Student growth oriented and academic mindsets, a mixed methods descriptive case study of Washington State MESA high school students

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ABSTRACT

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Pre-college programs have broadly focused on college access, with some addressing specific disciplines such as those in Science, Technology, Engineering and Math [STEM]. For more than 40 years, STEM pre-college programs like the Mathematics, Engineering, Science Achievement [MESA] Program have worked to diversify the pool of students who are prepared to enroll in postsecondary education, persist in a STEM major, graduate from college, and enter the STEM workforce. The literature supports the MESA approach that focuses on exposure and preparation through a holistic, longitudinal model.

The development of programs like MESA are in response to the looming challenge of filling industry positions in the United States [U.S.], changing population demographics, U.S. competitiveness in the global market, and a drastic shift in the U.S. economy. Individuals who

have typically entered STEM fields have been Caucasian males. With many of these males approaching retirement, there will be a significant number of vacant positions. There are two challenges in filling these positions. First, the fastest growing U.S. populations (Latino/Hispanic, African American, Native American and Pacific Islander), who by sheer numbers *should* be able to fill these positions have also been some of the most systematically marginalized in the American education system. Second, females are more than half of the college enrollment population but are not accessing STEM disciplines in proportion to their numbers in the overall college enrollment population. There are several reasons to explain why minority and female students do not persist through the education pipeline and into STEM disciplines and careers. Challenges include academic under-preparedness, financial barriers, fewer opportunities for experiential learning, stereotype threat, diminished sense of belonging, lack of a science identity, poor self-esteem and low self-efficacy. Supportive environments (Bronfenbrenner, 1976, 1994, 2006; Seymour & Hewitt, 1997) that foster growth oriented and academic mindsets (Blackwell & Dweck, 2007; Good, Rattan & Dweck, 2012; Yeager & Dweck, 2012; Dweck, 2016; Farrington et al., 2012) are key to increased academic performance, strengthening of science identity (Carlone and Johnson, 2007) and ultimately the retention and persistence of minorities and females in their pursuit of STEM disciplines and or careers.

For this dissertation, the primary focus centered on student growth oriented and academic mindsets. Carol Dweck defines a growth mindset as, "the belief that your basic qualities are things you can cultivate through your efforts, your strategies, and help from others. Although people may differ in every which way-in their initial talents and aptitudes, interests, or temperaments-everyone can change and grow through application and experience" (Dweck, 2016 p. 7). Academic Mindsets are defined as the, "beliefs, attitudes, or ways of perceiving

oneself in relation to learning and intellectual work that support[s] academic performance" (Farrington et al., 2012, p. 28). This mixed methods descriptive case study examined Seattle MESA and the five high schools that make up the program (there are six Washington State MESA [WSM] K-12 Programs: Seattle, Tacoma/South Puget Sound, Spokane, First Nations, Yakima/Tri-Cities, Southwest Washington). The dissertation drew on the work of Carol Dweck (Blackwell & Dweck, 2007; Good, Rattan & Dweck, 2012; Yeager & Dweck, 2012; Dweck, 2016), and on a model developed by Farrington et al. (2012). The Farrington et al. model (2012) guided the conceptualizations of the factors that have the potential to increase persistence and retention of minority and female students in the STEM pipeline. Farrington et al. acknowledges that the work of Dweck served as one of a select number of foundational theories for their construct of academic mindset, including works by Dweck (1986) and Dweck and Leggett, (1988). Finally, Bronfenbrenner's theory of Ecological Human Development (1976, 1994, 2006) provided context for the role of the environment on student outcomes. Drawing from a student survey, student focus groups and individual semi-structured interviews as research methods, this dissertation addressees the following questions:

1) How do high school minority and female students participating in the Seattle MESA program describe their growth oriented and academic mindset?
2) Are there gender differences in growth oriented and academic mindset as reported by students? If so, what types of differences exist?
3) In what ways does the Seattle MESA environment foster a growth oriented and academic mindset for students? What strategies are used, and what is the rationale provided for these strategies?

4) What are the implications of this inquiry for policies and practices used in implementing a MESA high school program?

Understanding how growth oriented and academic mindsets have the potential to influence the academic perseverance and ultimately performance of minority and female students in the Seattle MESA high school program can provide key information to practitioners, administrators and policy makers who desire to scale up and enhance best practice models in an intentional manner. Given the current STEM industry reality, there is an urgent need to find solutions that enhance the persistence and performance of minority and female populations through the STEM pipeline and into STEM careers.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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disrupters, and the promise of what a better future might look like. Dream big…don't let anyone dim your bright light…Go forward in your convictions and purpose!

DEDICATION

This dissertation is dedicated to those brave and courageous souls who have come before me and whose shoulders I stand on. I am because of you.

Chapter 1. **INTRODUCTION**

1.1 STATEMENT OF THE PROBLEM

While technological innovations have resulted in large financial gains and productivity, individuals who have typically entered fields associated with STEM have been Caucasian males. With many of these males approaching retirement, there will be a significant number of vacant positions. However, the fastest growing U.S. populations (Latino/Hispanic, African American, Native American and Pacific Islander), who by sheer numbers *should* be able to fill these positions have also been some of the most systematically marginalized regarding STEM disciplines and careers *(*The National Academies Office of News and Public Information, 2010; National Science Foundation [NSF], 2011*)*. Additionally, female participation in STEM disciplines is not always proportional to their representation in the college enrolled population (varies by subgroup) (NSF, 2011).

There are many reasons as to why minority and female students do not persist through the education pipeline and into STEM disciplines and careers. The national conversation pertaining to minority and female populations in STEM points to a number of factors that contribute to: a) students exiting the STEM pipeline in middle and high school, b) students deciding not to enter into competitive STEM disciplines, and c) students switching from STEM majors to non-STEM majors. Based on the literature, minorities and females are likely to exit the pipeline due to a number of factors including: a) lack of resources, learning/academic preparedness (Lundy-Wagner et al., 2014; Russell & Atwater, 2005; Cole & Espinoza, 2008), b) poor science identity/esteem (Carlone & Johnson, 2012; Allen-Ramdial. et al., 2014; Good et al., 2012;), and c) lack of social networks and community for support (Seymour & Hewitt, 1997; National

Academies of Sciences, National Academy of Engineering, Institute of Medicine, 2005; Byars-Winston, Estrada & Howard, 2008).

1.2 Lack Of Resources, Learning and Academic Preparedness

There are many inhibiting factors that are related to students' lack of preparation and exposure prior to entry into post-secondary institutions (Seymour & Hewitt, 1997). These factors include several variables relative to students' educational and family environments. Low resourced educational environments can include lack of access to school resources (e.g. text books, funding, lab materials), inexperienced teachers, retrograde curriculum, poor advisors, few career centers, and a non-college going culture (McDonough, 1997). Without proper advising on high school course selection, students may not acquire the foundational knowledge in math or science that is necessary to succeed at a post-secondary level. Family environment also influences students' predispositions prior to entry into post-secondary education (Aschbacher et al., 2009; Lundy-Wagner et al., 2014; Cabrera et al., 2006; Cooper et al., date unknown). For low-income families, there may be a lack of resources and few opportunities that are critical for success. Research has shown (McDonough, 1997; Dervarics, 2011; Aschbacher et al., 2009; Cabrera et al., 2006; Cooper et al., date unknown; Cole & Espinoza, 2008) that both family and educational environments affect the quality of preparation, student disposition, and self-efficacy in relation to post-secondary attainment and persistence. If the necessary supports are not present early in a students' educational experience, the chance of entry into post-secondary education and the opportunity to major in a competitive STEM discipline are greatly diminished.

1.3 SCIENCE IDENTITY AND ESTEEM

A poor science identity and low self-esteem have also been studied to help explain why minority and female students do not pursue or persist in STEM. Research has demonstrated that minorities and females at multiple stages along the STEM education continuum often: a) reported they felt isolated as the only female or minority in a class of white males or the climate was unwelcoming (Seymour & Hewitt, 1997; Cabrera et al., 2001 as cited in Byars-Winston et al., 2008), b) did not receive professionalization into the major via faculty mentorship (Carlone and Johnson, 2009), c) lack of hands-on science opportunities and preparation that left students feeling inadequate (Aschbacher et al., 2010; Russell & Atwater, 2005), and d) claimed they experienced the onset of imposter syndrome or were told they were not science material (Good et al., 2012; Aschbacher et al., 2010; Ramsey et al., 2013). Allen-Ramdial et al., (2014), talked about the impact isolation and lack of interaction with peers who have similar backgrounds can have a deleterious effect on students (referring to college students):

> "the sense of isolation diminishes self-efficacy and resurrects stereotype threat feelings that can have a negative impact on their scientific identity (Steele 1997). Identity and self-efficacy benefit from the presence of peers to whom trainees relate best and whose presence affirms their sense of belonging (Saha et al. 2013). Although non-URM [underrepresented minority] peers can serve as excellent mentors and role models for URM trainees, they alone are not sufficient to legitimize the early professional and social identities that are crucial to an early adjustment to a new training environment" (Allen-Ramdial, & Campbell, 2014, p. 616).

Students who participate in post-secondary education are introduced to the dominant institutional culture. This institutional culture, particularly in STEM environments, can both overtly and covertly impose its values, beliefs and attitudes regardless of student background. Female and minority students may feel out of place or inferior, and these feelings may result in stereotype threat (Steele et al., 1995). Stereotype threat in the context of Steele's work, is when a person internalizes a societal stereotype that in turn impacts their performance in a negative manner.

For women, stereotype threat may result from being the only female in a course of men and not being called on by a faculty member. This action is then equated in the mind to not being smart, which in turn may lead to further questioning about why the student is in the course. For a minority student, they may feel the only reason they were selected into an engineering program was because of race and not skill set. This negative self-perception may lead a student to question why they should continue with the program.

While any individual can experience stereotype threat, the triggers for a certain individual may differ depending on negative societal messages that are affiliated with a group(s) the individual may be a part of. The transfer, interface or exposure of one culture onto another can manifest in challenging experiences if students are not fully prepared to navigate this new set of expectations. Multiple forms of capital are cited in the literature as having the potential to create positive or negative experiences for students in academic settings (including STEM). Several prominent researchers (Bourdieu,1977; Pascarella et al., 2004 as cited in Cole & Espinoza, 2008; and McDonough and Calderone, 2006) speak specifically to educational systems. Bourdieu believed education systems reflect the dominant culture and for individuals to be successful they would need the cultural competence that would be learned and modeled in the family home environment. Therefore, if a minority and/or female student had parents who did not graduate high school or were not employed in a STEM career, these individuals would be at a deficit. On the other hand, some students would have an advantage if they possessed the necessary cultural capital to help them navigate their educational and STEM journey. The term cultural incongruence is also used to refer to the misalignment students will encounter based on cultural capital. An example of cultural incongruence might include low socioeconomic students in a post-secondary environment where the majority of students are predominantly white and come

from higher socioeconomic backgrounds (Gloria & Kurpius, 1996 as cited in Cole & Espinoza, 2008). This misalignment of expectations and experience can result in stereotype threat, isolating behaviors, and or poor academic performance (Steele, et al., 1995; Seymour and Hewitt, 1997; Carlone and Johnson 2007).

Several researchers (Astin, 1996; Morning and Fleming, 1994; Reichert, 1997, as cited in The Center on Education and Work [CEW], Byars-Winston et al., 2008) support the idea that minority students show interest in STEM disciplines when they enter college with the same promising intentions, but they eventually end up not majoring in a STEM discipline due to the reasons identified above. Research by Good et al. (2012) provides some encouragement. When looking at "math identity" Good et al. noticed that when women believed or were told math ability could be developed (growth mindset), women were more likely to shield themselves from stereotype threat and persist in the discipline. Math identity was defined as sense of belonging in math, being a part of an academic community, being at the heart of a discipline and not outside of the discipline, accepted by peers in the discipline, and recognized for their contributions to the discipline. These attributes as outlined by Good et al., align with Carlone and Johnson's Science Identity Framework [SIF] of: Competence, Performance and Recognition. Competence is a student's ability to gather scientific knowledge and technical expertise. The second critical aspect of the SIF is performance. Performance includes a student's knowledge, technical skills, acumen, use of scientific terms and ability to present across multiple domains (e.g. a research presentation). A student must demonstrate to others in their field their knowledge and expertise. Recognition is one of the most critical aspects of the SIF. A student needs to be recognized and validated by their scientific community. Carlone and Johnson (2009) indicate recognition is in

many ways a gatekeeper and potential perpetuator of keeping science relegated to a white male population.

1.4 Harnessing Social Networks and Community For Support

One of the concerns related to STEM disciplines are these disciplines create competitive environments that fail to foster a sense of community and acknowledgment of diverse individuals as contributing members to the disciplines. This idea is also experienced during the primary and secondary years as students are tracked as being "math abled" or "not good in math". Competitive factors include but are not limited to the following: a) lack of support or accommodation for different learning speeds (Lundy-Wagner et al., 2014), b) inequities in the level of academic material provided to various groups within in environment (Ramsey et al. , 2013), c) unapproachable faculty and or exclusion from study groups (Seymour and Hewitt, 1997), and d) competitive "weed out courses" (Carole and Johnson, 2007).

To address the aforementioned challenges, WSM has developed a holistic, longitudinal program focused on exposure and preparation. Through its program, WSM strives to mitigate the educational and family opportunity gaps for their students. Through various prescriptive program components, WSM systematically attempts to alter the trajectory of program participants for success in middle and secondary school, entry into post-secondary education, and ability to major in a STEM discipline. In many ways, the WSM program components align with the three macro-level challenges in secondary/postsecondary STEM preparation/retention. The program aims to help minority and female (though not exclusively) students by improving their learning and academic preparedness in STEM courses, fostering their science identity and science self-esteem, and providing social networks and communities that support growth in the STEM fields.

From the limited public information available on the WSM program, personal conversations with staff, and first-hand observations and engagement with the program, the following are general takeaways about the program: a) WSM builds social networks and communities with students via team projects, competitions, MESA clubs/classes, and continual interaction with MESA peers, b) through social networks, students come to brand themselves as a community of MESA scholars, and c) identity and self-esteem are fostered through positive encounters with various MESA stakeholders, leadership opportunities, and individual and group work with students who demonstrate an interest in STEM. Moreover, learning and academic preparedness for entry into STEM disciplines are achieved through access to resources, development of career capital, and the formation of early expectations related to STEM college to career pathways (Somerton et al., 1994).

1.5 Purpose, Significance Of The Study and Research Questions

The goals of pre-college programs vary in scope. WSM focuses on "building a pathway to college and careers in STEM" and "develop[ing] programming and initiatives to improve diversity and retention with an emphasis on traditionally underrepresented students in STEM fields, including African Americans, Native Americans, Hispanic/Latinos, Pacific Islanders and women" (MESA website, About US, October 22, 2017). While current literature outlines WSM prescriptive components and historical accounts of the overall program, there is limited public information or research on student perceptions about the program and how these perceptions provide insight into student growth oriented and academic mindset.

