program data gathered from a FOIA request to supplement the program-level data; however, the FOIA request was never granted. To overcome this limitation, an additional survey was conducted of LSAMP program participants from one alliance. This survey was generated to gain access to data regarding program participants' employment outcomes related to entrepreneurship. However, this still results in some limitations to the overall generalizability of the study, which is discussed in Chapter 5.

The reliance of survey and interview data can be a limitation as it can compromise results due to low survey response rates or interview participation rates. A low response rate to LSAMP surveys can be a limitation as a small sample size impacts the ability to generate statistical solid evidence, a small sample does not allow the use of chi-square which is the preferred method of analysis. The Fisher's Exact test was used to address this; however, there are still potential issues drawing statistical inferences from the data. Despite this, however, the benefit of the Fisher's Exact test is there is no minimum sample or cell size required so it is often used in place of Chi



Square when sample numbers are less than 5 and associated with 2x2 tables, it is called an exact test because it identifies the exact difference from the null or no difference hypothesis (McDonald, 2014). In reviewing Fisher's Exact test multiple examples of its use were found in medical and math journals. Using survey data also presents a limitation as the results may be subject to perception and bias from the participant. The non-standardization of collecting data in the programs was a limitation that impacted the research design as it was discovered that institutions did not all collect the same data. However, despite the limitations of survey and interview data, this was deemed as an appropriate method of data collection as there is no other data source available that asks these questions.

Lastly, the study relies on cross-sectional data collected from program administrators. The use of cross-sectional data hinders the ability to make causal connections. However, given that this is a descriptive study and one of the first to explore the relationship between STEM programs and high tech entrepreneurship detecting causality was not prioritized. However, this does limit the ability to make causal generalizations about the relationships between STEM programs and high tech entrepreneurship.

To summarize the methods used in this dissertation, the three phases of data collection and analysis were conducted to 1) establish the characteristics of African American high-tech entrepreneurs (phase 1), to 2) determine what program factors present in STEM-support programs, mentoring, social networking, role models, and financial support, are likely to influence program participants to pursue entrepreneurship (phase 2a), to 3) determine the likelihood of African Americans who complete STEM-support programs to become high-tech entrepreneurs (phase 2b), and lastly 4) consult with LSAMP experts to identify trends and

patterns based on the survey findings to explain the outcomes of the LSAMP program (phase 3).

In the next chapter, the results are presented.

## Chapter 4

### Results

This chapter presents the results of the data analysis from the three phases of research that was conducted in this study. The three phases of this study utilized a variety of data sources to answer the research question, do African American's that participate in STEM programs pursue high technology entrepreneurship? And, what STEM program factors are related to high technology entrepreneurship? The first phase of research utilized the Kauffman Firm Survey (KFS) and provided a quantitative assessment of the fields of study of African American entrepreneurs and employment in high-tech fields. The second phase of research utilized a survey research design to gather data from STEM program administrators and alumni from a STEM program. This phase provided quantitative data on STEM program elements, participants who have been exposed to STEM programs and the relationship between that programming and high technology entrepreneurship. The third phase of the research consulted three experts, which provided data to supplement the trends found in phase 2.

I anticipated using statistical techniques such as Fisher's Exact Test or a Chi-square analysis to determine significant relationships between the STEM program factors and high-tech entrepreneurship. However, results from the survey indicate that LSAMP program administrators report a very low percentage of STEM program participants pursuing high-tech entrepreneurship. Furthermore, even though the LSAMP program administrator survey resulted in a response rate of 39%, this represents 18 alliances, limiting more substantial statistical testing. Thus, emphasis is placed on interpreting the patterns and trends identified. Data from the statistical tests are presented; however, caution should be exercised in interpreting the significance of the effects.

## **Phase 1. Establish the Relationship between the Education of African American Entrepreneurs and High Tech Entrepreneurship**

The Kauffman Firm Survey (KFS) data from Phase 1 was filtered to include only those participants who were African-American entrepreneurs, including both those who had STEM degrees and those who did not. There were 223 African Americans in the KFS sample. Variables collected for this data include race of owner, field of study, high-tech industry involvement (yes/no question), years of experience, level of education, and gender. The STEM variable was created as described in Chapter 3, using the CIP code data provided by the NCES, for the African American entrepreneurs in the sample.

The KFS data provide a descriptive account of the characteristics of African American entrepreneurs, with a particular focus on their educational background (human capital) in a STEM field and its relationship to high-tech entrepreneurship. Descriptive statistics for the categorical response data are illustrated in Table 4-1. About 13% of African Americans are high tech entrepreneurs, a significantly higher percentage than the overall sample of 6.5%, ( $z=4.04$ ,  $p<.0001$ ). About 81% of African American entrepreneurs in the sample are male, which is a significantly higher proportion than the 68% of males in the whole KFS data set. In regards to level of education, African American entrepreneurs in the sample have no significant difference in levels of education in comparison to the whole KFS data set, except for the master's degree level. A higher percentage of African American entrepreneurs have a master's degree, 20.2%, compared to the entire KFS sample, 15.3% ( $z=2.01$ ,  $p=.045$ ). African American entrepreneurs possess the equivalent of a high school, vocational school or less level of education at a percentage of 33.2%, compared to the entire KFS sample, 36.7% ( $z=-1.13$ ,  $p=.257$ ), which was not significantly different from the sample. African American entrepreneurs reported a slightly

higher percentage of Associate's degree, 9.9%, compared to the entire KFS sample, 7.9% ( $z=1.09$ ,  $p=.276$ ); however it was not significantly different from the sample. African American entrepreneurs possess bachelor degrees at a percentage of 30.5%, compared to the KFS sample, 33.4% ( $z=0.93$ ,  $p=.354$ ). Finally, the percentage of African American entrepreneurs holding professional or doctoral degrees is 6.3% compared to 6.7% for the sample ( $z=-0.15$ ,  $p=0.877$ ), which is not significantly different from the population.

To summarize, the data provides a profile of African American entrepreneurs, which show they are overwhelmingly male, have businesses that are predominately non-high tech, and 66.9% of them have formal education at the level of an associate's degree or higher, with 57% having a bachelor's degree or higher. These percentages of formal education for African American entrepreneurs are slightly higher compared to the whole sample of 63.3% at the level of associate's degree or higher and 55.4% at the level of bachelor's degree or higher. However, in this sample, the percentage of African American high tech entrepreneurs is significantly higher compared to the whole sample of entrepreneurs. The results indicate an association with higher education and entrepreneurship for African Americans. The level of education indicates a large percentage of African American entrepreneurs possess the human capital component of advanced education.

Table 4–1 Descriptive Statistics of KFS Variables

<b>Variable</b>	<b>African American (n=233)</b>	<b>Whole Sample (N=4,928)</b>
<b>Entrepreneur (n=233)</b>		
High tech Entrepreneur	31 (13.3%)*	320 (6.5%)
Non High tech Entrepreneur	202 (86.7%)	4608 (93.5%)
<b>Gender (n=223)</b>		
Male	187 (80.3%)	3351 (68%)
Female	46 (19.7%)	1577 (32%)
<b>Level of Education (n=223)</b>		
High School, Vocational School, or Less	77 (33.2%)	1809 (36.7%)
Associate’s Degree	23 (9.9%)	389 (7.9%)
Bachelor’s Degree	71 (30.5%)	1646 (33.4%)
Master’s Degree	47 (20.2%)*	754 (15.3%)
Professional School or Doctorate	15 (6.3%)	330 (6.7%)
Notes:*p<.05, ***p<.0001		

The purpose of phase 1 is to see if there is an association between STEM education (human capital) and high tech entrepreneurship. Hypothesis 1 tests this relationship and focuses on the type of human capital related to high tech entrepreneurship.

**Hypothesis 1.** A positive association will exist between African American entrepreneurs with STEM degrees (undergraduate or graduate) and high tech entrepreneurship.

A positive, significant relationship exists between African American entrepreneurs who complete STEM degrees (undergraduate or graduate) and high tech entrepreneurship. A chi-square analysis was used to determine if there is a difference between African Americans pursuing high tech entrepreneurship, those with and without STEM field degrees. The independent variable was STEM degree, and the dependent variable was high-tech entrepreneurship. The sample size was reduced to 148 to test this hypothesis due to several respondents not indicating a response to the field of study variable used to determine STEM education. The results indicate that of those participants with a STEM degree, 36.8% were entrepreneurs in a high-tech field, as opposed to 9% of those without a STEM degree, indicating that the rates for pursuing high-tech entrepreneurship were higher for those with STEM degrees. The chi-square test indicated a significant association between STEM degree and high tech entrepreneurship ( $X^2 = 16.01$ ,  $df=1$ ,  $p<.001$ ). These results indicate that there is an association between earning a STEM degree and high-tech entrepreneurship for African Americans, supporting Hypothesis 1. The STEM degree results suggest human capital in the form of STEM education is an important factor associated with high technology entrepreneurship among African Americans. A summary of these two variables is illustrated in Table 4-2.

Table 4–2 Percent of high-tech firms with STEM and Non-STEM educated owners

	<b>STEM (n=38)</b>	<b>Non-STEM (n=110)</b>
<b>High-Tech</b>	14 (36.8%)	10 (9%)
<b>Not High-Tech</b>	24 (63.2%)	100 (91%)

## **Phase 2: Identify the Social Capital and Entrepreneurial Elements of STEM Programs and Outcomes**

The second phase of the study is divided into two parts. Part A aims to identify patterns and trends in STEM programming and a relationship to entrepreneurship. Part B aims to identify the relationship between participation in a STEM program and entrepreneurship among a subgroup of LSAMP participants. Specific STEM program elements under consideration include social capital factors, such as mentoring, role models, social networking (among cohorts, faculty, industry professionals, and capital providers), and financial capital such as financial resources.

In Part A, the LSAMP program administrators survey captured 18 LSAMP Alliances (n=18) out of the 46 current LSAMP Alliances in the U.S., with a response rate of 39%. The purpose was to identify patterns and trends in STEM programming and a relationship to high tech entrepreneurship. This sample represented 13 of the 34 states that have LSAMP alliances, with each alliance representing on average 9 institutions that provides data from about 175 institutions. The types of institutions represented were majority institutions (predominately white), historically black colleges and universities (HBCU), and Hispanic serving institutions (HSI). The LSAMP alliances sample was compared to the LSAMP 2011 - 2012 records found in the Alliances for Success, a publication that contains a profile of each alliance in Table 4-3, to illustrate differences in demographic breakdown. This publication was used as it is the most recent documentation of the composition of these programs; however, there may be modifications since this document was published. About 66% of the institutions in the sample are majority institutions, defined as predominately white institutions, which is slightly lower compared to the 71.9% LSAMP population. The HBCU institutions are 11.1% of the sample, which is slightly higher compared to the 8.4% LSAMP population. The HSI are 22.2% of the



sample, which is quite a bit larger compared to the 7.5% LSAMP population. Although the sample appears to have higher HBCU and HSI representation compared to the LSAMP population, the composition of the alliances surveyed do not drastically differ from the composition of the LSAMP population overall.

Table 4-3 Descriptive statistics for LSAMP Alliance Sample and LSAMP Alliance Population

	LSAMP Alliances Sample n=18	LSAMP Alliances Population (2011-2012) n=40
Type of Institutions by %		
Majority (primarily white)	66.7%	71.9%
Historically Black College/University – HBCU	11.1%	8.4%
Hispanic Serving Institute – HSI	22.2%	7.5%

The sample represented public, private, and community college institutions, as well as HBCUs (11.1%) and HSIs (22.2%). Most respondents were from alliances that are classified as majority white public schools. This is reflective of the LSAMP population as a whole, and is similar to what would be expected from a representative LSAMP institution sample. A breakdown of the types of institutions represented in the sample is displayed in Table 4-4.

Table 4-4 LSAMP Sample – Types of Institutions

LSAMP Survey - Type of institution by % (n=18)	
<b>Public</b>	89.0%
<b>Private</b>	16.7%
<b>Community College</b>	11.1%

The 18 responses represented 18 different alliances across the United States. The respondents provided data on alliances ranging in number of institutions, number of STEM program

participants, and alliance total STEM enrollment. Table 4-5 presents the summary of the sample characteristics. About 5.6% of the sample reported small STEM program enrollments of less than 75; however, the majority of the sample reported enrollments between 76 - 300. Finally, about 16.7% reported program enrollments, greater than 300.

Table 4-5 LSAMP Sample—Alliance and Program Participants

Alliance	Number of Institutions	Number of Program Participants	Alliance Enrollment
#1	9	76 – 150	>35,000
#2	3	226 – 300	10,000 – 15,000
#3	9	226 – 300	<5,000
#4	11	151 – 225	5,000 – 10,000
#5	7	76 – 150	<5,000
#6	6	>300	<5,000
#7	5	226 – 300	5,000 – 10,000
#8	9	76-150	>35,000
#9	8	151-225	<5,000
#10	11	76-150	>35,000
#11	8	>300	25,000 – 30,000
#12	11	151-225	>35,000
#13	11	226-300	<5,000
#14	11	226-300	>35,000
#15	2	1-75	>35,000
#16	4	76-150	<5,000
#17	9	>300	>35,000
#18	11	151-225	>35,000

The program elements that were the focus of the survey included components of social capital in the form of mentoring, and role models that include faculty, LSAMP staff, graduate students, industry professionals, and venture capitalist; social networking among faculty/staff, graduate students, industry professionals, venture capitalists, and representatives from financial institutions; and financial capital such as financial resources in the form of stipends, scholarships, grants, travel funds, competitive awards, and research funds.

The LSAMP program administrator survey asked several questions to identify program elements. Questions were asked to determine the amount and type of opportunities provided to students regarding role models and social networking. They were also asked to determine if students take advantage of the financial resources (financial capital), mentoring (social capital), role model (social capital), and networking (social networking) opportunities provided. The survey also included questions about the connection to venture capitalists and the promotion of entrepreneurship in order to obtain information about entrepreneurship pursuits in the alliance. Mean ratings for the scale variables from the LSAMP program administrator survey are shown in Table 4-6, and explained below. The scale ranges from 1 to 7, with 1 representing strongly disagree, 7 strongly agree, and 4 neutral. Program administrators were asked to indicate the degree to which they agreed or disagreed that these elements were present in all programs within the alliance. Program administrators were asked to indicate the degree to which they agreed or disagreed that students took advantage of the opportunities provided.