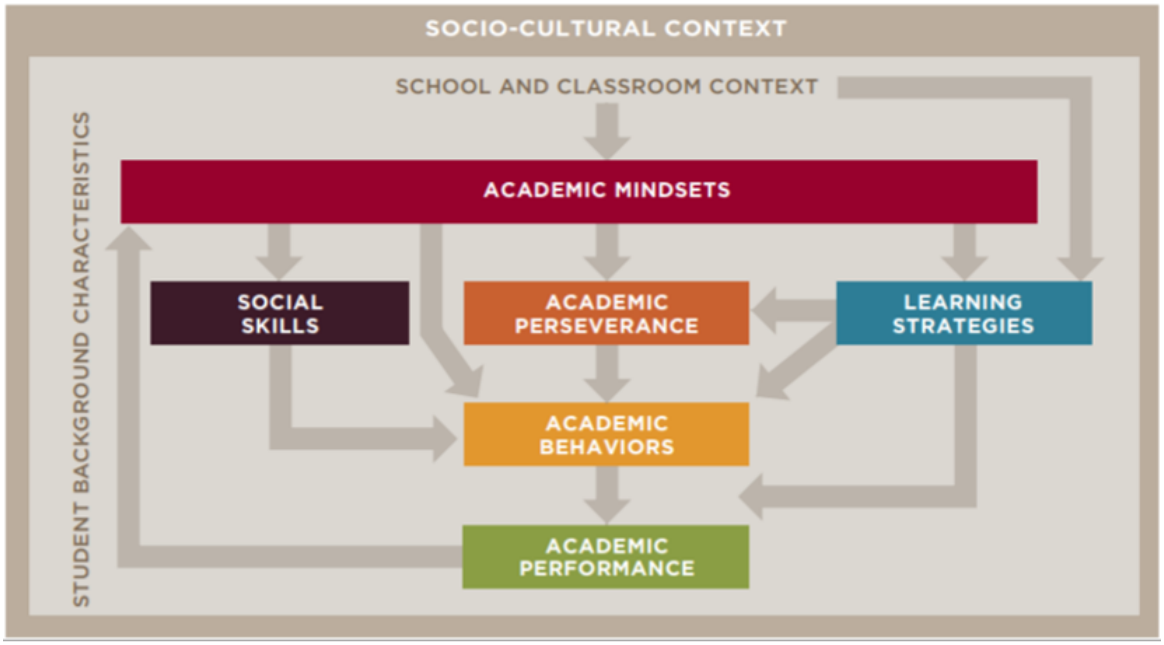
Drawing on the work of Carol Dweck's Mindset (Blackwell & Dweck, 2007; Good, Rattan & Dweck, 2012; Yeager & Dweck, 2012; Dweck, 2016) the Farrington et al. model

(2012), and Bronfenbrenner's theory of Ecological Human Development (1976, 1994, 2006), the questions explored in this mixed methods descriptive case study included the following:

1) How do high school minority and female students participating in the Seattle MESA program describe their growth oriented and academic mindset?
2) Are there gender differences in growth oriented and academic mindset as reported by students? If so, what types of differences exist?
3) In what ways does the Seattle MESA environment foster a growth oriented and academic mindset for students? What strategies are used, and what is the rationale provided for these strategies?
4) What are the implications of this inquiry for policies and practices used in implementing a MESA high school program?

This was an interactive model where I proposed that growth oriented and academic mindsets had the power to influence another factor (e.g. academic perseverance). Ideally, if all the different factors within the model were positive and sustained over time they would lead to increased persistence and retention of minority and female students in the cradle to career STEM pipeline. For this mixed methods descriptive case study, the primary focus was on student growth oriented and academic mindset. Figure 1 provides an overview of the Farrington et al. model (2012).

Figure 1: Causal model based on a hypothesized model of how five noncognitive factors affect academic performance within a classroom/school and larger socio-cultural context (Farrington et al. 2012)



1.6 Organization Of The Study

The first chapter introduced the purpose of this mixed methods descriptive case study. Chapter two will provide an overall organization of the mixed methods descriptive case study, including a literature review on pre-college programs, STEM, and MESA and a description of the supporting model and theories. Carol Dweck's Entity vs. Incremental Theory (Blackwell & Dweck, 2007; Good, Rattan & Dweck, 2012; Yeager & Dweck, 2012; Dweck, 2016), the Farrington et al. model (2012), and Bronfenbrenner's Bioecological Theory of Human Development (1976, 1994, 2006) will be included for discussion. Chapter three will focus on a description of the research methods. Chapter four will provide a discussion of the results and chapter five will conclude with discussion and implications for practice.

Chapter 2. **REVIEW OF THE LITERATURE**

2.1 INTRODUCTION

Chapter two will provide a more in-depth review of current literature associated with pre-college programs, STEM and MESA. The first few sections of chapter two will provide the necessary context for understanding the problem statement identified in the previous chapter. The chapter will also discuss how pre-college programs like MESA have attempted to address the complex and interwoven challenges related to the persistence of minorities and women in the STEM pipeline. The final section in chapter two will focus on related theories and frameworks that grounded this dissertation.

2.2 PRE-COLLEGE PROGRAM

Sections 2.2.1 through 2.2.7 will address various aspects of the pre-college program literature. These aspects include a historical timeline and rationale for the development of these programs, types of programs and services, and program design and implementation. Finally, efficacy and cost effectiveness, program duration and college attainment will be explored.

2.2.1 Overview and Timeline

As a response to the educational barriers faced by particular populations in the U.S., the federal government began to fund and implement pre-college programs (specifically TRIO) as early as 1965. There are eight TRIO programs that focus on students who are first-generation, low income or have a disability. TRIO programs are sponsored by the federal government. The main goal of TRIO programs is to help students move through the education continuum, from middle school to post-secondary completion (U.S. Department of Education, Federal TRIO

Programs-Hone Page, May 21, 2017). These programs were part of President Lyndon Johnson's "War on Poverty", the Economic Opportunity Act of 1964, and the Higher Education Act (McElroy & Armesto, 1998; Office of Post-Secondary Education History of Federal TRIO Program, May 21, 2017). Since the mid-1960s there has been an increase in pre-college programs which demonstrates the country's belief that education serves an important role in society (Fenske, Geranios, Keller, & Moore, 1997). As the U.S. transitioned from an industrial-service economy to a knowledge economy, the demand for a more educated workforce increased.

The notion that post-secondary education provides numerous benefits to our society and the individual is not new. *S*chools have long been viewed as institutions that provide both formal education for the country's citizenry and benefits to society (Levin & Belfield, 2003). While there may be positive intent in the role of pre-college programs, Cabrera, La Nasa, and Burkum, (2001); Mortenson, (2001); Perna, (2002); Terenzini, Cabrera, and Bernal (2001) assert that college access has not always been afforded to those most needing its benefits and attainment rates are still lagging for particular populations. Many of those who do not enroll or graduate are from underrepresented minority, first generation, and or low-income communities (Cabrera et al., 2006).

There has been an increase in pre-college programs (Domina, 2011), with more than 1000 programs operating across the country (Gandara & Bial, 2001; Perna, 2002 as cited in Domina, 2011) attempting to close the college access/attainment gap. With the expansion of pre-college programs, it will become imperative for these programs to not only describe their services but demonstrate their effectiveness at positively impacting the trajectory of the diverse

students who participate in these programs. There will also be increased competition for monies as new programs are introduced and a greater emphasis is placed on retention.

2.2.2 Purpose and Intent

Much has been written about the purpose and intent of pre-college programs. Pre-college programs assist students who are typically defined as "at-risk" for dropping out or not enrolling in college. These programs offer several services such as tutoring, college visitations, assistance with financial aid, and counseling. The main goal for many of these programs is to expose and prepare students for entry into post-secondary education. Pre-college programs may serve a variety of audiences. However, the students targeted for participation in these programs typically come from low-income families, demonstrate poor academic achievement, live in challenging home environments, or are not on a pathway to college attainment (The Center for Higher Education Policy Analysis [CHEPA], 2002). While pre-college programs may be found in schools serving low-income, first-generation and underrepresented populations there are also programs operating in middle and upper income schools and districts. However, there is a significant difference in the purpose of these programs (Tierney, Hallett, & Venegas, 2007). In schools where there is a sizable low-income population, the focus is providing services and instruction that are lacking during the school day or home life due to several factors related to teacher experience and available resources. In middle and upper-class schools and districts, pre-college programs serve as a supplement to what students are being taught in the classroom and social/cultural and career capital they possess (Tierney, Hallett, & Venegas, 2007).

2.2.3 Pre-College Program Types and Services

Because there is lack of uniformity regarding the definition of a pre-college program, Tierny et al. (2007) suggested practitioners consider four components: 1) program participants, 2) types of services, 3) service providers, and 4) program funders (p.5). They also assert there are three major pre-college program focal areas (Tierny et al. reference the term "college preparation programs" when referring to these focal areas. Most pre-college programs will incorporate at least one dimension): academic enrichment; college knowledge; and cultural/social enrichment (p.8). Pre-college programs generally focus on academic preparation, non-academic skill sets, subject specific disciplines, parental education, or a combination of multiple services. Per Fenske et al. (1997), an alternative to grouping pre-college programs is under the broad category identified as "early intervention". Fenske et al. (1997) indicated academic outreach programs fall under "early intervention" and are primarily characterized by their location within schools or post-secondary institutions. Fenske et al. (1997) stated there are two types of academic outreach programs: college-attainment focused and college discipline specific. Table 1 outlines another example of the burgeoning definition of what constitutes a pre-college program. CHEPA (2002) identified pre-college programs based on in-school or out of school programs.

Table 1: Types of Pre-College Programs and Services According to CHEPA (2002)

In-School Programs		Out of School Programs		
Academic	**Non-Academic**	**Academic**	**Non-Academic**	**Family**
Class Instruction	Career Guidance	College Information	Mentor Programs	Parent Education Sessions
SAT Preparation	Study Skills	Math & Science	Career Guidance	Family Counseling
Tutorials	Academic Advisement	Reading & Writing	Academic Advisement	
		SAT Preparation	Motivational Seminars	
		Tutorials	Social Skills Development	
			Cultural Awareness	

These programs can be supported by philanthropic groups, the federal government, state monies, K-12-college collaboration, and/or university sponsored (Fenske et al., 1997). While the intent is to assist students through the college-going process, there is a growing body of research that indicates substantial problems exist for many of these programs. Cabrera, La Nasa, and Burkum (2001); Mortenson (2001); Perna (2002); and Terenzini, Cabrera, and Bernal (2001) indicate that despite the financial investment and availability of programs, the college-going rates amongst populations still remains unequal (as cited in Cabrera et al., 2006). Gandara & Bial, (2001); Perna, (2002); Perna and Swail, (1998) argue that the siloed intervention strategies adopted by pre-college programs may result in lower college going rates for particular groups (as cited in Cabrera et al., 2006). And while, the siloed intervention strategy has been adopted by some pre-college programs, Cabrera and La Nasa (2001); Cabrera, La Nasa, and Burkham (2001); Hossler, Schmit, and Vesper (1999); McDonough (1997); and First and Venezia (2004) demonstrate the college process is multifaceted, should begin early in a student's academic career and include multiple stakeholders (as cited in Cabrera et al., 2006). In a study conducted by Perna (2002), 1, 110 pre-college programs were assessed in an attempt to discover how many programs offered services related to the 11 predictors of college enrollment. The results

indicated that about 25 percent of the identified programs that served populations typically served by these programs, contained only 5 of the college enrollment predictors and only 6 percent reflected all of the 11 components (as cited in Cabrera et al., 2006). While there are numerous beliefs about what constitutes a successful pre-college program, Alexander, Pallas, and Holupka (1987); Hossler, Schmit, and Vesper (1999); Hugo (2004); and McClafferty and McDonough (2002) suggest five elements for building a college culture and increasing college access that include: 1) academic momentum, 2) an understanding of how college plans develop, 3) a clear mission statement, 4) comprehensive college services, and 5) coordinated and systemic college support (as cited in Corwin & Tierney, 2007, p. 3).

2.2.4 Design and Implementation

With regards to program design and implementation, there are two pre-college program models: the targeted and the schoolwide model (J. Groutt, 2003 as cited in Domina, 2009). The targeted model recruits a limited number of students to participate in a program. Targeted programs involve collaboration among multiple entities such as colleges and high schools, nonprofits and or community organizations (Domina, 2009). Targeted models may focus on academic instruction during the school day, after school programming, intensive summer enrichment opportunities, or instruction on specific subject matter content. Targeted models *"*assume that students act as individual utility maximizers throughout the college choice process, developing their educational aspirations and making application and enrollment decisions on the basis of a fully informed, rational consideration of their odds of college admission, success in higher education, and the likely returns to educational attainment over the life course" (Domina, 2009, p. 129). Examples of targeted pre-college programs include MESA, Upward Bound, and Talent Search. School wide models may include participation by all students in a district or building.

These models typically provide fewer resources and rely on social dynamics within a building to influence change.

2.2.5 Efficacy and Cost Effectiveness

There are multiple pre-college programs throughout the U.S. and these programs have mixed effects. While there is general support, enthusiasm and funding for pre-college programs, there is still a need to explore program outcomes (Domina, 2009). Research by Perna, (2002); Reuda (2005); Swail, (2000); Swail and Perna, (2002) indicated there is information about the types of students who participate in these programs and the services they offer, but minimal research on the actual impact (as cited in Domina, 2009). Gandara and Bial (2001) conducted a survey in multiple K-12 outreach programs and concluded similar criticisms of pre-college programs (as cited in Domina, 2009, p. 129). According to CHEPA there is limited guidance on how to affectively design a pre-college program to reach maximum outcomes for the level of time and resources committed to the program. Longitudinal data is also lacking for many of these programs (CHEPA, 2002, p. ii). The absence of rigorous assessment and evaluation has also hindered pre-college programs. A review of the literature indicates one of the primary recommendations to ensure program success is utilization of assessment and evaluation. CHEPA (2002) conducted a longitudinal mixed methods study of 17 pre-college programs in five cities. The participating programs were primarily located in urban areas and were comprised of "at risk or disadvantaged youth". Their study gathered information related to: 1) constituents' perceptions of the goal, circumstances, and processes used to establish and maintain the program, 2) evidence of program success, and 3) evidence of problems, challenges and the effectiveness of inter-organizational coordination (CHEPA, 2002, p. 1). They found six challenges that limit pre-college programs and their ability to be successful and document their

best practices. Some of these challenges included, strategic planning, coordination amongst stakeholders, funding sources, and evaluative practices (CHEPA, 2002, p. 4). Based on CHEPA's research, there are nine suggestions for improving program performance, one of these being increased program evaluation (CHEPA, 2002, p. 10).

Domina (2009) also called for more rigorous assessment and evaluation of pre-college programs. Domina indicated there are relatively few programs that have conducted quasi-experimental research to assess and evaluate program impact. Gandara and Bial (2001) found that assessments did not consider multiple variables when comparing participants to non-participants (as cited in Domina, 2009). This assertion is also supported by Tierney et al. (2007). The inability to conduct such research may be attributed to student privacy issues, systematically denying some students service while supporting others, state or local policies such as a ban on affirmative action, or a culture that has primarily relied on anecdotal evidence.

One attempt to analyze the outcomes for specific model types were two quasi-experimental studies conducted by Domina (2009). Data from the Educational Longitudinal Study [ELS] was used to examine the potential impact of pre-college programs on student achievement (Domina, 2009). First, Domina (2009) studied the effects of the targeted pre-college model, looking at students who attended schools that implemented a targeted model compared to those schools that did not have a targeted model. Domina (2009) then studied the school-wide model by comparing students who were in a high school that implemented the model to those in high schools that did not have a school-wide model. The results from Domina's study (2009) indicate that while participants experienced modest gains, "the results suggest that targeted outreach programs do little to change the educational experiences of participating students. However, there is limited evidence to suggest that school-wide outreach

programs may have modest "spillover" effects, improving the educational outcomes of relatively unengaged students at participating schools" (Domina, 2009, p. 127).

In addition to assessment and evaluation, one of the prominent areas of discussion related to pre-college programs are the effects of exposure and preparation through direct services. Exposure can be characterized as a short-term experience that does not entail great depth. An example of an exposure-focused student service activity might include a day-long campus visitation. Preparation is characterized by investment in long-term behavior(s) that focus on repeated performance. These behaviors ideally lead to positive change (e.g. change in a grade, change in study habits). Examples of preparation activities include student participation in an intensive math course, with supplemental tutoring during the school year, followed by participation in a study skills seminar. Gandara and Maxwell-Jolly (1999) asserted long term investments and participation in a pre-college program will have a greater effect on a student (as citied in Oesterreich, 2000). Additionally, Fenske et al. (1997) indicated pre-college programs are effective when there is long-term engagement coupled with a focus on a culture of readiness (as cited in Oesterreich, 2000). This argument is further supported by a study from Miller (2006), where youth who consistently participated in programs benefited from program services. Miller (2006) indicated students experienced an overall increase on a number of indicators, including engagement in learning. One of the key reasons for increases in participant behaviors and attitudes was related to increased time of participation (as cited in Tierney et al., 2007).

2.2.6 Program Duration

The importance of program duration and participation has also been analyzed by Burkheimer, Riccobono and Wisenbaker (1979) from the Research Triangle Institute [RTI]. RTI conducted a longitudinal research study on the Upward Bound [UB] Program between the years 1973 and

1978. Burkheimer et al. (1979) indicated there were positive impacts on multiple variables including students' educational desires. Key to these positive impacts were the rate of participation in the UB program. The study concluded participants who frequently engaged with the program fared better than those that had a more random and casual engagement with the program (as cited in McElroy & Armesto, 1998).

Currently there are pre-college programs that students attend during the summer, after school, once a week, or when they deem necessary. While Horn & Chen (1998) attest any exposure has an impact (as cited in Domina, 2009), others have indicated, "such variation may be warranted, but surely, some frameworks must be more effective than others" (Tierney et al., 2007, p. 5). There are varied results about participation in pre-college programs. Until further research and evaluation are conducted it is difficult to determine with any confidence how program duration and exposure vs. preparation affects students. Bonous-Hammarth and Allen, (2005), and Hayward et al. (1997) believe the temporal framework of programs is a vital component to consider; however, "it causes concern when one looks at the literature about college preparation programs and discovers no sense of best practices in general, and with regard to timing in particular" (as cited in Tierney, Hallett & Venegas, 2007, p. 2).

2.2.7 College Attainment

Closely related to the discussion of exposure vs. preparation are what specific program components impact college attainment rates. There is an assertion that the college enrollment gap between white and minority students is the result of multiple variables including recruitment and retention strategies and prior academic preparation (Education Week, 2004). This claim raises the question: what are the critical components of a successful pre-college program?

One example of a pre-college program that has implemented a comprehensive program design and can serve as a potential model is ProTech, located in Boston, Massachusetts. This initiative connects high schools with an estimated 75 employers and community liaisons who support students in their quest to graduate from high school and their college enrollment and graduation. An evaluation of the program determined that graduates of the program experienced higher school graduation rates from high school, post-secondary enrollment, and increased wages (Jobs for the Future, 1998). Results were compiled from surveys of participants and a comparison group. ProTech is a pre-college program that enrolls 650 students and provides a comprehensive approach to working with students. This work includes academic support, learning technical subjects related to career aspirations, worksite learning, using technology, developing communication skills, and learning how to navigate complex systems.

The rationale for the existence of the pre-college programs has merit, but the lack of assessment and evaluation across multiple program dimensions hampers pre-college programs and their ability to demonstrate quantifiable-longitudinal outcomes relative to their mission. The Harvard Family Research Project (2004) states,

> "all of these potential benefits have weak results and end up being ineffective if the program's temporal aspects are ill conceived, poorly thought out, or developed for reasons other than those based on program outcomes" more importantly, "program benefits are not fully realized if the students do not consistently participate in program meetings, events, and other activities. Unfortunately, low attendance and/or attrition plague many college preparation programs, so it is difficult to completely recognize the full impact of these models" (as cited in Tierney et al., 2007, p. 11).

Pre-college programs have been in existence for more than 45 years. As the U.S. transitioned from an industrial/service economy to a knowledge economy, the demand for a more educated workforce increased. Pre-college programs are one vehicle for reaching individuals who have traditionally not accessed post-secondary education. These individuals include those from first-

generation, low-income, and underrepresented communities. Pre-college programs focus on services that center on both exposure and preparation and vary in the types of services delivered to participants. The schoolwide and targeted model are two overarching models that characterize pre-college programs.

There is much discussion in the literature regarding the efficacy of pre-college programs given the complexity of the college going process. As the literature indicates, part of the challenge with pre-college programs is related to data collection, longitudinal tracking, appropriate program model design, funding and offering services that align with predictors of college going success (Cabrera, La Nasa, and Burkum, 2001; Mortenson, 2001; Perna, 2002; Terenzini, Cabrera, and Bernal, 2001 as cited in Cabrera et al., 2006*;* Gandara & Bial, 2001; Perna, 2002; Perna & Swail, 1998 as cited in Cabrera et al., 2006; Perna, 2002 as cited in Cabrera et al., 2006; Domina, 2009; CHEPA, 2002; Tierney et al., 2007). While these programs have their share of challenges, there are opportunities to build on existing models. The aforementioned literature does indicate the intent of these programs to increase post-secondary access and prime the economic engine of the country has merit. While there are similarities and differences in how programs deliver services, track progress and fund activities, these programs fill a significant gap in the lives of the students and families who access them for services.

2.3 A FOCUS ON STEM

Sections 2.3.1 through 2.3.4 will address various topics relevant to the historical and current STEM landscape. These topics include an overview on past STEM hiring practices, changing population demographics and the challenge of filling STEM industry positions. These sections will discuss the implications for lack of investment in diverse STEM talent, the impact of talent

drain to the U.S. and Washington State, as well as recent attempts at both a national and state-level to address disparities in STEM talent production.

2.3.1 Overview

The development of programs like MESA are in response to the looming challenge of filling industry positions in the U.S., changing population demographics, U.S. competitiveness in the global market, and a drastic shift in the U.S. economy. Of concern is the fact that individuals who have typically entered STEM fields have been Caucasian males. With many of these males approaching retirement, there will be a significant number of vacant positions. There are two challenges in filling these positions. First, the fastest growing U.S. populations (Latino/Hispanic, African American, Native American and Pacific Islander) who by sheer numbers *should* be able to fill these positions have also been some of the most systematically marginalized in the American education system. According to NSF (2011), minorities will comprise about half of the U.S. population by 2050 and Latina women will be the largest group. Second, females are more than half of the college enrollment population but are not accessing STEM disciplines in proportion to their numbers in the overall population (The National Academies Office of News and Public Information, 2010; The Center on Education and Work [CEW], Byars-Winston et al., 2008; NSF, 2011; Allen-Ramdial et al., 2014).

There are several reasons to explain why minority and female students do not persist through the education pipeline and into STEM disciplines and careers. Challenges include academic under-preparedness, financial barriers, fewer opportunities for experiential learning, stereotype threat, diminished sense of belonging, lack of a science identity, poor self-esteem and low self-efficacy. Supportive environments that foster growth oriented and academic mindset are key to increased academic performance, strengthening of science identity and ultimately the

retention and persistence of minorities and females in their pursuit of STEM disciplines and or careers (Carlone and Johnson, 2007; Farrington et al., 2012; Dweck, 2007, 2012, 2016; Brofenbrenner, 1976, 1994, 2006; Seymour & Hewitt, 1997).

These challenges, paired with overall lower academic performance metrics of underrepresented populations, and the ability of these populations to be retained across the education pipeline (specifically the STEM cradle to career pipeline) has created an overreliance on imported talent to fill industry positions in the U.S. and Washington State. This overreliance on imported talent is not sustainable (HECB, 2011; Zumeta, Breneman, Callan & Finney, 2012). If the U.S. is going to remain a leader with economic reach and compete on a global level, it is imperative the country address disparities around ethnic and gender equity in STEM. One approach to systematically address the problem is to begin STEM pre-college outreach and preparation as early as middle and high school. Zumeta, Breneman, Callan & Finney (2012) state the problem as follows:

> "The widely varying degree attainment rates by age and ethnicity point to the root of the problem: groups with high rates of educational attainment are shrinking as a proportion of the U.S. population, while the proportions of those groups with low and relatively stagnant attainment are increasing. While these gaps in attainment have long been an issue of moral concern for many in a nation presumably dedicated to social equity, they are rapidly becoming an urgent matter for economic competitiveness in the knowledge-based economy as well" (p.13).

2.3.2 Support Of Science, Technology, Engineering and Math

Support for STEM were key aspects of the prior Obama Administration. The commitment of the administration was demonstrated in their support of STEM policy and increased investment in Research and Development [R&D]. The 2017 budget called for $152 billion for R&D, a 4% increase from the previous year (White House Office of Science and Technology Policy, 2016, p.

1). Priority areas identified in the White House Office of Science and Technology Policy Release included:

1. Commitment to world-class science research
2. Investing in innovation
3. Improving America's health
4. Accelerating the pace of innovation in manufacturing to create jobs
5. Cleaner American energy
6. Action on climate change
7. Growing agriculture research
8. Preparing student with STEM skills
9. Supporting private-sector R&D (p.1-2)

Washington State STEM goals mirror that of the previous Obama administration and in many ways, there is even greater emphasis on STEM education and talent. While all occupations are projected to grow at 14% between 2010-2020, STEM occupations surpass these, with Biomedical Engineers leading the way at a projected 62% growth rate between the same time period (Department of Education, 2013). This emphasis is greater in Washington State, because unlike other states in the U.S., Washington has a high concentration of STEM jobs. According to Washington STEM, Washington State is a STEM leader in the country and ranks at the top of the list in multiple STEM measures (Washington STEM Fact Sheet, 2013). Unfortunately, Washington State is not producing high school or college graduates who are prepared to enter STEM related careers. According to a policy brief from Governor Inslee's office, one out of four high school students in 2011 failed to graduate on time *(*Educating a 21st Century Workforce, 2013). This delayed graduation and or the ability to obtain a GED results in lost wages over time and higher unemployment rates. The Bureau of Labor Statistics reported that in 2012, 20-24 year olds were unemployed at a rate of 12 percent. These low performance numbers directly

translate to unfilled positions and have a negative economic impact on the state. In their most recently available 2017 fact sheet, Washington STEM indicated there were an estimated 25,000 STEM jobs in Washington State that were not filled in 2013. They state, "filling the jobs skills gap would have a big impact on our state economy, generating an additional 110,000 jobs, in addition to $720 million in annual state tax revenues and $80 million in local tax revenues by 2017" (Washington STEM Fact Sheet, 2013, p. 2). To ensure greater collaboration and success across the STEM pipeline Governor Inslee, in Educating a 21st Century Workforce, is focusing on the following areas for development:

1. High school initiatives (e.g. reengagement programs focused on skill training)
2. STEM related initiatives (e.g. support aerospace training, create electrical engineering program in Everett through Washington State University) (p. 1-2)

One of the state agencies conducting STEM policy research was the former Washington Higher Education Coordinating Board [HECB]. The board released a 2011 brief that outlined the findings of a regional workforce analysis that confirmed the need for a stronger STEM pipeline. One of the most telling statistics cited in the report was the following:

> "Washington is not producing enough high-demand degree holders-especially in the STEM fields-to meet its current and future needs. For every 100 baccalaureate degree holders Washington produces it imports 76. For every 100 graduate degree holders it produces, it imports 125. This over-reliance on importing talent is not a sustainable long-term strategy to maintain the state's competitiveness in the global, knowledge-driven economy" (HECB, 2011, p. 1).

Bowen et al. (2005) highlighted decreases in bachelor degree attainment across multiple STEM disciplines ranging from 8-20 percentage points, while other countries are increasing production in these disciplines. A similar trend is occurring at the graduate level where there has been a reduction in PhDs awarded to U.S. citizens yet an increase in foreign student degrees

awarded. As of 2006, underrepresented college educated citizens in STEM occupations is only nine percent (The National Academies, 2010).

2.3.3 Stereotypes

Overcoming stereotypes and expanding opportunities for all students in STEM was listed as a key component of the effort to create a more diverse STEM pool of talent, this included an NSF investment of more than $16 million to support diversity efforts that engage underrepresented students. This funding was in addition to a $100 million in competitive grants aimed at expanding access to computer science, with a focus on underrepresented populations (White House Office of Science and Technology Policy, 2016). Simultaneously, the administration launched the White House Science Fair, and the Educate to Innovate Initiative, a media campaign to highlight the opportunities in STEM for all people, as well as made investments in higher education opportunities for underrepresented populations through programs such as Gaining Early Awareness and Readiness for Undergraduate Programs [GEAR UP], TRIO and Hispanic serving institutions (White House Office of Science and Technology Policy, 2016).

2.3.4 Competitiveness

Given the federal and state STEM landscape, STEM pre-college programs can play a pivotal and decisive role in exposing and preparing the next generation of STEM professionals. The ability of STEM pre-college programs to share quantifiable outcomes paired with personal narratives of success will help stakeholders determine if their investment in STEM pre-college programs are effectively being utilized and the rate of return on investment. There is a growing consensus that all sectors of society from K-12 to industry need to assert greater effort to recruit and retain our diverse citizens to ensure a productive and competitive STEM workforce.

The academic and career readiness of our citizens has a direct impact on our ability to fill knowledge-based STEM jobs and our economic vitality. The National Academies (2005) identified multiple criteria global industries use as proxies when considering where to locate their businesses. These include but are not limited to a qualified workforce, research and development support by the government, availability and quality research and innovation of talent, and quality research universities. These are areas the U.S. is sluggishly attempting to maintain. The following data outlined by The National Academies (2005) suggest that U.S. STEM investment at the pre-college level has potential impact down the line:

- In 1999, 68% of U.S. 8th grade students received instruction from a mathematics teacher who did not hold a degree of certification in mathematics.
- American youth spend more time watching television than in school.
- In South Korea, 38% of all undergraduates receive their degrees in natural science or engineering. In France, the figure is 47%, in China, 50%, and in Singapore 67%. In the U.S., the corresponding figure is 15%.
- The U.S. is today a net importer of high-technology products. Its trade balance in high-technology manufactured goods shifted from plus $54 billion in 1990 to negative $50 billion in 2001.
- In one recent period, low-wage employers, such as Wal-Mart (now the nation's largest employer) and McDonalds's created 44% of the new jobs while high-wage employers created inly 29% of the new jobs.
- Chemical companies closed 70 facilities in the U.S. in 2004 and tagged 40 more for shutdown. Of 120 chemical plants being built around the world with price tags of $1 billion or more, one is in the U.S. and 50 are in China. No new refineries have been built in the U.S. since 1976.
- In 2005, only four American companies ranked among the top 10 corporate recipients of patents granted by the U.S. Patent and Trademark office (p. 11-13).

This data is alarming and highlights the gaping holes in our K-20 system, industry, and government relative to STEM preparedness, capacity, and output. There are multiple challenges facing our nation in relation to the STEM agenda and the direct symbiotic relationship to the country's global and economic vitality. At the crux of the solution is the untapped diverse talent across our nation. Participation by diverse populations in the STEM fields is critical to the country's well-being (The National Academies Office of News and Public Information, 2010). Waiting until students apply and or enroll in post-secondary institutions is far too late. One example of a program that has led in the STEM pre-college realm is MESA. For over forty years the MESA program has been a leader in changing the face of STEM in America.

Pre-college programs have focused on post-secondary access and college-going behaviors, with some of these programs focusing on STEM. With a change in population demographics, a shift to a knowledge economy, exit of older baby boomers from the labor market, an increase in technology use and accessibility, and global competitiveness, the environment has created the space for the emergence of pre-college programs that focus on both post-secondary access and STEM preparedness.