The data suggest students are likely to take advantage of financial resources, mentoring, and role models as evidenced by a mean rating of greater than 6.0 on all of these. However, alliances are not likely to promote entrepreneurship as evidenced by a mean of 2.50, or connect

students with venture capitalists, as evidenced by a mean of 2.06. This data suggests entrepreneurship is not a priority among programs.

Table 4-6 LSAMP Program Survey – Program Elements

	Mean	Standard Deviation	Min	Max
<b>Social Capital Factors</b>				
Connect with Venture Capitalists	2.06	1.66	1	7
Students Take Advantage of Mentoring	6.22	1.17	4	7
Students Provided Access to Role Models	6.28	1.13	3	7
Students Take Advantage of Role Modeling	6.06	1.16	3	7
Student Provided Access to Social Networking	5.72	1.71	1	7
Students Take Advantage of Social Networking	5.94	1.11	3	7
Program Promotes Entrepreneurship	2.50	1.65	1	7
<b>Financial Capital</b>				
Students Take Advantage of Financial Resources	6.33	0.84	4	7

Phase 2 also analyzed the relationship between these program factors and high tech entrepreneurship. As mentioned previously, the number of alliances reporting participants that pursue high tech entrepreneurship is low. A categorical measure captures the likelihood of pursuing self-employment and high tech industry. In the survey, program administrators were asked to indicate the percentage of graduates self-employed after graduation and the percentage self-employed in high tech fields. Two groups were created for the analysis, high and low. Low represents an alliance reporting that 25 percent or less of program participants pursue entrepreneurship. High represents an alliance reporting that more than 25 percent of program participants pursue entrepreneurship. This was determined based on the distribution of the survey responses. This variable was used to test for associations between high tech

entrepreneurship and four major program components: mentoring, role modeling, social networking, and financial opportunities. Fifteen of the alliances were classified in the low group and 3 alliances were classified in the high group.

Hypothesis 2a – 2d investigates whether LSAMP program components have a significant association with higher rates of high-tech entrepreneurship. A small sample did not allow the use of chi-square, which was the preferred method of this analysis. The Fisher's Exact test was used to address this; however, there were still potential issues drawing statistical inferences from the data. Despite this, however, the benefit of the Fisher's Exact test is there is no minimum sample or cell size required so it is often used with small samples and it is called an exact test because it identifies the exact difference from the null or no difference hypothesis (McDonald, 2014).

**Social capital program element: Formal mentoring.** The following hypothesis focuses on the formal mentoring program element as a social capital component of entrepreneurship.

*Hypothesis 2a.* STEM-support programs that include formal mentoring are more likely to be associated with higher rates of high tech entrepreneurship.

The mean scale rating for do students take advantage of mentoring opportunities was a 6.22, with a standard deviation of 1.17. Recall that these scale variables are measured on a scale from 1 to 7, with 7 being strongly agree. As seen in Table 4-7, the breakdown of the scale item presented indicated a lack of significance, in mean ratings in formal mentoring for alliances with low and high entrepreneurship rates. Due to a small sample size, a statistical t-test was not determined to be a valid to measure for statistical differences. However, the low entrepreneurship group mean of 6.13 and the high entrepreneurship group mean of 6.67 have a difference of 0.54 between the two mean ratings. Given the closeness of the values it does not suggest a significant difference among alliances reporting low and high entrepreneurship rates.

Again, caution should be taken in the interpretation of these results due to the small number of alliances reporting high rates of high tech entrepreneurship.

Table 4-7 Scale Item: Students Take Advantage of Formal Mentoring Opportunities

	Low Entrepreneurship (n=15)	High Entrepreneurship (n=3)
Mean	6.13	6.67
St. Deviation	1.246	0.577

Table 4-8 illustrates the patterns of structured mentoring by alliance rates of entrepreneurship. Overall, 16 out of the 18 alliances offer structured mentoring. Of these 16 alliances, 13 are classified as producing low rates of high tech entrepreneurship and 3 are classified as producing high rates of high tech entrepreneurship. The 2 alliances that did not offer structured mentoring were in the low entrepreneurship group. With the majority of all alliances (16 out of 18) including a structured mentoring program, an association between structured mentoring and entrepreneurship is not supported.

Table 4-8 Entrepreneurship and Structured Mentoring

	Structured Mentoring (n=16)	No Structured Mentoring (n=2)
Low Entrepreneurship	13 (81%)	2 (100%)
High Entrepreneurship	3 (19%)	0 (0%)

Due to the low sample size of 18 survey responses, Fisher's Exact Test was used to test for association as it is accurate with small sample sizes. Results indicated that there was no

significant relationship found between structured mentoring and rate of entrepreneurship (Fisher's Exact Test,  $p=0.686$ ).

**Social capital program element: Role models.** The following hypothesis focuses on the role model program element as a social capital component of entrepreneurship.

*Hypothesis 2b.* STEM-support programs that include role models are more likely to be associated with higher rates of high tech entrepreneurship.

The association between role models and high tech entrepreneurship was tested in several ways – if students took advantage of the opportunities, the number of role modeling opportunities offered, and the type of role modeling offered. The mean scale rating for how much students take advantage of role modeling opportunities was a 6.06, with a standard deviation of 1.16. The mean scale rating for how much students are provided access to role models was a 6.28, with a standard deviation of 1.13. Recall that these scale variables are measured on a scale from 1 to 7, with 7 being strongly agree. As seen in Table 4-9, alliances with higher entrepreneurship rates have a larger mean rating of students taking advantage of role modeling opportunities. Similarly, alliances with high entrepreneurship rates report a larger mean rating of students being provided access to role modeling opportunities. Due to a small sample size, a statistical t-test was not valid to measure for statistical differences. However, the low entrepreneurship group mean of 5.87 and the high entrepreneurship group mean of 7.00 have the difference of 1.13 between the means for students taking advantage of role modeling opportunities means there is more than 1 rating level difference, indicating that there might be a practical significance regarding taking advantage of role modeling and rate of pursuing high tech entrepreneurship. However, the low entrepreneurship group mean of 6.27 and the high entrepreneurship group mean of 6.33 have a the difference of 0.06 between the means for



students being provided access to role modeling does not appear to be of practical significance. This suggests that offering role modeling may not be enough, but rather students must take advantage of it. Again, caution should be exercised in interpretation of these results given the small number of alliances producing high rates of entrepreneurship. However, it does suggest that students in high tech entrepreneurship alliances do take advantage of role modeling opportunities.

Table 4-9 Scale Item: Students Take Advantage of Role Modeling Opportunities and Students are Provided Access to Role Modeling Opportunities.

		Low Entrepreneurship (n=15)	High Entrepreneurship (n=3)
Students Take Advantage	Mean	5.87	7.00
	St. Deviation	1.187	0.000
Students Provided Access	Mean	6.27	6.33
	St. Deviation	1.163	1.155

The number of role modeling opportunities offered was also considered. For example, if an alliance offered faculty role modeling and graduate student role modeling, they have a total of two types of role modeling opportunities. The possible number of opportunities was maximum 7 and a minimum of 1. On average, alliances report about 4 role modeling activities. Among alliances that produce high rates of entrepreneurship, about 4.67 different role modeling activities are offered. Alliances reporting lower rates of entrepreneurship have on average 3.6. As seen in Table 4-10, the breakdown of the scale item presented indicated a lack of significance regarding the mean number of role modeling opportunities offered between high and low

entrepreneurship rates. Due to a small sample size, a statistical t-test was not valid to measure for statistical differences. Again, caution should be taken in the interpretation of the results given the small number of alliances producing high rates of entrepreneurship. However, at initial glance there does not appear to be a substantial difference in the patterns in the number of role modeling opportunities offered, as both fall around the mean of the sample.

Table 4-10 Scale Item: Mean Number of Role Modeling Opportunities Offered

	Low Entrepreneurship (n=15)	High Entrepreneurship (n=3)
Mean	3.6	4.67
St. Deviation	0.910	0.577

Finally, the type of role modeling opportunity and its association with entrepreneurship rates are considered. Specifically, results are provided below for each individual type, i.e. faculty, staff, industry professional, graduate student, and venture capitalist role modeling.

***Faculty Role Models.*** All alliances offer faculty role models, so there were no tests for association for this program factor and its effect on rate of pursuing entrepreneurship.

***Staff Role Models.*** Table 4-11 illustrates the differences between high and low entrepreneurship rates for the alliances that offered staff role models and those that offered no staff role models. Staff role models (LSAMP alliance staff members) were offered in 14 of the low entrepreneurship alliances and all 3 of the high entrepreneurship alliances, more specifically 82% of the alliances that offer staff role models have low entrepreneurship rates and 18% of the alliances that offer staff role models have high entrepreneurship rates. The 1 alliance that did not

offer staff role models was in the low entrepreneurship group. With the majority of the alliances (17 out of 18) offering staff role models an association between staff role models and entrepreneurship is not likely to be supported as it appears to be a common program element.

Table 4-11 Entrepreneurship and Staff Role Models

	Staff Role Models (n=17)	No Staff Role Models (n=1)
Low Entrepreneurship	14 (82%)	1 (100%)
High Entrepreneurship	3 (18%)	0 (0%)

Due to the low sample size of 18 survey responses, Fisher’s Exact Test was used to test for association. There was no significant relationship found between offering staff role models and rate of entrepreneurship (Fisher’s Exact Test,  $p=0.833$ ). Therefore, entrepreneurship rate and staff role modeling showed no significant relationship with one another.

***Industry Professional Role Models.*** Table 4-12 illustrates the differences between high and low entrepreneurship rates for the alliances that offered industry professional role models and those that offered no industry professional role models. Industry professional role models were offered in 12 of the low entrepreneurship alliances and all 3 of the high entrepreneurship alliances, more specifically 80% of the alliances that offer industry professional role models have low entrepreneurship rates and 20% of the alliances that offer industry professional role models have high entrepreneurship rates. With the majority of the alliances (15 out of 18) offering industry professional role models an association between industry professional role models and entrepreneurship is not supported. The 2 alliances that did not offer industry professional role models were in the low entrepreneurship group.

Table 4-12 Entrepreneurship and Industry Professional Role Models

	Industry professional Role Models (n=15)	No industry professional Role Models (n=3)
Low Entrepreneurship	12 (80%)	3 (100%)
High Entrepreneurship	3 (20%)	0 (0%)

Due to the low sample size of 18 survey responses, Fisher’s Exact Test was used to test for association. There was no significant relationship found between offering industry role models and rate of entrepreneurship (Fisher’s Exact Test,  $p=0.558$ ). Therefore, there was no significant relationship between industry professional role models and rate of entrepreneurship.

**Graduate Student Role Models.** Table 4-13 illustrates the differences between high and low entrepreneurship rates for the alliances that offered graduate student role models and those that offered no graduate student role models. Graduate student role models were offered in 13 of the low entrepreneurship alliances and all 3 of the high entrepreneurship alliances more specifically 81% of the alliances that offer graduate student role models have low entrepreneurship rates and 19% of the alliances that offer graduate student role models have high entrepreneurship rates. The 2 alliances that did not offer grad student role models were in the low entrepreneurship group.

Table 4-13 Entrepreneurship and Graduate Student Role Models

	Grad Student Role Models (n=16)	No Grad Student Role Models (n=2)
Low Entrepreneurship	13 (81%)	2 (100%)
High Entrepreneurship	3 (19%)	0 (0%)

Due to the low sample size of 18 survey responses, Fisher’s Exact Test was used to test for association. There was no significant relationship found between offering graduate student role models and rate of entrepreneurship (Fisher’s Exact Test,  $p=0.686$ ). Therefore, there was no significant relationship found between offering graduate student role models and rate of entrepreneurship.

***Venture Capitalist Role Models.*** Table 4-14 illustrates the differences between high and low entrepreneurship rates for the alliances that offered venture capitalist role models and those that offered no venture capitalist role models. Venture capitalist role models were offered in 2 of the 3 high entrepreneurship alliances and none were offered in the low entrepreneurship alliances. There were 16 alliances that did not offer venture capitalist role models and 15 were in the low entrepreneurship group and 1 was in the high entrepreneurship group.

Table 4-14 Entrepreneurship and Venture Capitalist Role Models

	Venture Capitalist Role Models (n=2)	No Venture Capitalist Role Models (n=16)
Low Entrepreneurship	0 (0%)	15 (94%)
High Entrepreneurship	2 (100%)	1 (6%)

Due to the low sample size of 18 survey responses, Fisher’s Exact Test was used to test for association. There was a significant relationship found between offering venture capitalist role models and rate of entrepreneurship (Fisher’s Exact Test,  $p=0.02$ ). This provides partial support for Hypothesis 2b, indicating that there is a relationship between venture capitalist role models and entrepreneurship rate.

**Social capital element: Social networking.** The following hypothesis focuses on the social networking program element as a social networking characteristic of entrepreneurship.

*Hypothesis 2c.* STEM-support programs that include social networking (among cohorts, faculty, industry professionals, and capital providers) will be associated with higher rates of high tech entrepreneurship.

The association between social networking and high tech entrepreneurship was tested in several ways – if students took advantage of the opportunities, the number of social networking opportunities provided, and the type of social network opportunities offered. The mean rating for the scaled item, how much students take advantage of networking opportunities, was a 5.94, with a standard deviation of 1.11. The mean scale rating for how much students are provided access to networking opportunities was a 5.72, with a standard deviation of 1.71. Recall that these scale variables are measured on a scale from 1 to 7, with 7 being strongly agree. As seen in Table 4-15, alliances reporting high entrepreneurship rates have a slightly larger mean rating of students taking advantage of social networking opportunities. Similarly, alliances reporting high entrepreneurship rates have a larger mean rating of students being provided access to social networking opportunities. Due to a small sample size, a statistical t-test was not valid to measure for statistical differences; however, the low entrepreneurship group mean of 5.93 and the high entrepreneurship group mean of 6.00 have the difference of 0.07 between the means for students taking advantage of social networking opportunities does not appear to be practical or significant. Likewise, the low entrepreneurship group mean of 5.60 and the high entrepreneurship group mean of 6.33 have the difference of 0.73 between the means for students being provided access to social networking indicate a lack of significance among alliances reporting high and low rates of high tech entrepreneurship.