There has been increased acknowledgement that individuals from underrepresented communities and women have been systematically sidelined from participating in post-secondary education and STEM (women have increased their participation rates in accessing post-secondary education but are still significantly underrepresented in some STEM disciplines). This has led to a talent production gap as older white males are leaving the labor market. The overreliance on importing talent is cited as a short-term solution to the country's long-term employment and economic needs. This challenge impacts the country and is more salient for states like Washington where the state economy is heavily supported by aerospace, biomedical

and technology companies. While the needs and challenges are daunting, there is opportunity in the diverse talent that has not been tapped. This is where STEM pre-college programs can serve as a primer for the country's economic engine. There are multiple programs operating across the country as well as in Washington State. These programs range in their scope, delivery and financial support.

2.4 MESA

In 1970 the MESA program was launched at Oakland Technical School by U.C. Berkeley Engineering faculty Dr. Wilbur Somerton and fellow educators who were concerned about the lack of diversity in the College of Engineering. The MESA Minority Engineering Program [MEP] soon followed in the early 1970s and was based off the work of Dr. Ray Landis (California State Northridge) who focused on the retention of underrepresented college engineering students. Today the MESA U.S.A. office describes itself as follows:

> "nationally recognized for its innovative and effective academic development program. MESA engages thousands of educationally disadvantaged students so they excel in math and science and graduate with math-based degrees. MESA partners with all segments of higher education as well as K-12 institutions. With a proven track record of over 40 years, we focus on producing math-based graduates by providing support such as classes, hands-on competitions, counseling, transfer support and a community environment to students from middle school through university. Since 1970, MESA has helped students become scientists, engineers and mathematicians, filling an urgent need for qualified technical professionals*"* (Washington MESA Who We Are, 2017).

2.4.1 MESA Model and Foundational Components

MESA contributes part of its success to components of the MESA model. The MESA model as described in a 1993 report entitled *K through 12 School Reform: Implications and Responsibilities for Higher Education*, labeled MESA as an intersegmental structure consisting of multiple components. The MESA components are prescriptive, meaning they are standard

across the 11 states where MESA is operational (with slight variation). Each of the MESA components has a model that serves as a guide for how activities should be implemented. There are opportunities for directors and teachers to alter components of the model depending on many factors (e.g., location to industry or student suggestions). For example, Seattle MESA has three distinct program models: an afterschool MESA Club, an in-school MESA class, and a Saturday Academy. Each school determines which model is appropriate for their building. The afterschool MESA Club is led by a MESA teacher. Typical activities in a MESA club might include MESA day preparation, robotics hands-on learning, or guest speakers. Saturday academies occur once a month on the university campus and occur October through May. These academies draw participants across all the Seattle MESA high schools and center on lab simulation, engagement with university faculty and industry mentors. The Saturday academy is not part of the MESA core program but was added as part of a grant that was received by the program. The In-class model is regarded as the most desirable model because students are signed up to participate as a high school elective and are consistent in their attendance. The MESA in-class model can range from one to two semesters. Currently one of the five Seattle MESA high schools operate in this model. Table 2 provides a detailed overview of the MESA model and program components.

Table 2: MESA Program Pipeline Components

K-12 Schools Program: Serves primarily middle and high school students so they can excel in math and science and be competitive for college.	**MESA Community College Program (MCCP): Provides STEM support to educationally disadvantaged CC students with the intent to transfer to the four-year with calculus-based math.**	**MESA Engineering Program (MEP): Support students at four-year institutions as they strive for four-year degrees in engineering or computer science.**
Individual Academic Plans	Academic Excellence Workshops	Academic Excellence Workshops
Study Skills Training	Orientation Course	Orientation Course for Freshmen and Transfers
MESA Day Academies	Academic Advising/Counseling	Career Advising
Career and College Exploration	Student Study Center	Links With Students and Professional Organizations
Incentive Awards	Assistance in the Transfer Process	Professional Development Workshops
Parent Leadership Development	Career Advising	The Student Study Center and Computer Lab
MESA Periods	Links with Student and Professional Organizations	Industry Advisory Board
Teacher Professional Development Opportunities	Professional Development	
	Industry Advisory Board	

A more detailed account of the pre-college MESA components and specific outreach are outlined below (personal communication, WSM Senior Associate Director, 6/7/2016).

<u>Area One: Academic Enrichment includes the following</u>:

- MESA periods (classes wherein MESA curriculum is included no less than three times weekly)
- Other MESA academic support (After school models, Hard Math Café – a MESA lunch period activity, etc)
- Hands on science and math, including MESA Day
- Academic support (tutorials, facilitated small groups, collaborative learning)
- Periods and clusters – students should be part of a "learning community"
- Academic planning
- Extracurricular (Algebra Academies, Saturday Academies, 9th grade bridge, summer activities)
- Incentives: incentives are not mandated but include any incentives, including recognition events, which you are able to sponsor.

Area Two: College Readiness and STEM Career Preparation includes the following:

- Information about types of higher education, orientation to STEM careers
- College admissions information and admission assistance
- Assistance with the personal essay
- Mentoring
- Field Trips to campus or industry centers
- College admission test preparation: consider preparation, application and waiver information.
- Career workshops and guest speakers

Area Three: Teacher Professional Development includes the following:

- Center specific training events (related to math and science and/or cultural competency)
- Summer Teacher Institutes
- Regional collaborative professional development seminars and workshops
- Collaboration and engagement with district Science and Math coaches

Area Four: Parent Education and Involvement includes the following:

- Orientation
- Workshops
- Specialized trainings

Based on the literature and personal communication with a WSM MESA source (the interviewee has worked with two state programs), the assumed theory of action that emerged was one of intersegmental, holistic, active learning with high motivational encouragement to impact post-secondary access and preparation for STEM disciplines. One idea offered by the MESA source highlighted the fact that MESA was not originally founded on theory. The source suggested it was founded on the heels of the Civil Rights Era and was created to address specific injustices in communities of color. The source somewhat frowned upon the notion that some individuals would assert program staff had the luxury of sitting back and constructing theory in the immediacy of the day-to-day work. Eventually, theories were embedded into the MESA program, especially as MESA personnel began to realize students were entering universities but not graduating. The assumed theory of action for MESA's work is carried out and influenced by various stakeholders including: industry, government officials, community members, families, teachers, faculty, post-secondary institutional staff, and school district leaders. The vehicle for

moving theory to practice is the standardized MESA components. MESA believes the program components (e.g. industry/career exposure, tutoring/study skills, MESA Day involvement, and MESA class periods) should lead a student to access post-secondary education, be prepared for entry into a STEM major, and graduate. The macro-level goal is to prime the nation's STEM industry pipeline.

MESA's assumed theory of action is supported by the literature (Oesterreich, 2000). MESA focuses on the K-20 pipeline and a holistic approach to the work. Gandara and Bial (2001), Perna (2002), Perna and Swail (1998, 2006), Cabrera and La Nasa (2001), Cabrera, La Nasa, and Burkham (2001), Hossler, Schmit, and Vesper (1999), McDonough (1997), and First and Venezia (2004) conclude part of the challenge with pre-college programs is their siloed approach, especially given the multifaceted dimensions of the college-going process (as cited in Cabrera et al., 2006). Thus MESA's holistic approach aims to support students in a variety of areas from career aspirations to study skills development. Active learning is also a key aspect of the of the program.

There are many prominent theories in student development literature pertaining to active learning including Kolb's theory of experimental learning (1982,1984 as cited in Evans et al. 1998). This body of literature focuses on students' interaction with subject material and how this interaction leads to the formation of additional ideas, hypothesis testing, and high engagement. MESA incorporates active/experimental learning through hands-on programming including MESA Day curriculum where students work in teams to build structures that are judged at state and national competitions.

Motivational encouragement is the final attribute of MESA's assumed theory of action. MESA's assumed theory of action is strengths-based; therefore, the program does not consider

itself a remedial program where students are overcoming deficits. Through a series of extrinsic rewards such as certificates, trophies, cash incentives, and dinner banquet recognitions, it is assumed students' self-efficacy and motivation will lead to persistence and achievement. While literature on the MESA program does not explicitly cite theories on motivation and achievement one can deduce the operating theory at work. In a study that focused on high achieving African-Americans, Suk Hwang, Echols, and Vrongistinos (2002) conclude students utilized multiple orientations to achieve success. Suk Hwang et al. (2002) wrote,

> "according to Husman and Lens (1999), highly intrinsically motivated students can simultaneously be extrinsic in terms of future goal orientations. Students' extrinsic motivational factors combined with positive future goals can actually facilitate their present value and intrinsic motivation (Van Calster, Lens, & Nuttin, 1987). For example several ethnographic studies of African Americans (Farrell, 1994; O'Connor, 1997; Rowley, 2000) found that students, who related extrinsic factors to positive future goals were more engaged in school and received better grades. Understanding the relationship between the utility and importance of future outcomes of tasks may facilitate present value and intrinsic motivation of the tasks. This would imply high academic performance goals with extrinsic factors do not necessarily diminish the effect of students' intrinsic motivation but operate together with various modes of *motivation" (p. 1-2).*

2.4.2 Implementation Of MESA

MESA is a collaborative program and requires multiple stakeholders to implement the MESA components within each pipeline program. While there is a national office (MESA USA) each state has an executive director and a team who leads and engages with directors/local districts/schools/MESA teachers and industry. One example of how a model component was implemented during the late 1970s was the study assistance/study skills component. Study assistance/study skills are core components of the MESA model. These are carried out at the individual level and in group settings. The group model was adopted in 1978 at a MESA Advisors Institute and developed by Dr. Uri Treisman (Somerton, Perry Smith, Finnell, & Fuller, 1994). This model has been taught to individuals in the program who implement programming.

Historical records indicate the total expense to implement MESA in the year 1977-78 was $262,609 with the cost per student at $321 (819 students served). By the last reporting year on file, 1992-1993, 17,028 students were served at a cost of $3,460,951 with the cost per student at $203 (Somerton et al., 1994, Appendix XI). School districts and schools across the U.S. can become MESA affiliated and implement the program on the guarantee they utilize partial in-house resources, select in-school teachers to serve as advisors, and provide space for a MESA center (Vocational Training News, 2002).

Implementation over the years has been incremental. When analyzing the California and Washington State histories, it took a span of multiple years to build the programs to where they are today. California started as a high school program with support from one post-secondary institution. The formal MESA Industry Advisory Board was not established until eight years after (1978-1979) the inaugural MESA program was launched. It was not until the early 1980s when California MESA experienced large growth when the MESA MEP program went from three sites to nine. During the same time period California MESA met for an informational gathering with interested parties from Colorado, New Mexico, Texas, Arizona, and Washington state. The goal of these meetings was stated as follows:

> "to ensure that any replication would adhere to the original model in its most significant dimensions, e.g. local leadership, an academic setting, matching funds, promoting academic excellence, fostering efficiency and effectiveness. California MESA leaders had always sought to ensure the program neither duplicated nor supplanted existing efforts. When MESA staff members visited sites, they insisted that the introduction of the MESA model would result in enhancing local resources and initiatives" (Somerton et al., 1994, p. 133).

In 1996, the state of California experienced a major policy change with Proposition 209, followed by the 2000s that saw drastic budget cuts. In Washington State there was a gap of almost 27 years from when the initial program was launched to when the NSF step grant for the

WSM Community College Program [MCCP] came into existence (Washington MESA Community College Program Webpage, 5/21/2017; Washington MESA Webpage, 5/21/2017).

Early implementation of the MESA program had its skeptics. As the MESA program set forth a plan for expansion including a new funding model, they gained the attention of California state legislators who were supportive of their efforts. However, there were three major arguments levied against the MESA program. First, various directors who ran outreach programs at the university level viewed MESA as a potential competitor. MESA would make the argument these programs focused on recruitment and access but not on preparation. As MESA built its case for funding the facts began to emerge, including the realization that many students could not enter certain majors even if admitted due to a lack of preparedness. The counter argument was underrepresented enrollment numbers were growing on California university campuses; however, MESA argued that students were not graduating nor were students majoring in STEM disciplines. The second argument centered on a particular component of the MESA program. Historically, MESA provided students extrinsic financial rewards (about $400 per year) for school performance. Critics believed students should not receive financial rewards. MESA Executive Director Bob Finell would make the case "this is exactly what middle and upper-class parents do for their students, except their awards are much higher than MESA's. Many of our students come from families with limited incomes. Their parents can't offer bonuses" (as cited in Somerton et al., 1994, p.120). The third argument levied against MESA pertained to how one university would serve as the fiscal agent responsible for disseminating money to other sites and recording program match.

2.4.3 Impact And Outcomes Of Washington MESA

WSM began in 1982 (Washington MESA About Us Webpage, 5/21/2017). Today WSM is housed in the University of Washington's [UW] Office of Minority Affairs and Diversity [OMA&D]. The program was formally housed in the UW College of Engineering [COE]. WSM has a board that consists of industry representatives, academia, and government and community officials. WSM, *"*builds a pathway to college and careers in science, technology, engineering, and mathematics [STEM], for students who are underrepresented in STEM fields: African American, Native American, Latino, and women students.*"* (Washington MESA Who We Serve Webpage, 2017). The overarching mission is to leverage partnerships among school districts, institutions of higher education, government, business, community, families, and program alumni to prepare underrepresented students for STEM majors and careers. While there is no public performance data available on program participants, Table 3 provides an overview of students served.

Table 3: Washington State MESA Students Served

K-12 Programs	
Students(MESA/NON MESA)	4000
Engineering Fellows	1400
School Districts	18
Schools	56
High Schools	22
Middle Schools	34
Elementary Schools	4
University Partners	7
Teachers	85
Community College Programs	
Community Colleges	12
University Partners	2

*WA State MESA Website, Welcome Page 2018

The MESA Board and industry partners have been vital collaborators who have impacted MESA's ability to implement programming and serve thousands of participants. According to the MESA WAY, "from the earliest planning sessions, MESA program founders recognized the importance of linking with industry and business. Role model engineers who could meet with students on field trips and financial support from industry were both essential for program success" (Somerton et al., 1994, p. 97). While some industries in the early years of MESA were on board, it was difficult to bring others along because there was a general belief that the payoff for investment was not immediate. MESA officials and early industry partners were strategic as they developed a plan for greater industry engagement; they leveraged existing industry partners to help facilitate recruitment. A specific example is cited in the MESA Way where Stephen Bechtel Jr., Chairman of the Board of the Bechtel Corporation, decided to support MESA and requested other executives do the same.

With an initial board in place MESA was then able to actively solicit funds. As MESA's visibility grew the program received attention from local and state government officials. During the 1970s MESA noted most of the existing pre-college programs were requesting full funding from the state government but MESA believed they could offer an alternative funding model that was match-based with state funds and private dollars. By the late 1970s California MESA had received state funding (a trend that has continued). This pattern is also true in Washington State where the MCCP program received funding from the state legislature.

2.4.4 Nature Of Student Participants

MESA targets students who come from underrepresented minority communities and women from grades K-20. A student should have an interest in pursuing a STEM major in college and a STEM career. Finally, a student should be on track to take certain level science and math

coursework that will prepare them to be successful at the post-secondary level (Somerton et al., 1994, p. 3). During the early stages of the MESA program, elementary and middle school students are nurtured around math and science via hands-on activities. When students transition to high school they work closely with their advisor on course selection. It is important to note MESA recruits the family as an equal partner. Families are vitally important to student success and are involved in conferences and trainings.

MESA USA is the national office that has been in existence for no more than ten years. According to a source close to the MESA program, the national office would like to be a leader for the MESA consortium; however, they currently have little power as a volunteer board. The office primarily provides guidance on macro-level ideas (e.g. scope of national competitions) but with little follow-up on specific details. MESA USA communicates with state offices that are headed by an executive director. Each state office has a staff who oversees state programs and ensures programs adhere to the MESA model. State offices provide orientations and leadership development, grow the funding base, garner industry support, oversee board involvement, and conduct regional meetings and trainings. Each state office has an advisory board that consists of education administrators, government officials, industry, and community leaders. Within each of the states there are regional site directors who are supported and housed on a university campus. These directors oversee programming with partner districts, schools and MESA teachers. According to a MESA source, leadership is key. The difference between a strong director compared to a laissez faire director can make or break a program, as they influence student recruitment and student engagement (MESA Source, personal communication, July 16, 2014). The regional sites also have boards. Each of the programs has a MESA center and each of the centers requires a university sponsor.

MESA had the foresight in 1970 to see the challenges relative to STEM talent production and the shift to a knowledge economy that would negatively impact the country in future years. The previously cited pre-college literature outlines the complexities of the college-going process. It also cites one of the major challenges with pre-college programs is their ability to provide well-funded and coordinated services that mirror the complexities and predictors of college readiness. From its inception MESA can be described as an intersegmental program consisting of multiple prescriptive components. Part of the rationale for the prescriptive components that make up the MESA model are attributed to the known complexities of the college-going process. Through the years, MESA has gained national and state notoriety. In recent years MESA has received additional funding to support efforts in specific Washington State community colleges. Building on more than 40 years of service delivery, there are opportunities to ask new questions and consider ways to enhance the foundational work of the MESA program.

2.5 Introduction Of Theory

The remainder of chapter two provides context for Carol Dweck's Entity vs. Incremental Theory (Blackwell & Dweck, 2007; Good, Rattan & Dweck, 2012; Yeager & Dweck, 2012; Dweck, 2016), the Farrington et al. model (2012), and Bronfenbrenner's Bioecological Theory of Human Development (1976, 1994, 2006).

2.5.1 Theoretical And Practical Implications

Theory is the result of, "the need people have to make sense out of life. It enables the organization and interpretation of the enormous amount of information that exists in the world" (Evans, Forney, & Guido-DiBrito, 1998, p. 16). Rodgers (1980) supported the idea that formal theory provides, "a set of propositions regarding the interrelationship of two or more conceptual

variables relevant to some realm of phenomena. It provides a framework for explaining the relationship among variables and for empirical investigations" (as cited in Evans et al. 1998, p. 16). DiCaprio, (1974) asserted theory has four main functions: the ability to describe, explain, predict and control (as cited in Evans et al., 1998).

2.5.2 Carol Dweck's Mindsets

Carol Dweck's work on growth vs. fixed mindsets has been a cornerstone of psycho-social literature related to persistence, motivation and perseverance. This theory and body of work is a cornerstone in the Farrington et al. model (2012). There is supporting evidence that mindsets impact academic success (Aronson, Fried, & Good, 2002; Blackwell, Trzesniewski, & Dweck, 2007; Cury, Da Fonseca, Zahn, & Elliot, 2008; Good, Aronson, & Inzlicht, 2003; Good, Rattan, & Dweck, 2012; Stipeck & Gralinski, 1996 as cited in Dweck et al., 2012). Blackwell et al. (2007) cite research by Aronson et al. (2002) that looked at students who were in college and their direct exposure to growth mindset teachings. The researchers had three groups: one that received instruction on growth mindset, a second group who had no treatment and a third group who learned about "multiple intelligences". The researchers controlled for several variables. The results showed the students who had explicit instruction on growth mindset earned higher grades than the other two groups.

Fixed vs. growth mindsets rests on the belief that intelligence is either innate (a "fixed" trait) or it is malleable and can be altered through experience, learning, and hard work. Depending on the type of mindset an individual prescribes to, this has an impact on how they approach academic tasks. Mindsets have the potential to influence growth or derail student success. Those with a fixed mindset are crippled and afraid people will judge them as failures; they are not resilient. However, individuals with growth mindsets see failure as an opportunity for growth

and to learn from the set back. Dweck has tested this theory of the mindsets across multiple research studies with varying age groups.

> "As you begin to understand the fixed and growth mindsets, you will see exactly how one thing leads to another-how a belief that your qualities are carved in stone leads to a host of thoughts and actions, and how a belief that your qualities can be cultivated leads to a host of different thoughts and actions, taking you down an entirely different road" (Dweck 2016, p. 10).

The theory acknowledges that mindsets alone are not enough, people also have variable access to different opportunities and resources. Table 4 draws on characteristics of growth and fixed mindsets as outlined in Blackwell & Dweck (2007), Good, Rattan & Dweck (2012), Yeager & Dweck (2012), and Dweck (2016).

Table 4: Carol Dweck's Mindset

Fixed	**Growth**
Intelligence is fixed	Intelligence is malleable
Student stay where they are safe	Student thrives on a challenge
Student does not seek help as this would show weakness	Student lean on others for help
Student hides deficiencies	Student is not afraid to ask for help
Student believes it is about proving your smart/talented	Student believes it is about developing new areas
Student will give up when faced with failure	Student will repeat tasks that they fail out
Student believes it is about the outcome	Student believes it is about the learning

2.5.3 Farrington et al. Model

Farrington et al.'s model (2012) grounded the conceptual framework for this descriptive case study. The model is based on their literature review of noncognitive factors as key aspects of student academic performance. As part of the basis for their model the authors researched questions that included:

1) What is the relationship of each factor to student academic performance;
2) Is the factor malleable;
3) What is the role of classroom context in shaping the factor;
4) Are there clear, actionable strategies for developing the factor as part of classroom practice;

5) Is there evidence that attention to the noncognitive factor would address racial/ethnic or gender gaps in student achievement?

Farrington et al. (2012) indicate that one of the best predictors of success is the GPA. However, these researchers raise the question: what does a GPA also capture or tell us about students? They assert the GPA provides insight into student academic behaviors, attitudes/mindsets, study skills, attendance, habits, time management and social skills. They believe the interface between these dynamic noncognitive and cognitive factors has a powerful influence on student academic performance. These factors interact in an environment where socio-cultural dynamics and student background also have an influence on student performance.

Noncognitive factors can have a very direct impact on student performance, "recent research on noncognitive factors has not only suggested their importance for student academic performance but has also been used to argue that social investments in the development of these noncognitive factors would yield high payoffs in improved educational outcomes as well as reduced racial/ethnic and gender disparities in school performance and educational attainment" (Farrington et al, 2012, p. 5). The researchers outlined five general noncognitive factors they believe are critical to academic performance: a) academic behaviors; b) academic perseverance; c) academic mindsets; d) learning strategies; and e) social skills.

Academic behaviors are defined as studying, handing in homework, paying attention in class or engaging in material. What distinguishes academic behaviors, is they can be seen, experienced and are visible (positive or negative). They are closely tied to achievement or academic performance. For example, greater effort and engagement with material should increase student achievement.

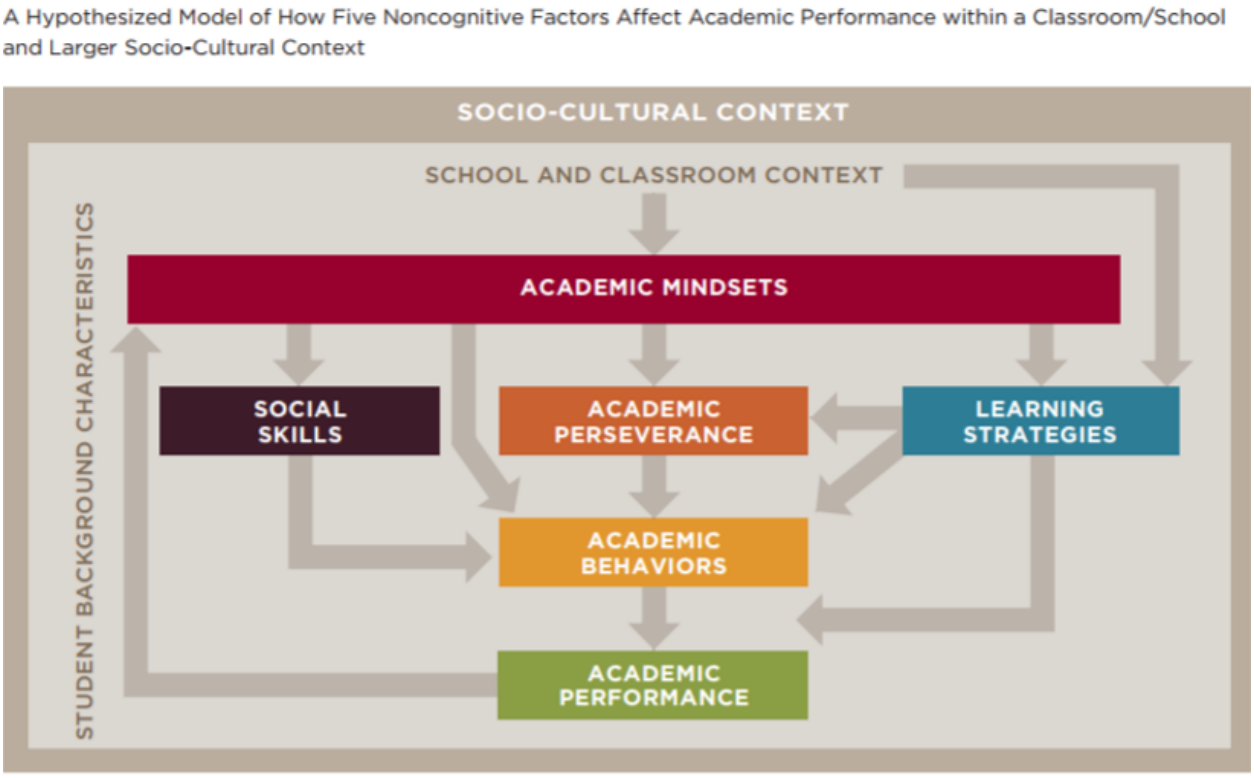
Academic perseverance is also a key component of their model. Academic perseverance is described as grit, tenacity, self-discipline, or self-control. Academic

perseverance is psychological. According to Farrington et al. (2012), what distinguishes academic perseverance are those students who do the minimal amount of work required vs. those who go above and beyond. Students described as having academic perseverance can overcome academic and or personal challenges; that is, they are resilient.

Academic Mindsets are a central part of the model. Farrington et al. acknowledge that the work of Dweck serves as a foundation theory for their concept of academic mindset, including Dweck (1986) and Dweck and Leggett (1988). Academic mindsets are described as a student's belief about their ability to change, grow, and develop in relation to their academic prowess and performance. Farrington et al. (2012) indicate, "there is also a reciprocal relationship among mindsets, perseverance, behaviors, and performance. Strong academic performance "validates" positive mindsets, increases perseverance, and reinforces strong academic behaviors. Note this reciprocal, self -perpetuating system also works in a negative loop. Negative academic mindsets stifle perseverance and undermine academic behaviors, which results in poor academic performance" (Farrington et al., 2012 p. 9). There are four academic mindsets: a) belonging to an academic community, b) ability and competence to grow with effort, c) belief in the ability to succeed, and d) recognition that the work has value. As these four academic mindsets are strengthened, there should be an increase in academic perseverance and academic performance. **Learning strategies** are also part of the model that fosters academic perseverance, academic behaviors and academic performance. Learning strategies can be characterized as study skills, metacognition or goal setting. Finally, there are **social skills** that influence academic behaviors and academic performance. Social skills are defined as cooperation, interpersonal skills, or assertion.

The literature review conducted by Farrington et al. (20102) provides evidence to support the authors' model. The authors do acknowledge more research needs to be conducted on how the model and strength of the relationships among all the factors interact. Most of the research is correlational and not casual, limiting practitioners' ability to make informed decisions about practice and student growth. The figure below is the Farrington et al. model (2012).

Figure 2: A Hypothesized Model of How Five Noncognitive Factors Affect Acdemic Performance Within a Classroom/School and Larger Socio-Cultuarl Context



2.5.4 Bronfenbrenner's Bioecological Theory Of Human Development

Bronfenbrenner's theory (1976, 1994, 2006) also informed this study. His theory, one of the most recognized in the genre of socio-ecological models, examines relations across individual and environmental interactions. Two propositions ground his theory.

Proposition One:
As individuals move through life their interactions and experiences are more complex. The interactions occur in dynamic environments that involve other individuals as well as symbols or objects that delineate meaning. While the interactions are complex the depth and breadth are critical to growth and outcomes (proximal process).

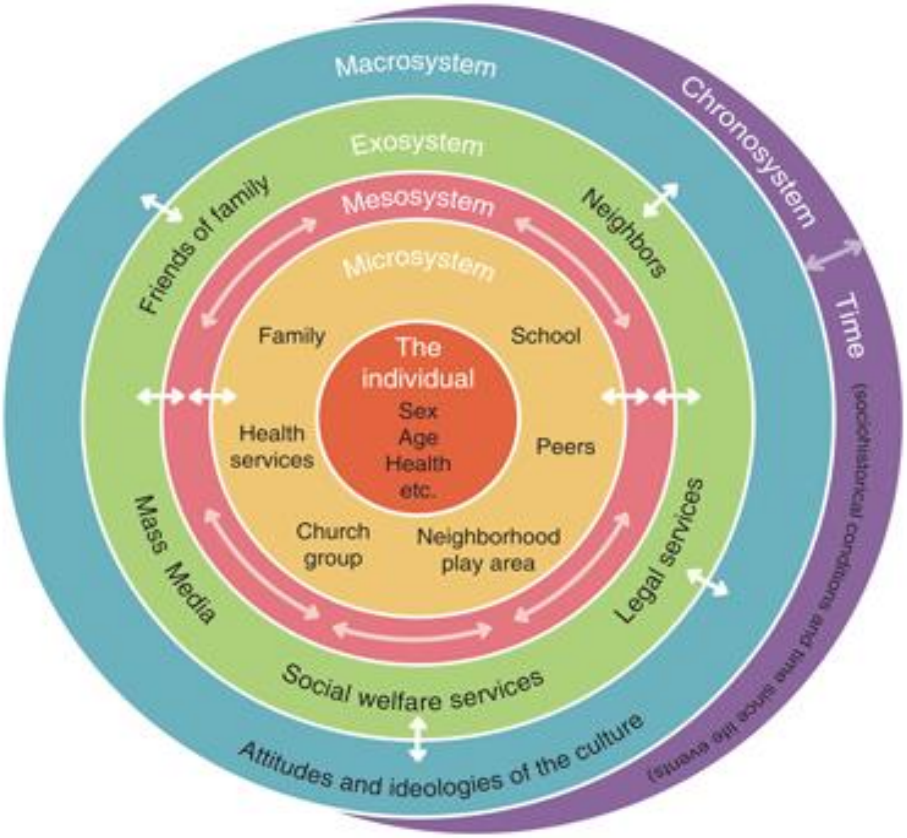
Proposition Two:
Proposition two focuses on the dimensions of the interaction including the form, power, content, and direction of the proximal processes (Bronfenbrenner, 1993, pg. 38).

This theory was applicable to this mixed methods descriptive case study because: a) it supports the idea that students are impacted by the ecosystems they are a part of, and b) the spheres of influence in an ecosystem can have a small or a more robust impact depending on proximity (e.g. day to day family interaction vs. government policy), duration of engagement and depth and breadth of interaction. This theory aligns with Farrington et al.'s model (2012), specifically with respect to the student academic mindsets. Farrington et al. (2012) emphasize the role of academic mindsets as a key factor in increased academic performance. This includes "belonging to an academic community". Students need to feel like they are part of an academic learning community. As students enter the MESA program they are selected into an ecosystem with actors and influences that have the potential to have profound effects on their academic performance. In the MESA ecosystem, there are a set of prescriptive components that students are exposed to during their time with the program, as well as environmental actors.