Table 4-15 Scale Item: Students Take Advantage of Social Networking Opportunities and Students are Provided Access to Social Networking Opportunities.

		Low Entrepreneurship (n=15)	High Entrepreneurship (n=3)
Students Take Advantage	Mean	5.93	6.00
	St. Deviation	1.16	1.00
Students Provided Access	Mean	5.60	6.33
	St. Deviation	1.805	1.155

The number of social networking opportunities offered was also considered. For example, if an alliance offered faculty/staff role social networking and graduate student social networking, they have a total of two types of social networking opportunities. The possible number of opportunities were maximum 8 and a minimum of 1. On average, alliances reported about 4 social networking activities. Among alliances that produced high rates of entrepreneurship, about 4.333 different social networking activities were offered. Alliances reporting lower rates of entrepreneurship had on average 3.47. As seen in Table 4-16, the scale item breakdown presented indicated a lack of significance regarding the mean number of social networking opportunities offered between high and low entrepreneurship rates. Due to a small sample size, a statistical t-test was not valid to measure for statistical differences. Again, caution should be taken in the interpretation of the results given the small number of alliances producing high rates of entrepreneurship. However, at initial glance, there does not appear to be a substantial difference in the patterns of the social networking opportunities offered, as both fall around the mean of the sample.

Table 4-16 Scale Item: Mean Number of Social Networking Opportunities Offered

	Low Entrepreneurship (n=15)	High Entrepreneurship (n=3)
Mean	3.47	4.333
St. Deviation	1.246	0.577

In order to investigate whether the type of social networking opportunity was associated with entrepreneurship rates, I looked at the results for each individual type, i.e., faculty/staff, student peer, graduate student, venture capitalist, industry professional and financial institution social networking.

**Faculty/Staff Social Networking.** Table 4-17 illustrates the differences between high and low entrepreneurship rates for the alliance that offered faculty/staff social networking and those that offered no faculty/staff social networking. Overall, 17 out of the 18 alliances offered faculty/staff social networking. Of these 17 alliances, all are classified as producing low rates of high tech entrepreneurship and 0 are classified as producing high rates of high tech entrepreneurship. The 1 alliance that did not offer faculty/staff social networking was in the low entrepreneurship group.

Table 4-17 Entrepreneurship and Faculty/Staff Social Networking

	Faculty/Staff Social Networking (n=17)	No Faculty/Staff Social Networking (n=1)
Low Entrepreneurship	17 (100%)	1 (100%)
High Entrepreneurship	0(0%)	0(0%)



Due to the low sample size of 18 survey responses, Fisher’s Exact Test was used to test for association. There was no significant relationship found between offering faculty/staff social networking and rate of entrepreneurship (Fisher’s Exact Test,  $p=0.833$ ). This suggests no association between faculty/staff social networking and high entrepreneurship rate alliances.

***Student Peer Social Networking.*** All alliances offer student peer social networking, so there appear to be no differences between student peer social networking and differences in high tech entrepreneurship outcomes.

***Graduate Student Social Networking.*** Table 4-18 illustrates the difference between high and low entrepreneurship rates for the alliances that offered graduate student social networking and those that offered no graduate student social networking. Graduate student social networking was offered in 11 of the low entrepreneurship alliances and all 3 of the high entrepreneurship alliances more specifically 79% of the alliances that offer graduate student social networking have low entrepreneurship rates and 21% of the alliances that offer graduate student social networking have high entrepreneurship rates. The 4 alliances that did not offer graduate student social networking were in the low entrepreneurship group.

Table 4-18 Entrepreneurship and Graduate Student Social Networking.

	Graduate Student Social Networking (n=14)	No Graduate Student Social Networking (n=4)
Low Entrepreneurship	11 (79%)	4 (100%)
High Entrepreneurship	3 (21%)	0(0%)

Due to the low sample size of 18 survey responses, Fisher’s Exact Test was used to test for association. There was no significant relationship found between offering graduate student social networking and rate of entrepreneurship (Fisher’s Exact Test,  $p=0.446$ ). This suggests that

graduate student social networking opportunities do not differ among alliances producing high or low rates of high tech entrepreneurs.

***Industry Professional Social Networking.*** Table 4-19 illustrates the difference between high and low entrepreneurship rates for the alliances that offered industry professional social networking and those that offered no industry professional social networking. Industry professional social networking was offered in 8 of the low entrepreneurship alliances and all 3 of the high entrepreneurship alliances, more specifically 73% of the alliances that offer industry professional social networking have low entrepreneurship rates and 18% of the alliances that offer industry professional social networking role models have high entrepreneurship rates. The 7 alliances that did not offer industry professional social networking were in the low entrepreneurship group.

Table 4-19 Entrepreneurship and Industry Professional Social Networking

	Industry Professional Social Networking (n=11)	No Industry Professional Social Networking (n=7)
Low Entrepreneurship	8 (73%)	7 (100%)
High Entrepreneurship	3 (27%)	0(0%)

Due to the low sample size of 18 survey responses, Fisher’s Exact Test was used to test for association. There was no significant relationship found between offering industry professional social networking and rate of entrepreneurship (Fisher’s Exact Test, p=0.202).

***Venture Capitalist Social Networking.*** No programs offer venture capitalist networking, so there were no comparisons for this program factor and its effect on rate of pursuing entrepreneurship.

***Banks, Credit Unions or other Financial Institutions Social Networking.*** No alliances offer this type of networking, so there were no comparisons for this program factor and its effect on rate of pursuing entrepreneurship.

**Financial capital program element: Financial support.** The following hypothesis focuses on the financial support program element as a financial capital component of entrepreneurship. Financial capital can be provided both to assist students in completing STEM programs (scholarships, grants, stipends, research funds, and travel funds) as well as to encourage students to pursue or explore entrepreneurial activities (competitive awards).

***Hypothesis 2d.*** STEM-support programs that include financial support will be associated with higher rates of high tech entrepreneurship. Several different sources of financial support were considered.

The mean scale rating for how much students take advantage of financial support opportunities was a 6.33, with a standard deviation of 0.84. Recall that these scale variables are measured on a scale from 1 to 7, with 7 being strongly agree. As seen in Table 4-20, the scale item breakdown presented indicated a lack of significance as the mean number of social networking opportunities offered between high and low entrepreneurship rates are the same. Due to a small sample size, a statistical t-test was not valid to measure for statistical differences. Again, caution should be taken in the interpretation of these results due to the small number of alliances reporting high rates of high tech entrepreneurship.

Table 4-20 Scale Item: Students Take Advantage of Financial Support Opportunities

	Low Entrepreneurship (n=15)	High Entrepreneurship (n=3)
Mean	6.33	6.33
St. Deviation	0.816	1.155

The number of financial support opportunities offered was also considered. For example, if an alliance offers grants and stipends, students have a total of two types of financial support opportunities. The possible number of opportunities was maximum 8 and a minimum of 1. On average, alliances report about 3 financial support opportunities. Among alliances that produce high rates of entrepreneurship, about 3.33 different financial support opportunities offered. Alliances reporting lower rates of entrepreneurship have on average 2.93. As seen in Table 4-21, results of this test indicated a lack of significance between high and low entrepreneurship regarding the mean number of financial support opportunities. Again, caution should be taken in the interpretation of these results given the small number of alliances producing high rates of entrepreneurship.

Table 4-21 Scale Item: Mean Number of Financial Support Opportunities Offered

	Low Entrepreneurship (n=15)	High Entrepreneurship (n=3)
Mean	2.93	3.33
St. Deviation	1.438	3.215

In order to investigate whether the type of financial support opportunity was associated with entrepreneurship rates, a review of the results was completed for each type of financial support individually for scholarships, grants, stipends, travel funds, research funds, and competitive awards.

**Scholarships.** Table 4-22 illustrates the difference between high and low entrepreneurship rates for the alliances that offered scholarships and those that offered no scholarships. Scholarships were offered in 4 of the low entrepreneurship alliances and 1 of the high entrepreneurship alliances, more specifically 80% of the alliances that offer scholarships have low entrepreneurship rates and 20% of the alliances that offer scholarship have high entrepreneurship rates. There were 13 alliances that did not offer scholarships, 11 were in the low entrepreneurship group and 2 were in the high entrepreneurship group.

Table 4-22 Entrepreneurship and Scholarships

	Scholarships (n=5)	No Scholarships (n=13)
Low Entrepreneurship	4 (80%)	11 (85%)
High Entrepreneurship	1 (20%)	2 (15%)

Due to the low sample size of 18 survey responses, Fisher’s Exact Test was used to test for association. There was no significant relationship found between offering scholarships and rate of entrepreneurship (Fisher’s Exact Test,  $p=0.650$ ).

**Grants.** As illustrated in Table 4-23, there is a breakdown between high and low entrepreneurship rates for the alliances that offered grants and those that offered no grants. Grants were offered in 3 of the low entrepreneurship alliances and 1 the high entrepreneurship alliances, more specifically 75% of the alliances that offer grants have low entrepreneurship rates

and 25% of the alliances that offer grants have high entrepreneurship rates. There were 14 alliances that did not offer grants, 12 were in the low entrepreneurship group and 2 were in the high entrepreneurship group.

Table 4-23 Entrepreneurship and Grants

	Grants (n=4)	No Grants (n=14)
Low Entrepreneurship	3 (75%)	12 (86%)
High Entrepreneurship	1 (25%)	2 (14%)

Due to the low sample size of 18 survey responses, Fisher’s Exact Test was used to test for association. There was no significant relationship found between offering grants and rate of entrepreneurship (Fisher’s Exact Test,  $p=0.554$ ).

**Stipends.** Table 4-24 illustrates the difference between high and low entrepreneurship rates for the alliances that offered stipends and those that offered no stipends. Stipends were offered in 13 of the low entrepreneurship alliances and all 3 of the high entrepreneurship alliances, more specifically 81% of the alliances that offer stipends have low entrepreneurship rates and 19% of the alliances that offer stipends have high entrepreneurship rates. The 2 alliances that did not offer stipends were in the low entrepreneurship group.

Table 4-24 Entrepreneurship and Stipends

	Stipends (n=16)	No Stipends (n=2)
Low Entrepreneurship	13 (81%)	2 (100%)
High Entrepreneurship	3 (19%)	0 (0%)

Due to the low sample size of 18 survey responses, Fisher’s Exact Test was used to test for association. There was no significant relationship found between offering stipends and rate of entrepreneurship (Fisher’s Exact Test,  $p=0.686$ ).

**Travel Funds.** Table 4-25, illustrates the difference between high and low entrepreneurship rates for the alliances that offered travel funds and those that offered no travel funds. Travel funds were offered in 14 of the low entrepreneurship alliances and 2 of the high entrepreneurship alliances, more specifically 88% of the alliances that offer travel funds have low entrepreneurship rates and 12% of the alliances that offer travel funds have high entrepreneurship rates. There were 2 alliances that did not offer travel funds, 1 in the low entrepreneurship group and 1 in the high entrepreneurship group.

Table 4-25 Entrepreneurship and Travel funds

	Travel Funds (n=16)	No Travel Funds (n=2)
Low Entrepreneurship	14 (88%)	1 (50%)
High Entrepreneurship	2 (12%)	1 (50%)

Due to the low sample size of 18 survey responses, Fisher’s Exact Test was used to test for association. There was no significant relationship found between offering travel funds and rate of entrepreneurship (Fisher’s Exact Test,  $p=0.314$ ).

**Research Funds.** As illustrated in Table 4-26, there is a similar breakdown between high and low entrepreneurship rates for the programs that offered research funds and those that offered no research funds. Research funds were offered in 7 of the low entrepreneurship programs and 1 of the high entrepreneurship programs, more specifically 88% of the alliances that offer research funds have low entrepreneurship rates and 12% of the alliances that offer

research funds have high entrepreneurship rates. There were 10 alliances that did not offer research funds, 8 were in the low entrepreneurship group and 2 were in the high entrepreneurship group.

Table 4-26 Entrepreneurship and Research funds

	Research Funds (n=8)	No Research Funds (n=10)
Low Entrepreneurship	7 (88%)	8 (80%)
High Entrepreneurship	1 (12%)	2 (20%)

Due to the low sample size of 18 survey responses, Fisher's Exact Test was used to test for association. There was no significant relationship found between offering research funds and rate of entrepreneurship (Fisher's Exact Test,  $p=0.588$ ).

**Competitive Awards.** Table 4-27 illustrates the difference between high and low entrepreneurship rates for the alliances that offered competitive awards and those that offered no competitive awards. Competitive awards were offered in 2 of the low entrepreneurship alliances and 1 of the high entrepreneurship alliances, more specifically 67% of the alliances that offer competitive awards have low entrepreneurship rates and 33% of the alliances that offer competitive awards have high entrepreneurship rates. There were 15 alliances that did not offer competitive awards, 13 were in the low entrepreneurship group and 2 were in the high entrepreneurship group.

Table 4-27 Entrepreneurship and Competitive awards

	Competitive Awards (n=3)	No Competitive Awards (n=15)
Low Entrepreneurship	2 (67%)	13 (87%)
High Entrepreneurship	1 (33%)	2 (13%)



Due to the low sample size of 18 survey responses, Fisher's Exact Test was used to test for association. There was no significant relationship found between offering competitive awards and rate of entrepreneurship (Fisher's Exact Test,  $p=0.442$ ).

**Program Elements.** All the alliances in the survey sample offered the social capital elements of mentoring, role models, social networking, and financial capital elements of financial support. All alliances provided STEM support programs through the three program types (alliances, bridge to baccalaureate, and bridge to doctorate), 100% offered undergraduate support, 72% graduate support, 67% summer support offered, and 28% offered pre-college support.

**Social capital elements (mentoring, role models, and social networking).** Mentoring was provided in all alliances. Role models and social networking were offered through various forms, all alliances provided exposure to STEM careers and professions, 89% offer internships, and 83% provide exposure to industry professionals and 100% of alliances provide opportunities to conduct research and complete STEM projects.

**Financial capital element (financial support).** Financial support was offered through various forms, 89% provided stipends and travel funds, 44% provided research dollars, 28% offered scholarships, 22% offered grants, and 17% provided funds for competitive awards, 100% provide funds for student travel and presentations.

**Human Capital. (Entrepreneurship training, entrepreneurship challenges).** Entrepreneurship training and challenges were provided at some alliances, business training was provided by 17% of alliances, while 83% did not provide this training. Entrepreneurship challenges were supported by 17% of the alliances, 67% did not provide this support while 17% were unsure.

Overall this sample included alliances that provided the majority of its support to undergraduate and graduate students. The human capital elements provided were in the form of exposure to STEM careers and professions primarily through research, projects, and internships. Human capital elements of business training were also provided to promote entrepreneurship by a small number of programs. The social capital elements provided were in the form of interactions with industry professionals. Financial capital elements were provided through financial awards, which were primarily stipends and travel funds; just under half of the programs provided research dollars. A small number of programs did provide funding to participate in entrepreneurial challenges. This information was consistent with the LSAMP goal of undergraduate and graduate degree completion and student research.

**Student Participation.** Overall in this sample, student participation in mentoring, role models, social networking opportunities, and financial resources was positive. Program administrators reported either agree or strongly agree to students taking advantage of the opportunities provided to them with financial resources, mentoring, and role models at similar ratings and social networking having a slightly lower rating. This is consistent as evidenced by data that funding is provided for all students and majority of programs require structured mentoring.

**High Tech Entrepreneurship Outcomes.** Overall most programs in this sample are not promoting entrepreneurship through exposure to entrepreneurs, entrepreneurship challenges, and providing business training. However, a few programs do report higher percentages of students who are self-employed in high tech fields after graduation. These programs differ from other programs that did not promote entrepreneurship by providing mentoring and faculty support for entrepreneurial challenges, business training, and one program even required participation in

entrepreneurial challenges as well as provided financial support to participate in the challenges. The requirement to participate in entrepreneurial challenges was part of an alliance, which suggests some alliances, although few, are putting an emphasis on entrepreneurship and preparing students for this sub sector of the workforce. However, this does not appear to be a major component of focus of STEM programming.

### **Phase 2b: STEM Program Participants Workforce Outcomes**

In Part B, LSAMP program alumni were selected for an in-depth analysis of outcomes from one of the LSAMP alliances. The purpose of this phase was to see if STEM program graduates engaged in entrepreneurship after completing a STEM degree and to collect individual level data including the experiences of African Americans. The LSAMP alumni survey data resulted in 38 complete responses out of 428 listserv members, for a response rate of 9%. To gain the desired response rate the survey was open for 5 weeks, with email reminders going out on 3 separate occasions. Since the listserv had restricted access by members and administrators only, permission to make additional attempts to contact listserv members directly to encourage survey completion by the researcher was prohibited. Out of the 38 participants, 12 identified as African American. LSAMP alumni respondents had an average of 3.3 years of work experience in their current field, with a standard deviation of 3.8, minimum of 0 years and maximum of 15 years. A demographic breakdown of the categorical statistics for LSAMP alumni results is illustrated in Table 4-28. About 55.3 % in the sample were female and 44.7% male. About 31.6% (12) of the sample were African American. Entrepreneurs made up 15.8% of the sample. In regards to age, the majority of the respondents (about 65%) were between 20 and 30 years old. Specifically, 42.1% were in the 20 – 25 range, 23.7% in the 25 – 30 range, 10.5% were in the 31 – 35 range, 10.5% in the 36 – 40 range, and 13.2% were over 40.

Table 4-28 Descriptive Statistics for LSAMP Alumni Survey Participants

<b>LSAMP Alumni Sample</b>	
<b>Variable</b>	<b>Percent (n=38)</b>
<b>Gender</b>	
Male	17 (44.70%)
Female	21 (55.30%)
<b>African American</b>	
Yes	12 (31.60%)
No	26 (68.40%)
<b>Entrepreneurs</b>	
Yes	6 (15.80%)
No	32 (84.20%)
<b>Age Distribution</b>	
20-25	16 (42.10%)
26-30	9 (23.70%)
31-35	4 (10.50%)
36-40	4 (10.50%)
40+	5 (13.20%)

Results from the survey provided employment data of the LSAMP alumni, more than half of the participants were either full-time students or research fellows, 47.3% were full time graduate students, 8% were research fellows, 2.6% reported unemployed, 15.8% reported self-employment, and the remaining 26.3% reported various employment in industry. This is consistent with LSAMP goals of promoting graduate education and research. Out of the 38 in the sample, 6 respondents reported starting businesses, 3 (50%) males and 3 (50%) females, and 3 of the businesses were identified as high tech. The business types varied, 3 (50%) reported businesses that were classified as health, education, or social services, 1(17%) reported retail, 1 (17%) reported communications, and 1(17%) reported other. The ages ranged for this sample

with 2 (33%) between 20 – 25, there was 1 (17%) between 26 - 30, also 1 (17%) between 31 – 36, and 2 (33%) between 36 – 40.

This hypothesis focuses on one LSAMP program and the entrepreneurial outcomes of its graduates.

***Hypothesis 3.*** African American graduates of STEM programs that pursue entrepreneurship will be associated with high tech entrepreneurship.

The OK LSAMP has program characteristics that include the social capital components of structured mentoring, role models among faculty, staff, graduate students, and industry professionals, and social networking among peers, faculty/staff, graduate students, and industry professionals, it also includes financial capital that provides stipends and travel funds as financial support per information obtained from the alliance. It does not possess the components that are most associated with high entrepreneurial rates (i.e. venture capitalist role models, entrepreneurship competitions). Data was obtained on the 12 African Americans from the sample. Of the African Americans in the survey 7 (58%) were male, 5 (42%) were female. The education levels ranged, 1 (8%) had a PhD, 5 (42%) had a master's, 5 (42%) had a bachelor's, and one respondent did not answer. The ages ranged for this sample with 5 (42%) between 20 – 25, 3 (25%) between 26 - 30, 2 (17%) between 36 – 40, 1 (8%) between 31 – 35, and 1 (8%) greater than 40. The areas of study varied with 4 (33%) completing degrees in engineering, 4 (33%) completing degrees in biology, zoology, or microbiology, and 1(8%) each in the areas of computer science, chemistry, math, and biomedical sciences. The career outcomes varied with 6 (50%) reported being a graduate student and researcher, 4 (33%) were self-employed, and 2 (17%) worked as engineers.

Due to the small sample size of only 12 African American respondents, statistical testing was not valid to determine statistical differences among African American and non-African American program participants, however the results appear to lend support to the hypothesis given 2 or 50% of the African American LSAMP alumni entrepreneurs pursued high-tech entrepreneurship. Of the 12 African American respondents, 4 reported entrepreneurship, these 4 rates are summarized in Table 4-29.

Table 4-29 LSAMP African American Alumni High-tech Entrepreneurship

	LSAMP Alumni (n=4)
High-Tech Entrepreneurship	2 (50%)
Non High-Tech Entrepreneurship	2 (50%)

Data on the African American entrepreneurs indicates that out of the 4 entrepreneurs identified 3 (75%) of the African American entrepreneurs were male, and 3 (75%) held master's degree, with 2 of the master's degrees in engineering. The idea to pursue entrepreneurship came from varied sources, 1 (25%) reported their business emerged from STEM program experiences, 1 (25%) reported previous work experience, and 2 (50%) reported it came from an idea from self or a team member. The business types varied with 3 (75%) in the areas of health, education or social science and only 1 (25%) in the area of communications. It does not appear that the African American entrepreneurs pursued businesses that were directly related to their areas of study (engineering, math, or computer science). The results suggest there is not a direct connection between a specific STEM degree and high tech entrepreneurship in a particular industry. Furthermore, while a STEM degree may prepare African Americans to pursue high

tech entrepreneurship, it appears those with STEM degrees that pursue entrepreneurship do not exclusively pursue high tech entrepreneurship.

In reviewing the African American entrepreneurs who did have high tech businesses there were 2, both were male, 1 had a bachelor's degree and 1 had a master's degree, both were in the 30 – 40 age range, 1 reported starting their business based on previous work experience and the other based the idea from self or member of the startup team. Of the African American entrepreneurs who did not have high tech businesses one was male and one female, both had master's degrees in engineering, both were in the 20 – 30 age range, and both classified their business as health, education, or social services related. One of the two respondents did report that the STEM program experience did influence their business startup, while the other was influenced from previous work. Results from the LSAMP Alumni survey were analyzed to determine whether the African Americans participation in a STEM-support program (LSAMP) is associated with high-tech entrepreneurship. The sample size had 4 African American respondents who were entrepreneurs, of the 4 African American entrepreneurs, 50% were high-tech entrepreneurs and 50% were not. The low number of participants in the survey and the focus on only one alliance made it difficult to statistically test this hypothesis and to make generalizations. However, the results provide some preliminary evidence that suggests a STEM degree may provide an avenue to pursue high tech entrepreneurship, but just having a STEM degree does not link or limit one to only high tech entrepreneurship. The percentage of STEM program alumni that pursue entrepreneurship is about 15.8%, whereas the majority of the alumni report pursuing graduate education or research careers. African Americans with STEM degrees also pursue non high technology entrepreneurship ventures. Thus, STEM can provide the human

capital necessary for high tech entrepreneurship, but other human capital factors (work experience) and social capital factors may be at play.

### **Phase 3: Explore Trends and Patterns with Program Experts**

The third phase of the research is to explore the trends and patterns present in the survey data. Qualitative methods were used to interview three experts from the Louis Stokes Midwestern Center for Excellence (LSMCE). The individuals who were interviewed were administrators and longtime contributors to LSAMP. The expert responses fell into 4 categories, mentoring, role models, funding, and entrepreneurship.

#### **Mentoring**

In this category, the program administrators were presented the results from the LSAMP survey regarding mentoring and entrepreneurship. Experts provided insight on the mentoring component of STEM programs and the consensus among the group was that mentoring plays a big role in students achieving success. One example that was given regarding mentors is “research faculty train others to be research faculty especially in STEM,” and “we push the student to get a PhD”. Another example of a response is “faculty mentor research” and encourage students “to go into academia and doing research”. These and other comments suggest that most of the mentoring is conducted by faculty mentors who encourage students to continue their education, go into academia to become faculty, and conduct research. It was also mentioned that the amount of information students receive about jobs depends on the mentor. This explains the goals of the LSAMP program which is to promote academic achievement through degree completion, to conduct research, to pursue advanced education, and diversify the STEM workforce. The mentors are meeting the goals of the program promoting degree



completion and advanced education, an example of using social capital to promote human capital.

The information provided by the experts suggests that mentoring is a key component of STEM programs. However, the data also suggest that the type and nature of the mentoring matters, thus providing further insight on the connections and bridges for students. Experts emphasized that the type of mentor matters, and faculty as mentors serves as an important connection to facilitate degree completion and exposure to careers in academic and research. This resonates with the survey data that indicates fewer alliances include entrepreneurs' as mentors, and thus, this exposure to high tech entrepreneurship mentors may be lacking.

#### Role Models

Experts suggested that role models are valued in STEM programs; however, the role models presented are often faculty members that provide exposure to the norms and expectations of institutions of higher learning. In response to data shared that role models had a partial association with entrepreneurship in STEM programs, patterns emerged from the repetitive words and statements gathered from the experts' responses regarding entrepreneurship and LSAMP. An example of a response given regarding role models is "faculty want people to go back in academia because they want the role models to be there". In this statement the expert was stating the desire to have more URM complete advanced degrees and pursue careers in academia in order to be role models and resources to future URM pursuing STEM education. Role models are a social capital component that aids in the creation of human capital through the promotion of degree completion and employment as faculty in STEM. In response to findings that support venture capitalist role models and pursuit of entrepreneurship a positive a response of "it makes sense" was given. Based on their understanding of entrepreneurship and what was provided in

LSAMP programs they agreed that the presence of venture capitalist role models would be a promotion of entrepreneurship, referencing venture capitalists as inspiration for entrepreneurship and the role of venture capitalists to invest and support business startups. It must be noted that these programs are using social capital to build a bridge with role models, but the connections being made are not for entrepreneurship.

### Funding Resources

Experts provided insight on the funding resources provided by STEM programs, noting the lack of funding associated with entrepreneurship. Statements were made regarding NSF providing funding to support student research and to become scientists, in reference to the NSF support it was stated “fund the money so students can go do research and then become scientists, some of your results show that”. The statements suggest that funding resources are targeted towards research and science careers, which is consistent with information obtained from NSF regarding LSAMP program goals to promote student research and education to diversify the STEM workforce. Through funding the LSAMP program can provide human capital needed for the 21<sup>st</sup> century workforce. In response to findings showing no significant relationship with funding and entrepreneurship in LSAMP, a statement suggested students funded by LSAMP fail to have the opportunity to see and apply knowledge to the STEM workplace, with most funds being provided to support student research and science. Thus, funding is not available to assist with entrepreneurship.

### Entrepreneurship as a Program Priority

Experts also provided insight on the importance or value of entrepreneurship as a post-graduate option for program participants. Entrepreneurship is generally not promoted in LSAMP unless it is part of a business school or in an engineering program. It was stated that LSAMP

trains PhD students to know the discipline but not to contribute to the industry. One administrator stated that they are aware of some programs that are now proposing how to prepare students for business and the entrepreneurial spirit. They commented on a program called Innovation Corp (I-Corps), an NSF initiative that provides resources and funding to researchers to promote entrepreneurship through curriculum and training. The comment was “I saw they have the program innovation corps, I-Corps,” and “the national chemistry society is encouraging them to produce products that can be adapted for industry.” The comments regarding I-Corps, was identifying existing resources within NSF that could be utilized to bring the promotion of entrepreneurship to LSAMP. Another administrator suggested that LSAMP programs should begin to add a business component, they commented that the “school of medicine now realizes professionals like dentists or doctors don’t know how to run a business so they are now having a dual degree MD, MBA even law and MBA to encourage people to entrepreneurship and understand how to be”. This comment is suggesting that LSAMP programs should duplicate efforts that medical professional programs have begun to do, which is to provide supplemental training in business, which provides them with knowledge necessary for business success. This becomes valuable for students who may later decide to pursue a business startup.