This theory focuses on the role of the environment as a system that is comprised of five smaller ecosystems that are bi-directional in influence: microsystems, mesosystems, exosystems, macrosystems and chronosystems. Microsystems are closest to the individual and can include interactions with family and relatives. These interactions are the most salient given proximity

and influence. Mesosystems are the interaction between two systems (e.g. family unit and school community). Exosystems are larger social systems that an individual may not directly participate in but the system has influence in their life. Examples include a parental workplace. Macrosystems are made up of cultural values, customs and laws. These systems may coalesce around class, ethnicity or gender and can drastically impact an individual. An example might include the criminal justice system and its potential effects on communities, families and the individual. Finally, chronosystems acknowledge the dimension of time. Examples include aging, death, and or moving (Bronfenbrenner, 1994). Figure 3 depicts the five ecosystems that an individual may be part of or influenced by during their lifetime.

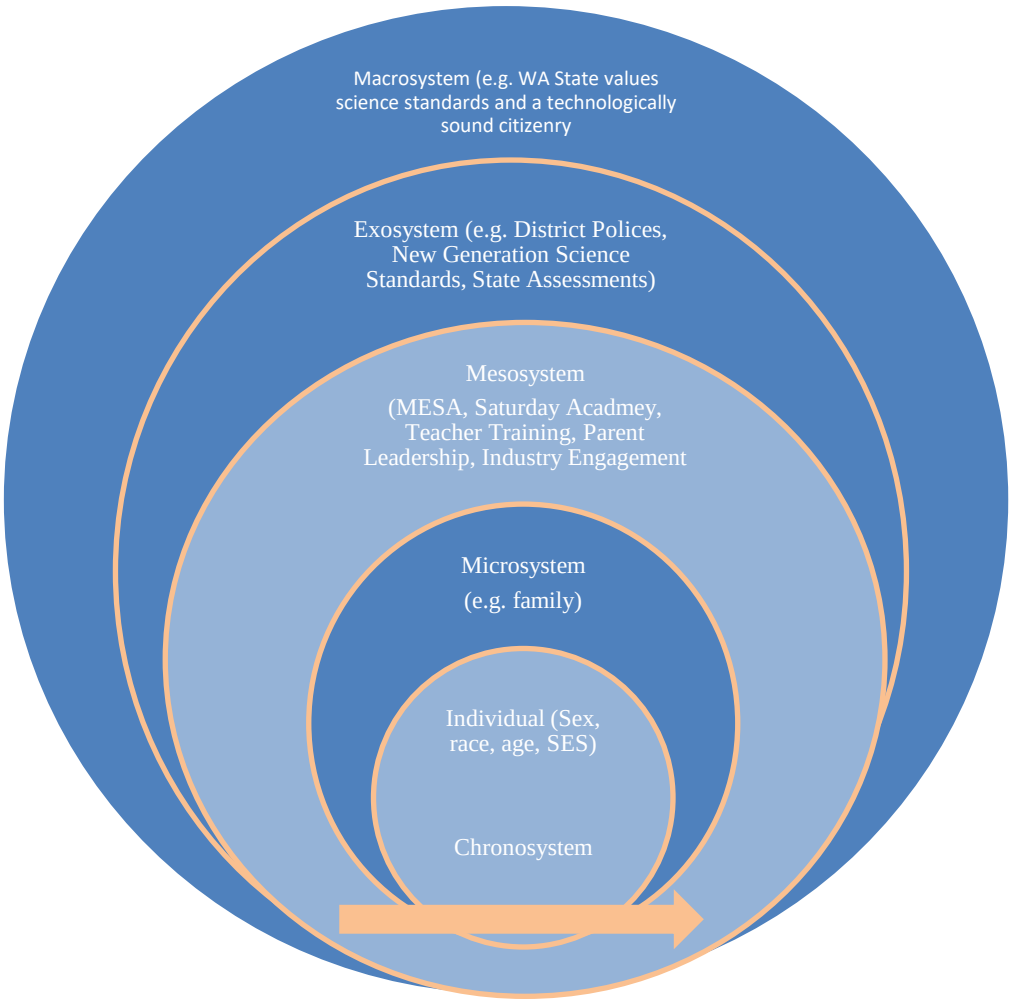
Figure 3: Bronfenbrenner's Bioecological Theory of Human Development



*Retrieved from Microsoft images November 2018, Images of Bronfenbrenner's Bioecological Model

Figure 4 provides an adaptation of Bronfenbrenner's Bioecological Model as designed by the researcher. What is unique to this reimagined model are the components of the WSM program are included in each of the systems. This model helps to connect theory to practice. The program components are most appropriately situated in the model based on the definitions for each of the systems included in Bronfenbrenner's theory and knowledge gained from the MESA and WSM literature review. For example, Mesosystems are the interaction between two systems such as family unit and school community, thus Parent Leadership Development would be included within the Mesosystem.

Figure 4: Adaptation of Bronfenbrenner's Bioecological Theory of Human Development to Include MESA Programmatic Components



Individual Level

At the individual level, MESA participants enter the program with individual pre-determined and or circumstantial demographic characteristics e.g. gender, race, age, and family income status. It is acknowledged that other forces and experiences outside of MESA may influence student outcomes, this is also supported by the Farrington et al. model (2012). As students progress through the education continuum it is well documented that race, ethnicity, and income are strong predictors of the types of schools students access, and the quality and credentialing of the teacher and school resources that will be available to them. Students from underrepresented, and

low-income families are disproportionately affected from an early age, as they are usually concentrated in less resourced schools, and with teachers who have fewer years of experience in the classroom. This is compounded with a lack of college role models and few opportunities for experiential learning to enhance social, cultural and career capital that are necessary for success within post-secondary environments. These dynamics then have the potential to impact student mindsets, academic perseverance, academic behaviors and ultimately their performance. If resources are not available for experiential field trips, lab equipment or text books this hinders a student from being able to participate in critical learning. The interface of individual demographic variables and the environment, place greater emphasis on the need for MESA programming.

Microsystem

These systems are characterized as interactions with those closest to the individual (family, relatives or friends). Because of the proximity of these interactions and their significance to the individual they are critical to the formative years and experiences of a student (individual). Many of the students targeted for participation by MESA are from first generation, low-income and or underrepresented minority backgrounds. Because students with these demographic characteristics may not have parents or guardians who went to college, obtained a credential/degree, and or work in a STEM field, they may be limited in their ability to assist their student with the STEM content that is necessary to learn and master at the high school level. The operating assumption is those individuals closest to student participants may be able to provide general support, but not the specificity or technical level of support needed to master content, apply to college, and or seek out STEM related career opportunities. The result will be a greater reliance on MESA peers and actors (e.g. teachers, STEM professionals, mentors, college

tutors) in the MESA ecosystem who can provide the needed support to build a specific set of competencies.

Mesosystem

The mesosystem is where much of the MESA interactions occur among participant's and actors. This system is categorized as the interface between two systems (e.g. family/student and MESA program situated in a school building), though sometimes has the potential to fall outside of a school context (e.g. at an industry site). These components are closely linked to the actors in the environment whose role and responsibilities (formal and informal) are to facilitate learning, knowledge acquisition and content mastery. Components and actors may exert more influence than others depending on their function (e.g. parent leadership development vs. MESA periods).

Exosystem

These are larger social systems that an individual may not directly participate in but the system has influence over their life. Examples might include district policies, MESA advocacy work, federal accountability, parent workplace, STEM industries, and higher education institutions. One example is federal education policy such as the reauthorized Every Student Succeeds Act [ESSA]. This policy is being implemented in Washington State K12 schools and calls for 95% of students to be tested through a statewide assessment. Because of federal policy and state-level assessments required for graduation from Washington State high schools (note there are some exceptions to alternative testing) there is a focus on students becoming competent in subject matters including English Language Arts and Math. There are also New Generation Science Standards that require teachers focus on interdisciplinary applicable science content. Both examples would have the potential to influence student outcomes.

Macrosystems

Values, culture and belief systems are at the center of the macrosystem. Being in the Pacific Northwest where there is a saturation of STEM companies. This is seen in the new construction of research labs, policy, the Governor's budget, product launches, the news, philanthropic giving, and STEM companies that are partnering with K12 education on special initiatives. STEM is highly valued in Washington State and has a major impact on the state's economy. Given the prevalence of STEM and the specific challenges of filling industry positions, there has been a concentrated effort in Washington State to expand access to computer science coursework, accelerated learning, a focus on New Generation Science Standards, and more involvement from STEM industries in the K20 pipeline. This has the potential to impact students as they are exposed to new opportunities to learn, participate in hands-on science, connect classroom learning to real-world industry and acquire technical skills such as coding.

In summary, the Farrington et al. model (2012) provides a framework to think about how students in the WSM program move through their STEM trajectory and identify areas for enhanced programmatic support. Each of the five factors identified in Figure 5 (Farrington et al. 2012) are critical to student success along the continuum. Figure 5 also includes specific descriptors of each of the five factors. This model acknowledges the role socio-cultural content, student background characteristics, and the environment can assert on student outcomes. This is reinforced by the Bronfenbrenner theory (1976, 1994, 2006) and supporting literature (Ramsey et al., 2013; Cole & Espinoza, 2008; Aschbacher et al., 2009). Research by Farrington et al. (2012) and multiple independent studies support the relevance and significance of the interactive noncognitive factors: academic mindsets, academic perseverance, social skills and learning strategies, academic behaviors, and academic performance (Ramsey et al., 2013; Cole &

Espinoza, 2008; Aschbacher et al., 2009; Russell et al., 2005, Wagstaff, 2014; Good, Rattan & Dweck, 2012; Yeager & Dweck, 2012; Dweck 2016; Carlone & Johnson, 2007; Steele et al., 1995; Seymour & Hewitt, 1997; Blackwell & Dweck, 2007).

Figure 5: Detailed Model Based on A Hypothesized Model of How Five Noncognitive Factors Affect Academic Performance Within a Classroom/School and Larger Socio-Cultural Context (Farrington et al. 2012)

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Chapter 3. METHODS

3.1 INTRODUCTION

Chapter three provides an overview of the mixed methods descriptive case study design, data collection, sampling and analytic approach.

3.2 STUDY DESIGN AND RELEVANT METHODOLOGICAL LITERATURE

A mixed methods descriptive case was selected for this dissertation. Yin asserts, "case studies arise(s) out of the desire to understand complex social phenomenon" (Yin, 2009, pg. 4). Case studies can be both exploratory and explanatory. The questions raised in this case study focused on both "the what-exploratory" (e.g. what we can learn about the growth oriented and academic mindsets of high school minority and female high students in the Seattle MESA program) and "the why and how-explanatory/descriptive". This method was selected after consideration of posed research questions, control over behavioral events, and a focus on current events/ phenomenon (Yin, 2009). Case studies typically rely on multiple data sources (triangulation), thus this study included a student survey, student focus groups and semi-structured interviews with individual teachers, program director and WSM administrator. Yin believes case studies can provide "analytic generalization" but they are not meant to "statistically generalize". For case studies to provide analytic generalization they would need to be repeated overtime with a focus on the same phenomenon (Yin 2009). The data gathered from this study was not randomized or generalizable; however, the value of the case study lies in its ability to complement an existing or future research study that is based on causal relationships. Before proceeding with the study an IRB application was submitted and it was confirmed that the nature of the dissertation did not require a more in-depth IRB review based on the scope of the

dissertation. It was also confirmed with WSM administration that there were signed student contracts on file that permitted students to participate in surveys and focus groups.

Table 5: Mixed Methods Descriptive Case Study Design

Method	**Data Collection Technique**	**Timeline**	**Sample/Population**	**Description**
Qualitative	Director Meetings	Winter/ Spring 2018	Selected MESA sites	General meetings with staff to articulate study-what is feasible, get a sense of how programming occurs in the field. One-two visits per site.
Quantitative	Student Survey	Spring 2018 (includes time to analyze)	Sampling strategy included census with an attempt to collect as many responses as possible from Seattle MESA high school students at five sites selected for the study	Surveys will provide quantitative data on minority and female students growth oriented and academic mindset.
Qualitative	Semi Structured Focus Group #1, Focus Group #2	Spring 2018	Purposeful sampling (typical case sampling) recommendations provided by advisors/directors (N=3-5). Audio recorded with transcription, 1 hour.	Open-ended questions may provide additional/complimentary information captured in the student survey.
Qualitative	Semi Structured Teacher Interviews *conducted separately	Spring 2018 (includes time to analyze)	Two Seattle MESA teachers identified by Seattle Director	Responses will be compared against student focus group responses.
Qualitative	Semi-Structured Director Interview	Spring 2018 (includes time to analyze)	One Seattle MESA Director	Responses will be compared against student focus group responses.
Qualitative	Semi-Structured WSM Administrator Interview	Spring 2018 (includes time to analyze)	One WSM Administrator	Responses will be compared against student focus group responses.

3.3 DATA SOURCES

Data for this study was drawn from high school minority and female participants in the Seattle MESA program and MESA Staff. Since its inception more than 40 years ago, MESA has served many students. Students are typically from low-income, first generation and or underrepresented backgrounds. MESA contributes part of its success to components of the MESA model. A1993 report entitled *K through 12 School Reform: Implications and Responsibilities for Higher Education* described MESA as an intersegmental structure consisting of multiple components. The MESA components are prescriptive, meaning they are standard across the 11 states where MESA is operational. Each of the MESA components has a model that serves as a guide for how activities should be implemented. The Seattle MESA program consists of five high schools that were selected for this mixed methods descriptive case study because of: 1) active leadership who could help facilitate data collection at the identified sites, 2) the schools selected within these areas had active programming, and 3) proximity to the researcher. The five high schools each prescribed to a different version of the MESA program model as illustrated in Table 6.

Table 6: Seattle MESA High School Program Models and Students Served

School 1	In-class Model	50 participants
School 2	After School Club	15-20 participants
School 3	After School Club	5 participants
School 4	After School Club	15 participants
School 5	Saturday Academy	2 participants
		87-92 total

*Students from all schools can participate in Saturday Academy

3.4 METHODOLOGY

There are six regional WSM K-12 offices around Washington State (and 15 high schools): Seattle MESA, Southwest Washington, Spokane, Tacoma/South Puget Sound, Yakima/Tri-Cities, and First Nations. Each of these offices is sponsored by a university program and has

multiple satellite schools with a MESA Center. Visiting each office and the centers was not feasible given time, resources, and distance; therefore, Seattle MESA was selected. The researcher met with the Seattle MESA director and the WSM Senior. Associate Director in person and via telephone to talk about the goals of the study.

3.4.1 Student Sample and Data Collection

Working with the Seattle Director, affiliated high school students within the five identified high schools were provided with an electronic survey (Appendix A). All MESA students (regardless of self-reported race/ethnicity) were asked to participate in the survey but there was a focus on responses from those who self-reported as a minority (defined as African American, Latino, Native American or Pacific Islander) and or of the female gender. The survey was developed by the researcher and informed by the dissertation questions and relevant literature cited in chapter two. The survey consisted of 33 close-ended questions. The goal was to have questions 6-19 address growth-oriented mindset and questions 20-33 address academic mindset. The questions were developed by drawing on Dweck's theory, definitions and characteristics of growth-oriented mindset and Farrington's model and description of the characteristics associated with an academic mindset. All questions were likert items that provided for the following responses: Strongly Agree, Somewhat Agree, Disagree, Strongly Disagree. No personal identifiers were part of the survey. The survey questions were primarily focused on the "what" (e.g. what is the current growth oriented and academic mindset of high school minority and female students in the Seattle MESA program). The survey was taken online using the Qualtrics platform and proctored by the researcher with assistance from MESA staff. The researcher first administered the survey at one of the five Seattle MESA high school sites were there were two MESA classes and then again at an all-day Saturday Academy were there was a mix of students from each of

the five Seattle MESA high schools. The responses to the survey questions were triangulated with responses from the focus groups (high school minority and female students in the Seattle MESA program), and semi structured individual interviews with WSM teachers, the program director and WSM state administrator.