The statements recorded by the experts provide an explanation for the findings that show most programs are not promoting entrepreneurship. The reason suggested is there is a primary emphasis on academia and not employment, and a lesser interest in entrepreneurship, with the exception of some programs. Programs have the choice to promote entrepreneurship in their alliance. When developing proposals to implement LSAMP alliances, institutions are given the opportunity to set priority areas to focus program efforts without mandates from the national office on how to meet the program goals. This allows programs freedom and creativity to meet

their institutional needs and as well as LSAMP goals. The flexibility of programs explains why some programs have a bigger emphasis on entrepreneurship and others do not.

### Results Summary

In summary, the research question is revisited: do African American's that participate in STEM programs pursue high technology entrepreneurship? And, what STEM program factors are related to high technology entrepreneurship? Per H1, there is a significant relationship between STEM degrees and high tech entrepreneurship among African American business owners, thus the need for education is supported when pursuing high tech entrepreneurship. When focusing specifically on program elements (mentoring, role models, social networks, and financial resources) to determine a link between these elements and the pursuit of entrepreneurship H2a-d, there is no relationship. One exception is the significant relationship between venture capitalist role models and the rate of entrepreneurship. Although these elements are associated with entrepreneurship, the results can be explained based on the program goals of using mentors, role models, and social networks to promote academic success, graduate education, and continued research. Funding provided by NSF is also solely provided to promote research. Lastly, when looking specifically at whether African American graduates of STEM programs that pursue entrepreneurship will be associated with high tech entrepreneurship H3, a relationship does exist that suggests there is some association with a STEM degree and entrepreneurship.

## Chapter 5

### **Conclusions, Discussion, and Suggestions for Future Research**

This final chapter relates the research findings to the body of the dissertation. The research questions in this study were as follows: do STEM programs provide a link to high technology entrepreneurship? And, what STEM program factors are related to high technology entrepreneurship? The 21<sup>st</sup> century workforce has identified a need for increased education attainment, more high technology jobs, and to strengthen the STEM workforce. One sub-set of the STEM workforce is high technology entrepreneurship, which is prioritized as a catalyst for economic growth through job creation. However, underrepresented minorities (URM) face disparities in both STEM education and the pursuit of high technology entrepreneurship. The purpose of this research was to explore trends in STEM programs to identify program elements related to STEM program completion and preparation for high tech entrepreneurship, with a focus on African Americans. The value of the research is that it explores an area for which data have not been previously collected. This section discusses the results of the study and offers policy and program recommendations to provide access and support among African Americans for high tech entrepreneurship through STEM programs.

#### **Summary**

The purpose of this dissertation research is to contribute knowledge on the relationship between STEM programming and one STEM sub-workforce group, high tech entrepreneurs. The research is important because a number of policies and initiatives focus on developing the STEM workforce, yet disparities exist among minority groups. African Americans represent approximately 6% of the STEM workforce, while White Americans make up approximately

77%, quite a disparity (Chubin et al., 2005). Although there is an increase in the number of firms started by African Americans, disparities still exist when specifically comparing high tech firms.

Three phases of research were conducted to answer the research questions. The three phases of this study utilized a variety of data sources to answer the research questions. The first phase of research utilized the Kauffman Firm Survey (KFS) to understand the connection between STEM education and high tech entrepreneurship, this phase provided data from African American entrepreneurs regarding their fields of study and employment in high-tech fields. The second phase of research analyzed data from STEM program administrators to determine the patterns and trends in STEM programming, particularly as it relates to human, social and financial capitals. The second phase also analyzed the relationship between different programmatic elements and high technology entrepreneurial participation among program participants, including alumni of one LSAMP program. The third phase of the research consulted three experts, which provided data to supplement the trends found in phase 2. Different methods of analysis were used to answer the research question, including chi-square and Fisher's exact test, to determine the factors associated with educational programs and the characteristics of African American entrepreneurs that are present to promote entrepreneurship in STEM fields.

The analysis suggests that most STEM programs include mentoring, role models, social networking, and financial support. This suggests that STEM programs are providing key supports to facilitate the development of the human capital necessary to be prepared for the STEM workforce - a STEM education. The analysis also suggested that high tech entrepreneurship is positively associated with a STEM education. However, the analysis also suggests that the majority of STEM programs, despite having the flexibility to do so, do not promote entrepreneurship.

## **Discussion**

### **Phase 1. Establish the Relationship between the Education of African American Entrepreneurs and High Tech Entrepreneurship**

The purpose of phase 1 was to see if there was an association between STEM education and high tech entrepreneurship. The first hypothesis addressed the human capital characteristic of obtaining advanced education in STEM and its relationship with high tech entrepreneurship. Hypothesis 1 states that a positive association will exist between African American entrepreneurs with STEM degrees (undergraduate or graduate) and high tech entrepreneurship. The results found that this hypothesis was supported, there was a significant association found between earning a STEM degree and high tech entrepreneurship for African Americans. As stated in the literature, STEM degrees are now a requirement for many high-skilled technology jobs (Chubin, May, & Babco, 2005). In high tech industries, technical education and training can favorably affect entrepreneurship (Bates, 1995; Nair & Pandey, 2006). This information supports the need to continue current and perhaps increase educational efforts in STEM to create human capital necessary for the 21<sup>st</sup> century workforce.

### **Phase 2: Identify the Entrepreneurial Elements of STEM Programs and Outcomes**

The second phase of the study was divided into two parts. Part A aims to identify patterns and trends in STEM programming and a relationship to entrepreneurship. Part B aims to identify the relationship between participation in a STEM program and entrepreneurship among a subgroup of LSAMP participants. Specific STEM program elements under consideration include mentoring, role models, social networking (among cohorts, faculty, industry professionals, and capital providers) which can enhance participant's social capital and social networks, and

financial resources as financial capital. The next few hypotheses addressed these program elements related to social capital, social networking, and financial capital.

Hypothesis 2a states STEM-support programs that include formal mentoring are more likely to be associated with higher rates of high tech entrepreneurship. The results found that the hypothesis was not supported; there was a lack of significance found between structured mentoring and rate of entrepreneurship. In intervention programs for minorities that provide mentoring students report that mentors provide a critical role in their career progress (Tsui, 2007). Mentoring relationships in these programs facilitate student success by providing information and support that aids in decision making when students are faced with choices (Freeman, 1999; Ginorio & Grignon, 2000; Tsui, 2007).

All of the alliances did offer mentoring in their programs but mentoring did not target support toward entrepreneurial efforts. Few alliances included entrepreneurs as mentors. According to Wilbanks (2013) mentoring is one of the key factors that can lead to an individual pursuing entrepreneurship. The literature states mentors can facilitate awareness of opportunities for new ventures and introduce them to entrepreneurial opportunities (Ozgen & Baron, 2007). Entrepreneurs often turn to mentors to assist them with knowledge and skill acquisition as well as help them avoid pitfalls (Ozgen & Baron, 2007; Wilbur, 2013). The role of mentors can help connect individuals to the sub group of entrepreneurship in the 21st century. Although formal mentoring is a social capital support, in the LSAMP programs it does not create a connection to high tech entrepreneurship. However, it must be noted that structured mentoring was present in the high-tech entrepreneurship alliances, indicating some association between high entrepreneurship and structured mentoring. The results can be explained when considering the



information from the LSAMP experts, the mentoring taking place in the LSAMP program regarding careers guides students toward research and academia, not entrepreneurship.

The next hypothesis addresses the STEM program element of role models as a social capital characteristic related to entrepreneurship. Hypothesis 2b STEM-support programs that include role models are more likely to be associated with higher rates of high tech entrepreneurship. Exposure to successful role models can motivate and inspire students to be more proactive with their career behavior (Buunk, Peiró, & Griffioen, 2007). Providing role models from STEM careers can be influential in developing STEM human capital. All of the alliances offered various types of role models but most role models were not targeted towards supporting entrepreneurial efforts, therefore there was a lack of connection to STEM participants to entrepreneurship. The hypothesis was partially supported when considering venture capitalist role models. When offering venture capitalist role models with regard to rate of pursuing entrepreneurship, there was a significant relationship found between offering venture capitalist role models and rate of entrepreneurship. This was consistent considering the role of a venture capitalist in business development. Venture capitalists provide funding and at times managerial contributions to a business venture (de Bettignies & Brander, 2007). There was a lack of significance found between faculty, staff, industry professional, or graduate student role models and rate of entrepreneurship. However, it must be noted that faculty, staff, industry professional, and graduate student role models are present in the high-tech entrepreneurship alliances, indicating some association between high entrepreneurship and role models. These findings indicate that the type of role model matters, the venture capitalist role model creates a weak tie that connects the program participants to the subsector of the workforce, high tech entrepreneurship.

Verheul et al. (2012) found many entrepreneurs state that their idea to start a business was influenced by others, in many instances these other individuals are entrepreneurs and role models. When considering program role models such as faculty, staff, graduate students, and industry professionals, the hypothesis was not supported. These results can be explained when considering the information provided by the LSAMP experts, whom report that students are provided role models to aid in their successful completion of STEM degrees. It supports the notion that program participants are going to be influenced by the career choices and behaviors of the role models that are present; however, the type of role models varies.

The next hypothesis addresses the STEM program element of social networking as a characteristic related to entrepreneurship. Hypothesis 2c states STEM-support programs that include social networking (among cohorts, faculty, industry professionals, and capital providers) will be associated with higher rates of high tech entrepreneurship. Networking among individuals provides access and support in the form of advice, information, guidance, and resources for the purpose of advancement (Hisrich, 1990; Ibarra, 1993). The support and access gained from social networking aids in the development of STEM human capital, but does not provide a connection to STEM entrepreneurship. The results found that the hypothesis was not supported; there was a lack of significance found between social networking and rate of entrepreneurship. There were no significant results for social networking among faculty/staff, student peers, graduate students, or industry professionals and entrepreneurship and none of the programs offered social networking with venture capitalists, banks, credit unions, or other financial institutions. Neither of the high-tech entrepreneurship alliances offered faculty/staff social networking. Neither high nor low-tech entrepreneurship alliances offered venture capitalist or financial institution social networking. To clarify, venture capitalists were presented as role

models, but opportunities to network with venture capitalists were not present. Social networking in this program does not create a connection to high tech entrepreneurship. However, it must be noted that student peer, graduate student, and industry professional social networking are present in all the high-tech entrepreneurship alliances, indicating some association between high entrepreneurship and social networking.

The literature states social networks among various groups tend to promote entrepreneurial activities (Djankov et al., 2008). In the area of entrepreneurship, social networks have been identified as providing an important role in assisting entrepreneurial success (Casey, 2014; Greve & Salaff, 2003; Zimmer, 1986). The small sample of programs that promote entrepreneurship and the void of networks that aid in business formation explain the lack of support for the hypothesis considering the important role of social networking to entrepreneurs.

The next hypothesis addresses the STEM program element of financial support as financial capital characteristic related to entrepreneurship. Hypothesis 2d states STEM-support programs that include financial support will be associated with higher rates of high tech entrepreneurship. Access to financial resources and financial support aid in the advancement of education (Crisp et al., 2009; George et al., 2001). The support and access gained from financial support aids in the development of STEM human capital, but does not provide a connection to STEM entrepreneurship. The hypothesis was not supported, as there was a lack of significance between financial resources (scholarships, grants, travel funds, research funding, and competitive awards) provided by LSAMP programs and the rate of entrepreneurship. All of the alliances did offer financial support in their programs but the support provided did not target support toward entrepreneurial efforts. Financial support in this program does not create a connection to high

tech entrepreneurship. The experts' interviews also supported this finding, explaining that the many programs emphasize funding support to encourage students to pursue research.

A key characteristic of successful business start-ups and management is access to sufficient funding (Basu & Parker, 2001; Bates, Jackson, & Johnson, 2007). Funding, a form of financial capital, was not being allotted to business startup or entrepreneurial activities. Experts further acknowledged this and reported that funding provided to students was used to encourage research. This suggests programs are providing the financial capital and structural supports necessary; however, they are targeted to other areas or priorities of the 21<sup>st</sup> century workforce, not necessarily high tech entrepreneurship.

### **Phase 2b: STEM Program Participants Workforce Outcomes**

In Part B, LSAMP program alumni were selected for an in-depth analysis of one of the LSAMP alliances. The purpose of this phase was to explore if STEM program graduates engaged in entrepreneurship after completing a STEM degree and to collect individual level data, specifically of African Americans. The LSAMP program included the program elements of mentoring, role models, social networking, and financial support. This final hypothesis focused on the entrepreneurial outcomes of the graduates.

Hypothesis 3 states that African American graduates of STEM programs that pursue entrepreneurship will be associated with high tech entrepreneurship. The results show that of the 12 African American respondents, 4 reported business startups. Two (50%) of the 4 African American alumni entrepreneurs pursued high-tech entrepreneurship while 2 (50%) pursued non high tech entrepreneurship. This lends support to the association of African American graduates of STEM programs and high tech entrepreneurship, but it also shows that African American entrepreneurs with STEM degrees do not exclusively pursue high tech entrepreneurship. One of

the respondents who did not have a high tech business did report that the STEM program experience did influence their business startup, two of the others reported their business emerged from an idea from self or others and the last was influenced from previous work. It can be noted that entrepreneurship training and education is not a priority for the program that these respondents attended.

### **Implications of the Research**

Overall, STEM programs are contributing to the development of the 21<sup>st</sup> century workforce by providing education offerings in the areas of STEM to a population that has been identified as an untapped pool of talent needed to fill STEM jobs. The findings suggest an association between education provided by STEM programs and high-tech entrepreneurship, this is specifically true for African Americans. Education as human capital provides support for high tech entrepreneurship.