3.4.2 Analytic Approach for Student Survey

The first phase of the descriptive case study examined the growth oriented and academic mindsets of high school minority and female students in the Seattle MESA program. The researcher analyzed responses to the 33 survey questions. Responses to each survey question were reported as a percent of the total survey respondents within each question (e.g. 40% of students who answered survey question #1 indicated they agreed with the statement). The researcher reported individual item response rates and then identified overall themes. Through survey analysis, the goal was to look for themes related to the following two questions: 1) how do high school minority and female students participating in the Seattle MESA program describe their growth oriented and academic mindset? and 2) are there gender differences in growth oriented and academic mindset as reported by students? Survey results were used to triangulate responses from the semi structured focus groups.

3.4.3 Student Sample and Data Collection (Semi Structured Focus Groups)

Two student semi structured focus groups were conducted during the spring. One was held at one of the Seattle MESA high schools that had an in-class MESA program. The other focus group was held at an all-day Saturday Academy where the participants were from each of the five Seattle MESA schools. The goal was to identify 3-5 students who could provide case rich information that expanded upon the survey data. Purposeful sampling (typical case sampling)

with recommendations from the program director, staff and teachers informed participant selection. Participants who identified as a minority or female were included in the focus groups. This data collection method (focus group) was a more viable option to obtain detailed responses versus the close-ended survey. The focus groups provided an opportunity to understand how students think about growth oriented and academic mindsets and what ways the Seattle MESA environment fostered a growth oriented and academic mindset for students, including the specific strategies and the rationale for those strategies. While there was a set of pre-determined questions, the researcher allowed for exploration of additional questions and themes that arose and connected with the dissertation topic. Responses were analyzed for common themes. Focus group participants included high school minority and female MESA students in grades 9-12. All focus groups were audio recorded with transcription. Participants were informed about the nature of the study and confirmed consent. The researcher worked with the site director and WSM administration to verify students' guardians cleared their participation via a consent form through the MESA program. Focus groups were no more than one hour.

The student focus group questions explored in this descriptive case study can be found in Appendix B. Open-ended questions were asked during the focus groups because the literature suggests student behavior cannot always be observed; therefore, the focus groups provided an opportunity to obtain a first-hand account of what students think about the topics raised by the researcher (Patton 2009). Patton (2009) also suggests there are three interview types: a) informal conversational interview; b) general interview guide approach; and c) standardized open-ended interview. In a general guided approach the research has predetermined questions that may serve as a guide but if there are themes or topics that emerge the researcher may ask additional questions that are not predetermined. This option was selected because the researcher wanted to

assure topics of interest were systematically covered by all respondents, as to minimize question variation and straying from the topic while also allowing for flexibility to pursue topics of interest to students.

3.4.4 Analytic Approach for Student Semi Structured Focus Groups

Focus group questions were based on the supporting framework and theories cited in chapter two. While qualitative data generated from the focus groups included a smaller number of cases, there were multiple pages of transcription for analysis. The goal included taking large amounts of qualitative data and analyzing and organizing the data into meaningful themes. Rev.com provided all of the transcription. The researcher developed a coding system that was based on a priori codes (pre-determined), however a limited number of codes were added as they emerged during the analysis phase (see Appendix H). Each transcript was reviewed multiple times.

3.4.5 Teacher Sample and Data Collection

Two MESA teachers were individually interviewed. These individuals were identified with the assistance of the program director and had worked in the same schools as the student focus group or survey participants. The individuals included a MESA teacher who ran an in-class, year-long MESA program, and a teacher who ran a MESA after school club. This data collection method (individual semi structured interview) was a more viable option to obtain detailed responses versus the close-ended survey. The individual semi structured interviews provided an opportunity to understand how Seattle MESA teachers thought about 1) the growth oriented and academic mindsets of their students, 2) the ways the Seattle MESA environment fosters a growth oriented and academic mindset for students and what strategies are used, and the rationale provided for these strategies, and 3) the implications of this inquiry for policies and practices

used in implementing a MESA high school program. Responses were analyzed for common themes among the students, teachers, program director and WSM administrator. Interviews were audio recorded with transcription. Participants were informed about the nature of the study and confirmed consent. Interviews were no more than one hour. The MESA teacher semi structured interview questions can be found in Appendix C.

3.4.6 Director Sample and Data Collection

The Seattle MESA director was individually interviewed. The director oversaw the MESA program that was operating in the same schools as the student focus group and survey participants. The individual interview provided an opportunity to understand how the Seattle director thought about 1) the growth oriented and academic mindsets of their students, 2) the ways the Seattle MESA environment fostered a growth oriented and academic mindset for students the strategies that were used, and the rationale provided for these strategies, and 3) the implications of this inquiry for policies and practices used in implementing a MESA high school program. Responses were analyzed for common themes among the students, teachers/instructors, the program director and WSM administrator. The interview was audio recorded with transcription. The participant was informed about the nature of the study and consent was confirmed. Interviews were no more than one hour. The Seattle Director semi structured interview questions can be found in Appendix D.

3.4.7 WSM Administrator Sample and Data Collection

One WSM administrator was independently interviewed as part of this mixed methods descriptive case study. This data collection method (semi structured interview) was a more viable option to obtain detailed responses versus the close-ended survey. The individual

interview provided an opportunity to understand how WSM administration thought about: 1) growth oriented and academic mindsets of their students, 2) the ways the Seattle MESA environment fostered a growth oriented and academic mindset for students, strategies that were used, and the rationale provided for these strategies; and 3) the implications of this inquiry for policies and practices used in implementing a MESA high school program. Responses were analyzed for common themes among the students, teachers, the director and WSM administrator. Interviews were audio recorded with transcription. The participant was informed about the nature of the study and consent was confirmed. The semi structured interviews were no more than one hour. The WSM administrator semi structured interview questions can be found in Appendix E.

3.4.8 Analytic Approach for Semi Structured Interviews

Semi structured interview questions were based on the supporting framework and theories cited in chapter two. The goal for the individual semi structured interviews involved taking large amounts of qualitative data and organizing into meaningful themes that were informed by the study's conceptual approach. Rev.com provided all of transcription. The researcher developed a coding system that was based on a priori codes (pre-determined), additional codes were added as they emerged during the analysis phase. Each transcript was reviewed multiple times. This approach was taken for each of the three semi structured interviews.

Chapter 4. **FINDINGS AND RESULTS**

4.1 INTRODUCTION

Chapter four provides a discussion of the findings from an analysis of the multiple forms of data which has been collected, namely, student surveys, student focus groups, and semi structured interviews with staff. Data analysis was guided by the previously cited literature and the study's conceptual framework.

4.2 STUDENT SURVEY DEMOGRAPHICS

An electronic survey was administered to current high school students who were affiliated with the Seattle MESA program. Out of an estimated 87-92 registered MESA high school students across the five Seattle sites, 37 students responded with 36 from the focus demographic (about a 43% response rate). Seventy five percent (N=27) of the responses came from High School 1. The overrepresentation of High School 1 in the survey was higher than their representation in the overall Seattle MESA program at 57% (N=50). Part of the reason for the higher response rate was the High School 1 MESA program had an in-class model where the researcher was able to survey a larger number of students at one time in a structured setting, the demographic mirrored the target population the researcher was trying to survey, and the teacher was very active in the MESA community. Additional information on response rates can be found in Appendix F. There were more male respondents than females (56%/N=20 to 44%/N=16); however, not knowing the overall gender breakdown of Seattle MESA participants hampered the ability to determine if the response rates were proportional to the gender representation in the overall population. More than half of the responses were from students who identified as Hispanic/Latino (62%/N=24), followed by African American (21%/N=8). An overwhelming

number of respondents identified as a high school junior (44%/N=16) or senior (36%/N=13). Most of the participants had been active in the MESA program (this could include elementary and middle school years) one year or less (72%/N=26) followed by 2-3 years in the program (25%/N=9). While there was no preconceived expectation on the number of years students were active in the program, the researcher does believe years of participation has the potential to impact results. Bronfenbrenner's theory as cited in chapter two, highlighted how various ecosystems with sustained exposure and services across time (with consideration of intensity of service) can affect an individual. Thinking about this in a MESA student context, it would be plausible that students who participated in a MESA program over a sustained number of years may have a stronger affinity for a particular mindset.

4.3 Student Survey-Growth vs Fixed Mindset

Questions 6-19 were based on characteristics associated with a Growth or Fixed Mindset (seven questions focused on growth mindset and seven focused on fixed mindset). Out of the seven questions that focused on growth mindset, most responses trended toward a positive affiliation with this mindset (see Appendix F). From the survey data that assessed growth mindset, it was evident most respondents held a positive disposition about their intelligence and ability to grow their intelligence despite challenges. More importantly, when presented with a challenge, respondents will ask for and seek out help. This insight was important given the challenges (discussed in chapter two) women and minority students face throughout the education continuum. If MESA students are explicitly taught about the attributes of growth versus fixed mindset and encouraged to ask for help, particularly when they feel challenged, this may facilitate persistence through the education continuum. While this study did not assess academic performance and the connection to mindset, a future study might build on information gathered

here to consider how students who prescribe to a particular mindset fair in terms of academic performance (e.g. grade point average, letter grade in STEM courses).

Part of the survey strategy was to intermingle questions that focused on growth vs. fixed mindset. For example, question six was a fixed mindset question while question seven was a growth mindset question. By randomizing the order of the questions in no particular pattern, the researcher hoped to triangulate the responses. Table 7 below captures the breakdown of survey question by mindset.

Table 7: Growth vs. Fixed Mindset Survey Questions

Growth Mindset	Fixed Mindset
Q7. I get excited when presented with a challenge.	Q6. Intelligence cannot be changed, you are born intelligent or not.
Q9. I am not afraid to ask for help.	Q8. When I do not know the answer to a question I do not ask for help because this would show weakness.
Q11. I enjoy the process of learning information that will be on my test as much as the letter grade I might receive on that test.	Q10. If I fail a task then I give up.
Q13. I have the power to change my intelligence.	Q12. When I do not succeed and fail, I hide this from others.
Q14. I seek out help when I need it.	Q15. I usually don't try new things because I might fail.
Q16. I pride myself on learning new material.	Q18. I only care about the grade I receive on my test.
Q17. Even when I fail I try again.	Q19. It is important for me to prove I am smart and talented to others.

While respondents tended to identify with growth mindset questions, at least four of the fixed mindset questions indicated mixed responses (Q12, Q15, Q18, Q19-see Table 8). For example, while respondents generally believed one could grow their intelligence and would ask for or seek out help, they were more concerned with the concept of failure, hiding failure, and not wanting to seek out new material where they might fail. An example of a contradictory response is Q9 (growth mindset question) and Q15 (fixed mindset question). Ideally, if a student is not afraid to ask for help when they need it, then they should not be hesitant to try new things because they

might fail. A student identifying with a true growth mindset would embrace the idea of failure and would seek out support despite knowing they might fail. These contradictory responses highlight potential areas for programmatic enhancement within MESA.

Table 8: Responses to Growth and Fixed Mindset Survey Questions

Question	Strongly Agree	Somewhat Agree	Disagree	Strongly Disagree
Q6. Intelligence cannot be changed, you are born intelligent or not.	3	8	12	13
Q7. I get excited when presented with a challenge.	15	16	5	0
Q8. When I do not know the answer to a question I do not ask for help because this would show weakness	3	5	19	9
Q9. I am not afraid to ask for help when I need it.	**20**	**13**	2	1
Q10. If I fail a task then I give up.	2	6	14	14
Q11. I enjoy the process of learning information that will be on my test as much as the letter grade I might receive on that test.	7	23	5	1
Q12. When I do not succeed and fail, I hide this from others.	**5**	**9**	20	2
Q13. I have the power to change my intelligence.	23	12	1	0
Q14. I seek out help when I need it.	15	17	4	0
Q15. I usually don't try new things because I might fail.	**2**	**12**	12	10
Q16. I pride myself on learning new material.	20	15	1	0
Q17. Even when I fail I try again.	20	15	1	0
Q18. I only care about the grade I receive on my test.	**6**	**12**	15	3
Q19. It is important for me to prove I am smart and talented to others.	**13**	**17**	6	0

4.4 STUDENT SURVEY-ACADEMIC MINDSET

Questions 20-33 focused on the Farrington et al. model (2012) with an emphasis on academic mindset, specifically: academic community, ability to grow mindset through effort, belief in ability to succeed and value of academic work. Most of the survey responses identified with a positive academic mindset. Out of fourteen questions, ten reflected an identification with a positive academic mindset. There were four academic mindset questions (Q21, Q23, Q29, Q31) where responses were mixed, highlighting possible areas where MESA may enhance programmatic offerings to address student concerns and or lack of belief in themselves (refer to Table 9). For example, on Q21,16 of the respondents "disagreed" or "strongly disagreed" they had the ability to be a math person, which signals students may have a diminished sense of their academic math ability or math identity. As students in a program focused on STEM, and most of the students indicating they wanted to pursue a STEM major in college, this view of math ability may hamper long-term persistence in STEM.

Table 9: Responses to Academic Mindset Survey Questions

Question	Strongly Agree	Somewhat Agree	Disagree	Strongly Disagree
Q20. I can learn new academic information if I try hard enough.	24	12	0	0
Q21. I was born with the ability to be a math person.	9	11	**7**	**9**
Q22. When I get a low score on my science test I seek out help to prepare for the next one.	13	17	**4**	**2**
Q23. When presented with a math concept I do not understand I get frustrated and give up.	**7**	**6**	16	7
Q24. When presented with an academic challenge I get excited about the opportunity to succeed at the challenge.	9	22	4	1

Q25. My MESA community is a group I go to for support.	12	16	6	2
Q26. If I put in more effort I will see better results on my homework.	29	7	0	0
Q27. I see myself majoring in college in STEM	22	9	3	2
Q28. The work I am doing now in MESA has no connection to life after high school	3	7	15	11
Q29. When I have an academic setback in my class, I tend to not want to engage in coursework anymore.	**2**	**13**	15	6
Q30. When I get a good grade on an assignment I am motivated to keep trying harder.	26	9	1	0
Q31. If I get a poor grade on an exam then I feel like I am not smart.	**4**	**14**	13	5
Q32. I feel like I am part of the MESA community.	15	19	1	1
Q33. When I put in more effort to my academic studies I learn more.	25	10	0	0

4.5 Survey Responses By Gender

Finally, there were gender differences in growth and fixed and academic mindset as reported in the student survey. There were more males who responded to the survey than females (56%/N=20 to 44%/N=16); however, not knowing the overall gender breakdown of Seattle MESA participants hampered the ability to determine if the response rates were proportional to the gender representation in the overall population (more information can be found in Appendix G. Crosstabulation of Gender and Survey Responses).

Out of 28 questions, eight questions (Q6, 8, 9, 10, 12, 18, 21, 23) highlighted areas of difference across gender. For example, on Q6 female respondents tended to believe intelligence could be changed whereas male respondents were more evenly split between intelligence being a static or malleable characteristic. Q8 also showed differences by gender. While males strongly disagreed with this question at (N=6) females did not have as strong of a response with only

(N=3) who indicated they strongly disagreed with the question. Males also overwhelmingly responded to Q9 “strongly agree” when asked ”I am not afraid to ask for help when I need it”. Female respondents were more evenly split between “strongly agree” and “somewhat agree”. Q10 also saw a similar pattern to Q8. Males where more likely to “strongly disagree” with the question where females did not have as strong as a response. While the numbers where small (N=2), a handful of males who responded to Q12 indicated they “strongly disagreed” with the question. None of the female respondents felt as strongly about this question (N=0). Table 10 highlights some of these differences.