However, the STEM program elements related to social capital and social networking, mentoring, social networking, and role models – with one exclusion venture capitalist, did not provide support for the 21<sup>st</sup> century workforce, specifically the sub-workforce group high tech entrepreneurship. The programs current structure provided the important social networking among various groups, but lacked promotion and exposure to entrepreneurship. Social network theory suggests that social networks are quite important to entrepreneurs as they provide the relationships and environments necessary for business formation. The network relationship refers to the establishing and maintaining a connection between the entrepreneurs and their networks (Aldrich & Zimmer, 1986; Jaafar et al., 2009). Social capital theory focuses on investing in social relations to create value (Lin, 2008). This suggests creating ties to entrepreneurship in order to generate the desired outcome of entrepreneurship.

The STEM programs provided social capital and social networks attributes and created the networks and weak ties that are often associated with entrepreneurship, but the lack of connections and access to individuals in high tech entrepreneurship decreases the quality or strength of the weak ties. This is consistent with Granovetter (1983), which states social networks that are most associated with entrepreneurs are those that are classified as weak ties, where an exchange of information and resources can aid in business startups. Lin (2008) points out that weaker and bridging ties are a critical part of a social structure. The STEM programs provided social structures that allowed access to resources, but limited access to entrepreneurs and venture capitalist that form weak and bridging ties to entrepreneurship. Financial capital in the form of financial support through scholarships, grants, stipends, travel funds, and research dollars was also provided but the resources provided do not allow access to or support for high tech entrepreneurship. Financial capital is considered a necessary component for business startup and survival (Coleman, 2007); although the programs provided financial support the ability to use these funds to gain assets or reduce debt was not supported as the funds were used primarily for education advancement.

### **Limitations**

There are several limitations that must be considered when conducting research. Particularly given the fact that this research involved the collection of primary data of an exploratory nature, there were several limitations encountered. However, despite the limitations, the research still provides an important foundational step from which future studies can be developed.

First, collecting cross-sectional data at the level of the program administrator was a limitation as it results in data aggregated to an alliance of institutions rather than data directly

from representatives at each institution or from individual program participants. The use of cross-sectional data hinders the ability to make causal connections. However, given that this was a descriptive study and one of the first to explore the relationship between STEM programs and high tech entrepreneurship, detecting causality was not prioritized. However, this does limit the ability to make causal generalizations about the relationships between STEM programs and high tech entrepreneurship.

To overcome the above limitations, the original research design planned to incorporate individual level program data gathered from a FOIA request to supplement the program-level data. However, the FOIA request was denied by NSF based on their LSAMP program policy to not release information owned by LSAMP. To overcome this limitation, an additional survey was conducted of LSAMP program participants from one alliance. The need to create an additional survey was unanticipated at the onset of the research. The survey was generated to gain access to data regarding program participants' employment outcomes related to entrepreneurship. However, this still resulted in some limitations to the overall generalizability of the study as it relied upon survey data.

The reliance of survey and interview data was seen as a limitation as it can compromise results due to low survey response rates or interview participation rates. Furthermore, the universe of high tech African American entrepreneurs with a STEM degree is a smaller population. A low response rate to LSAMP surveys was a limitation as a small sample size impacted the ability to generate statistical solid evidence. In order to mitigate this concern, extensive follow-up steps were taken to recruit participants and the survey was offered to participants in a variety of format, via email or telephone. Using survey data also presents a limitation as the results can be subject to perception and bias from the participant.

The non-standardization of collecting data in the programs was a limitation that impacted the research design as it was discovered that institutions did not all collect the same data. Each LSAMP program develops its own specific program goals and demonstrates how these meet the broader goals of NSF. Institutions were allowed to determine their priority areas where they want to focus their efforts, so there are no mandates from the national office, which allows for program freedom to create programs that meet their institutional needs. Since each program forms its own goals, a required standard of tracking and reporting data does not exist, thus making it difficult to compare each program using the same criteria. All programs collect degree completion numbers and student demographic data, but most do not collect data beyond that to include post-graduate plans such as type of employment, the pursuit of graduate education, and self-employment unless it was the focus of that particular program. In creating the initial proposal for this study, gathering program data was the desired way to link the program elements to graduate and self-employment data. However, despite the limitations of survey and interview data, this was deemed as an appropriate method of data collection as there was no other data source available that asks these questions.

Another limitation that presented was the use of an anonymous survey. Although the desired outcome was to gain information about LSAMP programs without identifying specific programs, it posed a challenge when there was a desire to ask follow-up questions. For example, the responses from one of the surveys had a strong presence of entrepreneurial promoting activities in their LSAMP, it would have been informative to determine which program this was and ask more specifics about their program goals, self-employment numbers of their graduates, and common fields of interest.



The last limitation was one that did not initially present itself as a limitation. The LSAMP program survey had a response rate of 39%, which seemed appropriate for analysis. However, among these alliances, only three could be classified as producing high tech entrepreneurs. When initially obtaining information on LSAMP and consulting with the alliances, it was suggested that I only survey the alliance program administrators and not the individual programs, because the alliance program administrators are the ones who compile all data from the alliances and send annual reports to NSF, thus alliance program administrators had all alliance data. This compilation of information should have made it easier to complete the survey. Once the survey was complete and the data was finally prepared for analysis, this led to a restricted sample size, limiting the ability for more sophisticated statistical tests. Thus, Fisher's exact test was used for the analysis.

### **Implications for practice**

The human capital component of advanced education and degree completion was found to have an association with African American entrepreneurs, specifically the link between STEM education and high tech entrepreneurship. The knowledge gained provides empirical data to inform policymakers as well as program creators to continue to support current programs as well as add programs with goals of degree completion among URM in STEM, but to also add an emphasis on employment goals, which can be implemented through curriculum additions and employment preparation.

The LSAMP programs, as a whole, do not provide entrepreneurial opportunities to program participants but the few programs that did have an emphasis on entrepreneurship reported greater than 25% and in some instances as high as 75% of their students pursuing entrepreneurship. The reporting from these specific programs is enough to urge programs that are

not currently providing entrepreneurial opportunities to begin to incorporate these opportunities through social capital and social networking with entrepreneurs and human capital through business training and preparation for entrepreneurial competitions, opportunities that were present in the high entrepreneurship programs. In the low entrepreneurship programs social capital and social networking provided the access to networks and weak ties, but the connections were not made with entrepreneurs and venture capitalist and the bridges didn't link to the sub sector of the workforce, high tech entrepreneurship.

The focus on entrepreneurship is important because of its contribution to the workforce through business and economic growth (Audretsch, Keilbach, & Lehmann, 2006; Blume-Kohout, 2014). Entrepreneurship, specifically in high technology areas, contributes to the overall advancement of technology in the workforce (Braguinsky et al., 2012). The emphasis on minority entrepreneurship in this study, specifically African American entrepreneurship, is due to the underrepresentation of African Americans in STEM and in high tech entrepreneurship. A concern is that disparities continue despite the increased resources, programming, and promotion of STEM education and training being allocated for this population.

Although this study did not fully support social network theory, the importance of this theory to the support of entrepreneurship remains. The programs did provide social capital and social networking opportunities that gave participants access to various resources; one way to introduce entrepreneurship is to modify the program by extending the current networks to include entrepreneurs, those who promote entrepreneurship, venture capitalists, and financial institutions.

The social capital opportunities of networking, mentoring, and role models made available by the STEM support programs provided access and resources to support students

pursuing STEM. These programs have used these various forms of social capital to promote STEM education. Although these opportunities are through weak ties, it goes beyond just the ties and looks at the nature of the content of the ties, which is the successful completion of STEM education.

### **Future Research and Recommendations**

For future research, a larger sample including more programs that produce and promote entrepreneurship would provide more information to explore the relationship between entrepreneurship and social networking in these LSAMP programs. A suggestion would be to focus on STEM programs at historically black colleges and universities (HBCU) to ensure a larger sample with the target population of African Americans. The research could be more narrowly focused on HBCUs that have specific STEM programs such as engineering programs, a degree that has a high link to entrepreneurship.

This study brings to light the need for a longitudinal analysis to track not only the graduation rates of URM who complete STEM degrees but also their post-graduation employment. This information can better help programs to determine if they have met their broad program goals of increasing the diversity of the STEM workforce. Some of the programs surveyed had an entrepreneurial component, for future research a focus can be on just those programs to determine the specific program elements, curriculum focus, business training, and employment goals of the program graduates. As a result of the study one recommendation for STEM-support programs is to follow in the path of some programs, which have begun to prepare students for business by consistently providing internships with companies.

In addition to these changes all programs need to consider diversifying their training to meet market place demands as well as global demands. The training can come in many forms;

some can consider introducing entrepreneurship in the curriculum, partnering with local business to bring in professionals to provide training, or consider educational partnerships like those of medical schools and business schools who now jointly grant MD/MBA degrees.

Another recommendation for next steps is to build on the successes of the STEM-support programs and to make slight modifications that can help them be more intentional about meeting the goals of diversifying the STEM workforce and to encourage and support qualified minority STEM graduates to pursue all aspects of employment in industries, academia, as researchers, and even entrepreneurs. This can be accomplished by coordinating efforts of STEM-support programs to establishing a tracking system for graduates.

Presently available data on entrepreneurs includes industry type and level of education, but researchers are now beginning to see the need to include type of education along with owner characteristics. High tech industries require education and technical skills, so it is recommended that determining types of education associated with specific industries can be helpful as we continue to monitor future workforce needs.

Current programs with the goal of increasing the number of URM completing undergraduate and graduate degrees are having positive results and many URM are now gaining the education needed to become competitive in the workforce. The goal of many of these programs is to diversify the STEM workforce, but now that these programs have been successful in increasing the numbers, they must now begin to expand their preparation and consider cultivating more entrepreneurs (Clewell et al., 2006). Additional studies can be conducted to determine the return on investment (ROI) and national impact of these programs.

## **Conclusion**

This study seeks to better understand the relationship between STEM education, STEM programming, and minority entrepreneurship. This research provides a correlation between education in a STEM field and high-tech entrepreneurship, specifically among African Americans.

As a result of this research supportive data has been presented that can be used to support key policy and programs which can promote equal or improved access for aspiring African American high technology entrepreneurs. The findings can guide policies and programs that encourage and support entrepreneurship among African Americans in the areas of STEM. It also supports the continued efforts of educational programming that promotes STEM education to URM. This dissertation also highlights current programs and initiatives that promote entrepreneurship, thus encouraging researchers to look into the structure and outcomes of these programs and their effects on high tech STEM entrepreneurship.

Appendix A  
LSAMP Program Survey

Questions for STEM Program Administrators (distributed via Qualtrics, if necessary by phone)

1. What type of STEM program do you offer? (Check all that apply)
  - a. Pre-college
  - b. Summer
  - c. Undergraduate support
  - d. Graduate school prep
  - e. All of the above
  - f. Other
  
2. Are financial resources provided? (If yes, check all that apply)
  - a. Scholarships
  - b. Grants
  - c. Stipends
  - d. Travel funds
  - e. Research dollars
  - f. Competitive Awards
  - g. N/A
  - h. All of the above
  
3. Your program connects students with Venture Capitalists and/or Investors for financial support. (Circle one)  
Strongly Disagree      –      Strongly Agree
  
4. Students take advantage of financial resources offered. (Circle one)  
Strongly Disagree      –      Strongly Agree
  
5. Does your LSAMP program (s) provide mentoring?  
Yes or No
  
6. Does your LSAMP program(s) provide structured mentoring?  
(Structured mentoring - students are assigned mentors and are required to meet)  
Yes or No
  
7. Students take advantage of program opportunities such as mentoring. (Circle one)  
Strongly Disagree      –      Strongly Agree

8. Does your program provide exposure to STEM careers/STEM Professions? (If yes, check all that apply)
- a. Internships
  - b. Research opportunities/STEM projects
  - c. Visits with industry professionals
  - d. Student travel/opportunities to present
  - e. All of the above
  - f. Other (please describe)

9. Does your program provide access to any of the following role models in STEM fields? (If yes, check all that apply)
- a. Faculty
  - b. Staff
  - c. Industry Professionals
  - d. Graduate Students
  - e. Venture Capitalists and/or Investors
  - f. All of the above
  - g. Other (please describe)

10. Students are provided access to role models. (Circle one)
- Strongly Disagree      –      Strongly Agree

11. Students take advantage of program opportunities such as role models. (Circle one)
- Strongly Disagree      –      Strongly Agree

12. Does your program provide opportunities for networking? (If yes, check all that apply)
- a. with student peers
  - b. with faculty and staff
  - c. with graduate students
  - d. with industry professionals
  - e. with entrepreneurs
  - f. with venture capitalists
  - g. with banks, credit unions or other financial institutions
  - h. Other (please describe)

13. Your program provides social networking opportunities for students (among cohorts, faculty, industry professionals, and capital providers)? (Circle one)
- Strongly Disagree      –      Strongly Agree



14. Students take advantage of program opportunities such as social networking. (Circle one)  
Strongly Disagree – Strongly Agree

15. Does your program provide access to business education/training? Yes/No  
(Ex: foundations in business, management, marketing, leadership, decision making)

16. Does your program support students to participate in entrepreneurial challenges or competitions? (Check all that apply)

- a. Financial resources
- b. Mentoring
- c. Faculty advisors
- d. Other (please describe)

17. Are students required to participate in entrepreneurial challenges or competitions prior to graduation? Yes/No

18. Annually, on average, about how many of your students participate in an entrepreneurial challenges or competitions?

19. Your program makes a significant effort to promote entrepreneurship among students.  
(Circle one)

Strongly Disagree – Strongly Agree

20. What percentage of your students pursue post graduate education upon graduation? (2012 – 2014)

0 - 25%      26 – 50%      51 – 57%      76 – 100%

21. What percentage of your graduates are employed after graduation? (2012 – 2014)

0 - 25%      26 – 50%      51 – 57%      76 – 100%

22. What percentage of your graduates go into high tech fields? (2012 – 2014)

0 - 25%      26 – 50%      51 – 57%      76 – 100%

23. How long has your program been in existence?

<1 years      1 – 5 years      6 – 10 years      11 - 20 years      21 - 25

24. What percentage of your graduates are self-employed after graduation? (2012 – 2014)

25. What is your institution type? (Check all that apply)

- a. Public
- b. Private
- c. Community College
- d. Technical College
- e. Historically Black College University (HBCU)
- f. Hispanic Serving Institution
- g. Other (please describe)

26. What is your student enrollment in your program?

1 – 75      76 – 150      151 – 225      226 – 300      >301

27. What is your student enrollment in your alliance?

0 – 5000, 5001 – 10000, 10001 – 15000, 15001 – 20000, 20001 – 25000, 25001 – 30000,  
30001 – 35000      >35001

28. What types of STEM degrees are awarded? (Check all that apply)

- a. Biology
- b. Chemistry
- c. Computer Science
- d. Engineering
- e. Geology
- f. Mathematics
- g. Nutritional Sciences
- h. Physics
- i. Psychology
- j. Other (please describe)

\*the questions were slightly modified to fit the electronic mode of delivery

Appendix B  
LSAMP Alliance Sample

LSAMP Alliance Sample

Name of Alliance	State Represented
Alaska Alliance-Alaska Native Science and Engineering Program (ANSEP)	Alaska
All Nations LSAMP	Montana
Arkansas LSAMP (ARK-LSAMP)	Arkansas
California LSAMP (CAMP)	Southern California
California State University LSAMP (CSU-LSAMP)	Northern California
Colorado LSAMP (CO-AMP)	Colorado
Florida-Georgia LSAMP (FGLSAMP)	Florida-Georgia
Garden State LSAMP	New Jersey
Georgia-Alabama LSAMP (GALSAMP)	Georgia-Alabama
Greater Philadelphia LSAMP	Pennsylvania
Houston LSAMP (H-LSAMP)	Texas
IINSPIRE	Iowa
Illinois LSAMP (ILSAMP)	Illinois
Indiana LSAMP	Indiana
Island of Opportunity Alliance	Hawaii
Kansas LSAMP	Kansas
Louisiana LSAMP (LS-LAMP)	Louisiana
Michigan LSAMP (MI-LSAMP)	Michigan
Mississippi LSAMP	Mississippi
New Mexico Alliance for Minority Participation	New Mexico
New York City LSAMP (NYC_LSAMP)	New York
North Carolina LSAMP (NC-LSAMP)	North Carolina
North Star STEM Alliance	Minnesota
Northeast LSAMP (NE-LSAMP)	Massachusetts
Ohio LSAMP Alliance	Ohio
Oklahoma LSAMP (OK-LSAMP)	Oklahoma
Pacific Northwest LSAMP	Washington
Peach State LSAMP	Georgia
Puerto Rico (PR-LSAMP)	Puerto Rico
South Carolina LSAMP	South Carolina
State University of New York (SUNY) LSAMP	New York
Tennessee LSAMP (TLSAMP)	Tennessee
Texas A&M University System LSAMP (TAMUS LSAMP)	Texas
University of Texas System (UTLSAMP)	Texas
University System of Maryland LSAMP	Maryland
Upstate LSAMP	New York
Urban Massachusetts LSAMP (UMLSAMP)	Massachusetts

Virginia-North Carolina LSAMP	Virginia-North Carolina
Washington/Baltimore/Hampton Roads LSAMP	Washington DC
Wisconsin LSAMP (WiscAMP)	Wisconsin
Alabama LSAMP	Alabama
Central Florida STEM Alliance	Florida
CIMA Alliance	Texas
North Carolina STEM Alliance	North Carolina
Northern New Jersey Bridges to the Baccalaureate	New Jersey
Kentucky-West Virginia LSAMP	Kentucky-West Virginia
Western Alliance to Expand Student Opportunities LSAMP (WAESO)	Arizona

Appendix C  
Alliances for Success 2010 - 2011

Alliances for Success 2010-2011

Institution Name	State abbreviation
Arizona State University-Tempe	AZ
California State University-Sacramento	CA
Chicago State University	IL
Clark Atlanta University	GA
Colorado State University-Fort Collins	CO
CUNY City College	NY
Drexel University	PA
Florida Agricultural and Mechanical University	FL
Howard University	DC
Inter American University of Puerto Rico-Central Office	PR
Jackson State University	MS
New Mexico State University-Dona Ana	NM
North Carolina A & T State University	NC
Oklahoma State University-Main Campus	OK
Purdue University-Main Campus	IN
Rutgers University-Newark	NJ
Salish Kootenai College	MT
South Carolina State University	SC
Southern University and A & M College	LA
Stony Brook University	NY
Syracuse University	NY
Tennessee State University	TN
Texas A & M University-College Station	TX
The University of Texas at El Paso	TX
University of Alabama at Birmingham	AL

University of Alaska Anchorage	AK
University of Arkansas at Pine Bluff	AR
University of California-Irvine	CA
University of Georgia	GA
University of Hawaii at Hilo	HI
University of Houston	TX
University of Kentucky	KY
University of Maryland Baltimore	MD
University of Massachusetts-Amherst	MA
University of Massachusetts-Boston	MA
University of Michigan-Ann Arbor	MI
University of Minnesota-Twin Cities	MN
University of Virginia-Main Campus	VA
University of Washington-Seattle Campus	WA
University of Wisconsin Colleges	WI



Appendix D  
LSAMP Alumni Survey

## LSAMP Alumni Survey

You are being asked to participate in an alumni survey for LSAMP participants to determine post-graduation activity. In order to participate you must be 18 years or older. Your participation is voluntary. Refusal to participate or discontinuing your participation at any time will involve no penalty or loss of benefits to which you are otherwise entitled. The survey will take about 10 minutes to complete. Your responses will remain anonymous. Do not leave the survey open if using a public computer or a computer others may have access to. Clear your browser cache and page history after completing the survey. Data will be stored on the researchers' password-protected computers. If you have any questions or concerns about the study, please contact the researcher: Zoranna Jones, [zoranna.jones@mavs.uta.edu](mailto:zoranna.jones@mavs.uta.edu), 817-829-5252

Thank you for your time!

Do you consent to participate in this study?

- Yes
- No

Instructions: Please read each question carefully. You must provide an answer in order to move on to the next question. If you don't have a response to the question just type into the text box N/A or not applicable.

At what institution did you attend the Louis Stokes Alliances for Minority Participation (LSAMP) program?

What STEM discipline did you pursue?

Have you completed a degree?

- Yes
- No

What degree and discipline did you complete?

What is the last degree in school you completed? (Assoc. degree, Bachelor's degree, Master's degree, PhD)

What is your current occupation and profession?

How many years in that occupation?

Since college, have you taken actions to start a new business that you will own all or part of?

- Yes
- No

In what month and year did you first think about starting this new business?

How did this new business emerge?

- Current work activity
- Previous work activity
- Separate business now own and manage
- Hobby or Recreational Past time
- Academic, Scientific, or Applied Research
- Idea from self or other member of startup team
- STEM Program experience
- Other \_\_\_\_\_

Which of the following best describes this new business?

- Retail Store
- Restaurant, Tavern, Bar, or Nightclub
- Customer or Consumer Service
- Health, Education, or Social Services
- Manufacturing
- Construction
- Agriculture
- Mining
- Wholesale Distribution
- Transportation

- Utilities
- Communications
- Finance
- Insurance
- Real Estate
- Business Consulting or Service
- Something else

High-tech firms have science- and engineering-intensive occupations, and/or industry workforce that promote research and development. Per this definition is your business HIGH TECH?

- Yes
- No

What is your gender?

- Male
- Female

Are you Hispanic?

- Yes
- No

Which of the following best describes your race?

- Asian or Asian American
- Black or African American
- White or Caucasian
- Other

What is your age?

- 20 - 25
- 26 - 30
- 31 - 35
- 36 - 40
- >41

## References

- Adebayo, A. O., Adekoya, A. A., & Ayadi, O. F. (2001). Historically black colleges and universities (HBCUs) as agents of change for the development of minority businesses. *Journal of Black Studies*, 32(2), 166-183. doi:10.1177/002193470103200202
- Ahn, T. (2011). Racial differences in self-employment exits. *Small Business Economics*, 36(2), 169-186. doi:10.1007/s11187-009-9209-3
- Aldrich, H., & Zimmer, C. (1986). Entrepreneurship through social networks. In D. L. Sexton & R. W. Smilor (Eds.), *The art and science of entrepreneurship* (3-23). Cambridge, MA: Ballinger.
- Anderson, M. (2010). Encouraging entrepreneurship. *Diverse Issues in Higher Education*, 27(15), 8.
- Anderson, D. (2010). STEM Initiatives. Research Brief. *Principals' Partnership*.
- Audretsch, D. B. (1995). *Innovation and industry evolution*. MIT Press.
- Audretsch, D. B., Keilbach, M. C., & Lehmann, E. E. (2006). *Entrepreneurship and economic growth*. Oxford University Press.
- Barlow, A. E. L., & Villarejo, M. (2004). Making a difference for minorities: Evaluation of an educational enrichment program. *Journal of Research in Science Teaching*, 41(9), 861-881. doi:10.1002/tea 20029

- Basu, A., & Parker, S. C. (2001). Family finance and new business Start-ups. *Oxford Bulletin of Economics and Statistics*, 63(3), 333-358. doi:10.1111/1468-0084.00224
- Bates, T. (1995). Self-employment entry across industry groups. *Journal of Business Venturing*, 10(2), 143-156. doi:10.1016/0883-9026(94)00018-P
- Bates, T., & Bradford, W. (2009). The impact of institutional sources of capital upon the minority-oriented venture capital industry. *Small Business Economics*, 33(4), 485-496. doi:10.1007/s11187-009-9200-z
- Bates, T., Jackson, W. E., & Johnson, J. H. (2007). Introduction: Advancing research on minority entrepreneurship. *The Annals of the American Academy of Political and Social Science*, 613(1), 10-17. doi:10.1177/0042098014534903
- Bates, T. & Robb, A. (2015). Has the community reinvestment act increased loan availability among small businesses operating in minority neighbourhoods? *Urban Studies*, 52(9), 1702-1721. doi:10.1177/0042098014534903
- Berger, A., & Udell, G. (1998). The economics of small business finance: The roles of private equity and debt markets in the financial growth cycle. *Journal of Banking and Finance*, 22(6), 613-673. doi:10.1016/S0378-4266(98)00038-7
- Bhide, A. (2000). *The origin and evolution of new businesses*. Oxford: University Press.

- Blanchflower, D. G., Levine, P. B., & Zimmerman, D. J. (2003). Discrimination in the small-business credit market. *The Review of Economics and Statistics*, 85(4), 930-943.  
doi:10.1162/003465303772815835
- Blume-Kohout, M. (2014). Understanding the gender gap in STEM fields entrepreneurship. *US Small Business Administration Office of Advocacy Report*, (424).
- Bogan, V. & Darity Jr., W. (2008) Culture and entrepreneurship? African American and immigrant self-employment in the United States. *The Journal of Socio-Economics*, 37, 1999-2019. doi:10.1016/j.socec.2007.10.010
- Boston, T. D., & Boston, L. R. (2007). Secrets of gazelles: The differences between high-growth and low-growth business owned by African American entrepreneurs. *The Annals of the American Academy of Political and Social Science*, 613(1), 108-130.  
doi:10.1177/002716207303581
- Braguinsky, S., Klepper, S., & Ohyama, A. (2012). High-Tech Entrepreneurship. *The Journal of Law & Economics*, 55(4), 869-900. doi:10.1086/666488
- Breiner, J. M., Harkness, S. S., Johnson, C. C., & Koehler, C. M. (2012). What is STEM? A discussion about conceptions of STEM in education and partnerships. *School Science and Mathematics*, 112(1), 3-11. doi:10.1111/j.1949-8594.2011.00109.x
- Brooks, A. K., & Clunis, T. (2007). Where to now? Race and ethnicity in workplace learning and development research: 1980–2005. *Human Resource Development Quarterly*, 18(2), 229-251. doi:10.1002/hrdq.1201

- Buunk, A. P., Peiró, J. M., & Griffioen, C. (2007). A positive role model may stimulate career-oriented behavior. *Journal of Applied Social Psychology, 37*(7), 1489-1500. doi: 10.1111/j.1559-1816.2007.00223.x
- Casey, C. (2014). Critical connections: The importance of community-based organizations and social capital to credit access or low-wealth entrepreneurs. *Urban Affairs Review 50*(3), 366-390. doi:10.1177/1078087413508915
- Casey, C. (2012). Low-wealth minority enterprises and access to financial resources for start-up activities: Do connections matter? *Economic Development Quarterly, 26*(3), 252-266. doi:10.1177/0891242412452446
- Campbell, P. B., Jolly, E., Hoey, L., & Perlman, L. K. (2002). Upping the numbers: Using research-based decision making to increase diversity in the quantitative disciplines. Commissioned by the GE Fund, January 2002. Available at <http://www.ge.com/foundation/GEFund>
- Chapman, D. W. (1981). A mode of student college choice. *The Journal of Higher Education, 52*(5), 490-505. doi:10.2307/1981837
- Chubin, D. E., May, G. S., & Babco, E. L. (2005). Diversifying the engineering workforce. *Journal of Engineering Education, 94*(1), 73-86. doi:10.1002/j.2168-9830.2005.tb.00830.x



- Clewell, B. C, Cosentino de Cohen, C, Tsui, L., and Deterding, N. (2006). *Revitalizing the nation's talent pool in STEM: Science, technology, engineering and math*. Washington, DC: The Urban Institute. doi:10.1037/e723012011-001
- Coleman, M. G. (2004). Racial discrimination in the workplace: Does market structure make a difference? *Industrial Relations*, 43(3), 660-689. doi:10.1111/j.0019-8676.2004.00354.x
- Coleman, J. S. (1988). Social capital in the creation of human capital. *American journal of sociology*, S95-S120. doi:10.1086/228943
- Coleman, S. (2007). The role of human and financial capital in the profitability and growth of Women-Owned small firms. *Journal of Small Business Management*, 45(3), 303-319. doi:10.1111/j.1540-627X.2007.00214.x
- Connelly, L. M. (2016). Fisher's exact test. *Medsurg Nursing: Official Journal of the Academy of Medical-Surgical Nurses*, 25(1), 58, 61.
- Cook, L. D., & Kongcharoen, C. (2010). *The idea gap in pink and black* (No. w16331). National Bureau of Economic Research. doi:10.3386/w16331
- Cooper, A. C., Gimeno-Gascon, F. J., & Woo, C. Y. (1994). Initial human and financial capital as predictors of new venture performance. *Journal of Business Venturing*, 9(5), 371-395. doi:10.1016/0883-9026(94)90013-2

- Craig, B. R., Jackson, W. E., & Thomson, J. B. (2007). Small firm credit market discrimination, small business administration guaranteed lending, and local market economic performance. *The Annals of the American Academy of Political and Social Science* 613(1), 73-94. doi:10.1177/0002716207303579
- Crisp, G., Nora, A. & Taggart, A. (2009) Student characteristics, pre-college, college, and environmental factors as predictors of majoring in and earning a STEM degree: An analysis of students attending a hispanic serving institution. *American Educational Research Journal*, 46(4), 924-942. doi:10.3102/0002831209349460
- De Meza, D. (2002), Overlending?. *The Economic Journal*, 112: F17–F31.  
doi: 10.1111/1468-0297.00681
- De Meza, D., & Southey, C. (1996). The borrower's curse: Optimism, finance and entrepreneurship. *The Economic Journal*, 106(435), 375-386. Retrieved from <http://www.jstor.org.ezproxy.uta.edu/stable/2235253>
- Djankov, S., Qian, Y., Roland, G., & Zhuravskaya, E. (2008). What makes an entrepreneur? *International Differences in Entrepreneurship*. doi:10.1007/978-1-4614-7227-8\_4
- Fairlie, R. W. (1999). The absence of the African-American owned business: An analysis of the dynamics of self-employment. *Journal of Labor Economics*, 17(1), 80-108.

Fairlie, R. W., & Robb, A. M. (2007). Why are Black-owned businesses less successful than white-owned businesses? The role of families, inheritances, and business human capital.

*Journal of Labor Economics*, 25(2), 289-323.

Fairlie, R. W., & Robb, A. M. (2010). *Race and entrepreneurial success*. MIT Press.

Farhat, J. B., & Robb, A. (2013). Analyzing the 2004-2011 KFS Multiply Imputed Data.

Fields, C. D. (1998). Black scientists: A history of exclusion. *Diverse Issues in Higher*

*Education*, 15(3), 12.

Fine, M. G. (1996). Cultural diversity in the workplace: The state of the field. *Journal of*

*Business Communication*, 33(4), 485-502. doi:10.1177/002194369603300408

Flint, T. A. (1992). Parental and planning influences on the formation of student college choice

sets. *Research in Higher Education*, 33(6), 689-708. doi:10.1007/bf00992054

Freeman, K. (1999). No services needed? The case for mentoring high-achieving African

American students. *Peabody Journal of Education*, 74(2), 15-26. doi

10.1207/s15327930pje.7402\_3

George, Y. S., Neale, D. S., Van Horne, V., & Malcolm, S. M. (2001). In pursuit of a diverse

science, technology, engineering, and mathematics workforce. Retrieved from American

Association for the Advancement of Science website:

[http://ehrweb.aaas.org/mge/Reports/Report1/AGEP/AGEP\\_report.pdf](http://ehrweb.aaas.org/mge/Reports/Report1/AGEP/AGEP_report.pdf).

- Glass, G. V., & Hopkins, K. D. (1996). *Statistical methods in psychology and education*. Allyn & Bacon, Needham Heights, MA.
- Ginorio, A. B., & Grignon, J. (2000). The transition to and from high school of ethnic minority students. *Access denied: Race, ethnicity, and the scientific enterprise*, 151-173.
- Granovetter, M. S. (1983). The strength of weak ties. *American Journal of Sociology*, 78(6), 1360-1380. doi:10.1086/225469
- Greve, A., & Salaff, J. W. (2003). Social networks and entrepreneurship. *Entrepreneurship Theory and Practice*, 28(1), 1-22. doi:10.1111/1540-8520.00029
- Griffith, A. L. (2010). Persistence of women and minorities in STEM field majors: Is it the school that matters? *Economics of Education Review*, 29(6), 911-922. doi: 10.1016/j.e.conedurev.2010.06.010
- Herman, A. M. (1999). *Futurework: Trends and challenges for work in the 21st century*. US Department of Labor.
- Hisrich, R. D. (1990). Entrepreneurship/intrapreneurship. *American Psychologist*, 45(2), 209-222. doi:10.1037/0003-066x.45.2.209
- Hisrich, R. D., & Brush, C. (1986). Characteristics of the minority entrepreneur. *Journal of Small business management*, 24, 1.

Hoffmann, A., Junge, M., & Malchow-Møller, N. (2015). Running in the family: Parental role models in entrepreneurship. *Small Business Economics*, 44(1), 79-104. doi:

10.1007/s11187-014-9586-0

Ibarra, H. (1993). Personal networks of women and minorities in management: A conceptual framework. *The Academy of Management Review*, 18(1), 56-87. doi:

10.5465/amr.1993.3997507

Jaafar, M., Abdul-Aziz, A. R., & Sahari, M. H. (2009). The use of social network theory on entrepreneur's linkages development. *Theoretical and Empirical Researches in Urban Management*, 4(1S), 101-119.

Kadushin, C. (2004). *Introduction to social network theory*. Boston, MA.

Karoly, L. A., & Panis, C. W. (2004). The 21st century at work: Forces shaping the future workforce and workplace in the United States. Rand Corporation. doi:

10.1037/e527212012-001

Koellinger, P., & Minniti, M. (2006). Not for lack of trying: American entrepreneurship in black and white. *Small Business Economics*, 27(1), 59-79. doi:10.1007/s11187-006-0019-6

Langdon, D., McKittrick, G., Beede, D., Khan, B., & Doms, M. (2011). STEM: Good Jobs Now and for the Future. ESA Issue Brief# 03-11. *US Department of Commerce*.

Lee, W. Y. (1999). Striving toward effective retention: The effect of race on mentoring african american students. *Peabody Journal of Education*, 74(2), 27-43.

doi:10.1207/s15327930pje7402\_4

Lin, N. (1999). Building a network theory of social capital. *Connections*, 22(1), 28-51.

Lin, N. (2008). A network theory of social capital. *The handbook of social capital*, 50, 69.

Louis Stokes Alliances for Minority Participation (LSAMP) Program (2003). US National Science Foundation (NSF) and Purdue University Discovery Park. Retrieved from

<http://www.nsf.gov/pubs/2003/nsf03520/nsf03520.htm> Retrieved from

<http://www.purdue.edu/discoverypark/lamp/about/overview.php>

Lumpkin, G. T., Steier, L., & Wright, M. (2011). Strategic entrepreneurship in family business.

*Strategic Entrepreneurship Journal*, 5(4), 285-306. doi:10.1002/sej.122

Marlow, S., & Patton, D. (2005). All credit to men? Entrepreneurship, finance, and gender.

*Entrepreneurship: Theory & Practice*, 29(6), 717-735. Doi: 10.1111/j.1540-

6520.2005.00105.x

Maton, K. I., & Hrabowski, F. A. (2004). Increasing the number of african american PhDs in the sciences and engineering: A strengths-based approach. *American Psychologist*, 59(6),

547-556. doi:10.1037/0003-066x.59.6.547

- Maton, K. I., Pollard, S. A., McDougall Weise, T. V., & Hrabowski, F. A. (2012). Meyerhoff scholars program: A strengths-based, institution-wide approach to increasing diversity in science, technology, engineering, and mathematics. *Mount Sinai Journal of Medicine: A Journal of Translational and Personalized Medicine*, 79(5), 610-623. doi:10.1002/msj.21341
- McClelland, D. (1961). *The Achieving Society*, Princeton, NJ: D. Van Nostrand. doi:10.1037/14359-000
- McDonald, J.H. (2014). Fisher's exact test of independence. *Handbook of Biological Statistics (3rd ed.)*. Baltimore, MD: Sparky House Publishing, 77-85.
- Melguizo, T., & Wolniak, G. C. (2012). The earnings benefits of majoring in STEM fields among high achieving minority students. *Research in Higher Education*, 53(4), 383-405. doi:10.1007/s11162-011-9238-z
- Merolla, D. M., & Serpe, R. T. (2013). STEM enrichment programs and graduate school matriculation: The role of science identity salience. *Social Psychology of Education: An International Journal*, 16(4), 575-597. doi:10.1007/s11218-013-9233-7
- Mertz, N. (2004). What's a mentor, anyway? *Educational Administration Quarterly*, 40(3), 541-560. doi:10.1177/0013161x04267110
- Nair, K. R.G, & Pandey, A. (2006). Characteristics of entrepreneurs: An empirical analysis. *The Journal of Entrepreneurship*, 15(1), 47-61. doi:10.1177/097135570501500104
- National Science Board (US). (2015). Revisiting the STEM workforce: a companion to Science and Engineering Indicators 2014.

- Ozgen, E., & Baron, R. A. (2007). Social sources of information in opportunity recognition: Effects of mentors, industry networks, and professional forums. *Journal of business venturing*, 22(2), 174-192. doi:10.1016/j.jbusvent.2005.12.001
- Pantazis, C. (2002). Maximizing e-learning to train the 21st century workforce. *Public Personnel Management*, 31(1), 21-26.
- Parker, M., & Welch, E. W. (2013). Professional networks, science ability, and gender determinants of three types of leadership in academic science and engineering. *The Leadership Quarterly*, 24(2), 332-348. doi:10.1016/j.leaqua.2013.01.001
- Peri, G., Shih, K., & Sparber, C. (2015). STEM workers, H-1B visas, and productivity in US cities. *Journal of Labor Economics*, 33(S1 Part 2), S225-S255.
- Quinones, M. A., Ford, J. K., & Teachout, M. S. (1995). The relationship between work experience and job performance: A conceptual and meta-analytic review. *Personnel Psychology*, 48(4), 887-910. doi:10.1111/j.1744-6570.1995.tb01785.x
- Reich, E. S. (2011). Scientists, meet capitalists. *Nature*, 480, 15. doi:10.1038/480015a
- Robinson, P. B., & Sexton, E. A. (1994). The effect of education and experience on self-employment success. *Journal of Business Venturing*, 9(2), 141-156. doi:10.1016/0883-9026(94)90006-X



- Simpson, M., Tuck, N., & Bellamy, S. (2004). Small business success factors: The role of education and training. *Education + Training, 46*(8/9), 481-491.  
doi:10.1108/00400910410569605
- Smith, D. T. (2005). Developing entrepreneurship among african americans: The effects of urban residence. *Race, Gender & Class, 12*(1), 152-168.
- Stake, J. E., & Mares, K. R. (2001). Science enrichment programs for gifted high school girls and boys: Predictors of program impact on science confidence and motivation. *Journal of Research in Science Teaching, 38*(10), 1065-1088. doi:10.1002/tea.10001
- Staniewski, M. W., Szopiński, T., & Awruk, K. (2016). Setting up a business and funding sources. *Journal of Business Research, 69*(6), 2108-2112.  
doi:10.1016/j.jbusres.2015.12.016
- Toossi, M. (2012). Labor force projections to 2020: a more slowly growing workforce. *Monthly Lab. Rev., 135*, 43.
- Tsui, L. (2007). Effective strategies to increase diversity in STEM fields: A review of the research literature. *The Journal of Negro Education, 555-581*.
- Turner, D. W. (2010). Qualitative Interview Design: A Practical Guide for Novice Investigators. *The Qualitative Report, 15*(3), 754-760. Retrieved from  
<http://nsuworks.nova.edu/tqr/vol15/iss3/19>
- U.S. Census Bureau. (2010). State & county Quickfacts: Allegany County, N.Y. Retrieved From <http://quickfacts.census.gov/qfd/states/00000.html>.

US 21st Century Workforce Commission. (2000). A nation of opportunity: Building America's 21st century workforce.

Verheul, I., Praag, v., M., Hessels, J., Bosma, N., & Schutjens, V. (2012). Entrepreneurship and role models. *Journal of Economic Psychology*, 33(2), 410-424. doi: 10.1016/j.joep.2011.03.004

Ware, J., & Stein, S. (2013). From "mentor" to "role model": Scaling the involvement of STEM professionals through role model videos. *Journal of Educational Multimedia and Hypermedia*, 22(2), 209.

Wilbanks, J. E. (2013). Mentoring and entrepreneurship: Examining the potential for entrepreneurship education and for aspiring new entrepreneurs. *Journal of Small Business Strategy*, 23(1), 93.

Windsor, A., Russomanno, D., Bargagliotti, A., Best, R., Franceschetti, D., Haddock, J., & Ivey, S. (2015). Increasing retention in STEM: Results from a STEM talent expansion program at the university of memphis. *Journal of STEM Education: Innovations and Research*, 16(2), 11-19.

Xu, Y. J., & Martin, C. L. (2011). Gender differences in STEM disciplines: From the aspects of informal professional networking and faculty career development. *Gender Issues*, 28(3), 134-154. doi: 10.1007/s12147-011-9104-5

Zimmer, C. (1986). Entrepreneurship through social networks. *The Art and Science of Entrepreneurship*. Cambridge, MA: Ballinger, 3-23.

## Biographical Information

Zoranna Jones received her PhD from the College of Architecture, Planning, and Public Affairs (CAPPA) in Public and Urban Administration at the University of Texas, Arlington. She previously earned a Bachelor's of Science degree in Nursing and a Master's of Science in Communication and Human Relations from Texas Christian University in Fort Worth. During her time at UTA she received a National Science Foundation Dissertation Improvement Grant, was invited to attend and present at a two-part special presentation and workshop sponsored by the Ewing Marion Kauffman Foundation that had an emphasis on Minority Entrepreneurship, and became a 2016 Equity and Inclusion Fellowship Recipient from the Association for Public Policy Analysis & Management (APPAM), where she also presented. She also became a member of Pi Alpha Alpha and presented at the Urban Affairs Association (UAA) national conference with two of her classmates. Zoranna has a true desire of improving the lives of others, which was exhibited through her early work as a registered nurse in the hospital taking care of patients and in her current position in higher education providing academic support for nursing and health science students at Texas Christian University. Upon graduation, Zoranna plans to continue her career in higher education.