Table 10: Difference in Survey Responses by Gender

Question	Strongly Agree	Somewhat Agree	Disagree	Strongly Disagree
Q6. Intelligence cannot be changed, you are born intelligent of not.				
Males	**2**	**6**	6	6
Females	**1**	**2**	6	7
Q8. When I do not know the answer to a question I do not ask for help because this would show weakness.				
Males	3	0	11	**6**
Females	**0**	5	8	**3**
Q9. I am not afraid to ask for help when I need it**.**				
Males	**14**	**6**	0	0
Females	**6**	**7**	2	1
Q10. If I fail a task then I give up.				
Males	0	2	6	**12**
Females	2	4	8	**2**
Q12. When I do not succeed and fail, I hide this from others.				
Males	3	3	12	**2**
Females	2	6	8	**0**

Question 18, “I only care about the grade I receive on my test”, saw more males (N=5) indicate they “strongly agreed” as compared to female respondents (N=1). On Q21 males (N=7) “strongly agreed” they were born with the ability to be a math person, females (N=2) did not feel “as strongly” as their male classmates. Finally, females who responded to Q23 were evenly distributed across the likert scale, with the largest number (N=5) “strongly agreeing” when presented with a math concept they did not understand they got frustrated and gave up. Male respondents were less likely to “strongly agree” (N=2) to this question and the majority “disagreed” (N=12).

Table 11: Difference in Survey Responses by Gender Continued

Question	Strongly Agree	Somewhat Agree	Disagree	Strongly Disagree
Q18. I only care about the grade I receive on my test.				
Males	**5**	6	7	2
Females	**1**	6	8	1
Q21. I was born with the ability to be a math person.				
Males	**7**	7	2	4
Females	**2**	4	5	5
Q23. When presented with a math concept I do not understand I get frustrated and give up.				
Males	2	2	**12**	4
Females	**5**	**4**	**4**	**3**

During the data collection phase of this study, the survey was being administered at the same time as focus groups and semi structured interviews were taking place. So while the survey did not influence questions during the open ended data collection process, the survey data was integrated into the overall results discussion of the dissertation. Survey data and coded data from

the focus groups and semi structured interviews were compared to assess triangulation across themes.

4.6 Student Semi Structured Focus Groups

The student semi structured focus groups centered on two main questions:

1. How do minority and female students participating in a MESA program describe their growth oriented and academic mindset?
2. In what ways does the MESA environment foster a growth oriented and academic mindset for students? What strategies are used, and what is the rationale provided for these strategies?

These central questions included several sub-questions that were informed by the literature outlined in chapter two. In this discussion of findings from the focus groups, references will be made to results from the student survey data in an effort to compare and triangulate data from different sources.

Overall, students believed one could grow their intelligence and that environmental factors influenced ones' ability to do so. Survey results mirrored themes captured in the focus group with 97% of respondents indicating they had the power to change their intelligence (Q13). An estimated 69% of survey respondents also indicated they "disagreed" or "somewhat disagreed" with Q6 "intelligence cannot be changed, you are born intelligent or not". This was evident in the quotes from focus group participants that are captured below:

> "I believe that it's definitely a growth mindset, and that it can be molded to however we want it to be. So, depending on how someone was raised, they could have different levels of intelligence, but that doesn't mean that they can't become smarter if they want to."

> "I think that your resources do count. If you don't have a STEM class, you're not really gonna know much about STEM. So, yeah, in elementary school, they don't really tell you much about the other STEM fields. You know engineering, but you don't know there's other levels like mechanical and stuff. So, you wouldn't know much about it until you get in an environment like that."

> "In the beginning of the program I didn't really know anything about Marine Ecology or about ocean life and now I do. I know more about how our actions and the things we do every day affect marine life and how they affect our ecosystem and our communities."

> "Students who have less resources than other[s], also have less opportunities in a way and I guess many of those students have more of a fixed mindset because they're constantly being told that they are in this situation because of their history or this or that. So many times, there's students who are very negative about learning because they believe that they can't. So, because they are told this and many times they see that they are stereotyped so the people who are running the government are many times saying negative things about them. So, that's why I believe that many times students of color struggle a little more with the fixed mindset."

As the survey bears out, some students believed intelligence was a fixed trait while others believed it could be developed. Focus group questions aimed to better understand what students attributed to these differences in mindset. For example, did students associate messages from society, teachers, peers, and or MESA staff with how they thought about themselves? Did students think positive or negative messages derailed or propelled them to grow as young adults on a STEM pathway? **Environmental factors were cited as the number one reason for differences in students' mindsets.** One focus group participant explained it in this way:

> "I think what people say to you, I think actually makes a difference. Let's say my last year[s] teacher told me don't go to AP Calc. You're not smart enough. You're not ready. You're just going to fail. But my parents or my friends, would say, oh don't do that. Why do you do that? I think that brings you down, but when you have people behind you that actually believe in you and support you, I think that affects the way you work and your mindset as well."

Ethnicity and race were also salient in the focus group conversations. A few participants were in honors or Advanced Placement courses and indicated they were one of a handful of minority

students in the class. When asked if being the only person who "looked like them" in the class impacted their mindset, they indicated "yes".

Part of the questioning during these semi structured focus groups probed to better understand mindset and its relation to how students approached and worked through an academic challenge. How does mindset play into how students recalibrated themselves when a challenge was presented? This is particularly significant when thinking about students being the "only one" in a classroom, or the student who did not pass the calculus exam. An estimated 86% of survey respondents indicated "they were excited when presented with a challenge" (Q7) and an estimated 78% "disagreed" or "somewhat disagreed" with Q8 "when they didn't know the answer to a question they did not ask for help because this would show weakness".

Focus group responses were coded across a priori codes that included: other, mindset helps them realize they need to reassess strategy, and their mindset encourages them to keep going and not give up**.** One focus group participant who identified with the common student theme "mindset encourages them to keep going and not give up" stated:

> **"It definitely does, yeah...I feel like if you fail at something and then your mindset is set like, oh, I can't do this. I'm gonna just try and change it like so something else but you're always gonna be afraid of that one thing. So, I feel like just keep trying. Eventually it's gonna come to you and then you're able to overcome that challenge at some point."**

More than 80% of survey respondents indicated that when they received a low score on their science test they would seek out help to prepare for the next one (Q22). On the contrary, almost 40% of respondents indicated that when they experienced a failure they would hide it from others (Q12) and almost 40% or survey respondents said when presented with a math concept they did not understand they get frustrated and give up (Q23).

Student responses varied when asked how a student's mindset impacted their academic behavior (e.g. wanting to go to class, doing homework). Focus group responses ranged from identifying with "they show up to class", "are more engaged in the classroom", "when they have a growth mindset they are more eager to lean in and ask a lot of questions" and "other". As the literature in chapter two indicates, if an individual has a growth mindset and they believe they can grow their intelligence (e.g. what can I learn from this experience), that will influence a person's behavior, including how they show up in the classroom. Ninety seven percent of survey respondents indicated when they get good grades on an assignment they were motivated to keep trying harder (Q30) but 50% then stated when they get a poor grade on an exam they feel like they are not smart (Q31). Which raises the question, how students show up in the classroom when they do not perform academically (e.g. passing a test)? One focus group participant student reinforced this finding by stating the following:

> **"I feel like your mindset does impact the way you behave. For example, I'm always trying to look forward, for next year. This year I'm taking just one math class but next year-I want to keep moving forward....I'm taking Algebra two and Geometry at the same time. I want to do Running Start, too, so I can just keep going."**

Most survey respondents (83%) indicated they enjoyed the process of learning information that would be on their tests as much as the letter grade they might receive (Q11) (even though 50% would later state in Q18 they only cared about the grade they received on their test), 98% prided themselves on learning new materials (Q16) and 98% indicated even when they fail they try again (Q17). However, almost 40% indicated they did not try new things because they might fail (Q15). This line of survey questioning and focus group responses exposed some contradictory viewpoints relative to growth, fixed and academic mindset.

Data from surveys and focus groups indicated students believed effort and competence were related, that more effort should grow one's competence. One hundred percent of survey

respondents indicated they could learn new academic information if they tried hard enough (Q33), and 100% said if they put in more effort they would see better results on their homework (Q26). Focus group participants were primarily coded as "the more effort the more competence" with one coded as "other". One focus group participant stated,

> "There was once where I was going to take a math test where I wasn't really very... I didn't study-and I came into the classroom and I was like, I don't know any of this. I don't have what it takes to be able to finish this test and get a good grade. So, the effort I put in I believe was lower than what it could have been if I did study."

Another student spoke to the impact of tutoring. They stated,

> "…an example, if there's a math test coming up and you decide to go to tutoring every day and stuff. So I definitely think on that test day you're going to be more confident. I know this, I know how to do this, I was taught this and everything…"

Students were asked how their participation in MESA provided value for life beyond high school. Focus group participants indicated they, "understood more about STEM majors and careers" and they learned necessary skills to be persistent". One student stated,

> **"Personally, for me, I want to go into a different field than what we're studying. It has helped me find more options in what I would actually like to do (prefers dentistry). It gave me more and more options that I never knew existed before this program".**

Programs like MESA focus on students who have not traditionally accessed and persisted in STEM fields. MESA prides itself on being a program with a high support environment that helps students persist along the STEM continuum. A main contributor to students' success is the countless staff, mentors and volunteers who interact with MESA students. Part of what the researcher wanted to determine was whether these individuals were explicit about the idea of growing one's intelligence. Did they talk about ideas like "failing forward" versus "you are a failure"? Focus group participants were able to clearly recall teachers who had not been supportive, but what were their thoughts on MESA staff, mentors, volunteers, and staff?

According to students, people in the MESA community did not explicitly talk about growing intelligence but they modeled positive behaviors. Multiple students cited examples where people affiliated with MESA encouraged them to seek out additional information, discussed how to improve a project, or how to find solutions to a problem. One student talked about the role of teachers and volunteers who helped with hands-on learning projects. Comments made during the focus groups included the following:

> "I think that, well for me, I learn better when it's a hands-on activity. And being able to do that in ... like, with people whose job it is to work with marine life and do this kind of research and be able to do it myself to some extent, it's very...it's new and it's also a way that it helps me understand what they're trying to show me."
>
> Like she was saying, they're constantly supporting you and giving you information that helps you understand on a deeper level. There're multiple volunteers in addition to the instructor that's giving us the lesson. They're always there giving us additional information one on one and they're there to support us."

Survey results reinforced the data from the focus groups, as more than 98% of survey respondents indicated when they fail a task they do not give up (Q17)**.**

In Farrington et al.'s model (2012), the role of community is an important component of academic mindset**.** Part of the semi structured focus group questioning was to better understand if MESA encouraged students to lean on others for help and support. And if the program did encourage such behaviors, how was this being communicated to students? Survey respondents overwhelmingly indicated (92%) they are not afraid to ask for help when they need it (Q9) and 77% said their MESA community is a group they go to for support (Q25). Part of the thinking behind a growth or fixed mindset is if an individual is in a fixed mindset one might not want to expose they lack knowledge. Exposure might highlight perceived weakness. **Focus group responses to the question of whether MESA encourages you to lean on others for help and support were mixed**. Most students indicated MESA did encourage students to lean on others

for help and support, while one indicated this happened to some extent, and one student did not fully answer the question. **Student responses varied in terms of how the message was communicated**. For example, some students indicated "they just knew" while one indicated the types of activities in MESA lend themselves to working on groups. One student said,

> "I do definitely think that MESA does that, because all the different activities they do, some of the students have never worked on it and everything. So, yeah we get a new topic and then we learn about it. Then there's all that...different ideas from my peers and the instructors and stuff. Yeah, I think that really helps with learning, especially for me."

There was at least one focus group participant who responded "other". One student stated, "to some extent but since there are different groups, different groups don't really interact with each other much which causes us to not know about what another group is learning about unless we talk to them." This line of thought might suggest that there is cross sharing within a group but not across groups or across MESA sites. While most survey and focus group participants indicated the importance of networks, an estimated 83% felt the need to prove their "smartness" and talent to others (Q19), raising the question of why being validated by others was prominent in their thinking about community.

As previously described, the literature on the persistence of underrepresented minority students and women in STEM deals in part with their ability to navigate through challenging environments and academic demands. Thus, part of the questioning during the focus groups was to better understand how MESA was helped to facilitate strategies to overcome academic challenges. In addition, the researcher wanted to know how and what MESA taught students about overcoming academic challenges. **Students indicated that MESA did teach them strategies for overcoming academic challenges. However, they differed in their responses regarding what was taught and how it was taught.** The researcher used a priori codes: metacognition, organization skills, how to access networks as strategies for overcoming

academic challenges, mindset workshops, and study skills workshops. These codes were integrated into the questions asked during the focus groups. Students identified "how to access networks" or "other" when responding to this line of questioning. One student stated,

> "what our teachers are doing is they're letting us see how easy it is to network and reach out for help. So even though [they] didn't do it [themselves], [they] saw how easy it is to just go out and reach out for help. So, basically, [they're] telling us if you're stuck, don't be afraid to go out and ask for help or use your resources."

Another student who indicated "other" stated, their teacher encouraged them to find outside knowledge and strategize on test taking behaviors. The student said,

> "The teacher also makes us stop and think. You may not know your code right now, but you could be ... instead of just sitting there and being like, okay, I don't know my code, I'm not going to do anything, I'm going to wait until it's finished… she makes you go out and find other things to make your project better and not focus on this one thing you don't know. On a test, if you don't know a question, you're obviously going to move on and go back to that question later. That's basically what the teacher does. It makes it not stressful, because you're over here stressing about one thing and the teacher says, 'there's other things you know. Why don't you start on that.' So, it takes out the stress."

Farrington et al.'s model (2012) is academic mindset where there is the belief that the work a student is engaging in has value. Students overwhelmingly responded "yes" to this question. When it came to articulate "how they knew what they had learned in MESA would have value after they left high school" their responses varied. Below are a few of the responses that showed the variety of rationales:

> "I would say yes, because I want to pursue something in engineering. So, a lot of the things that we focus on is somehow focused on engineering or a STEM career. So, I think some of the things I'm learning here in MESA I definitely will. From MESA, I definitely will take... you didn't fail, just find another way to do it differently. Just move on, move forward…."

> "There's definitely lessons I've learned. When I first signed up for MESA, I didn't really know what it is. I really just signed up for that class because [the teacher], I already knew [them] before I came in high school. I already had [them] in summer school. I just felt like I didn't know that [they were] going to be the all the CB teacher here, but once I came in this school, even though I kind of been in [their] classes, I was a freshman." [They] always told me, "oh, I feel like you're going to succeed. And I feel like when

you're old enough, and when you get in the next grade, you should just take my class because it's going to teach you a lot." And so, I feel like a lot of stuff I didn't know about coding or anything like that, or I didn't really have building skills**.** It's pretty close to the end of the year, and I feel like I've just learned a lot. And so, the class does have some type of value. But just some of the projects that we've done so far, they haven't been the best. But I still feel like I have learned some things in the class."

"In MESA, it's not only about the projects, too. We get exposed to scholarships and other programs, too, so I think that's a value that you can go out and ... because I'm pretty sure if I didn't take the class, I wouldn't have known that you can get scholarships for being left handed or something like that. So, it's teaching you that you should go out of your way to find things even if you don't think it's reachable. You can still reach it."

Focus group participants were also asked**,** what they thought about their MESA community and its relation to their academic or career pursuits (i.e., does it encourage you to take on challenges, support you, positive or negative message about your ability, do staff and mentors talk about mindset related to persistence)**.** An estimated 86% of survey respondents saw themselves as majoring in college in a STEM discipline (Q27) and 72% saw the connection between the work they were doing now in MESA and life after high school (Q28). **Focus group responses mirrored survey responses with most believing there was a positive impact or a direct link between their MESA experience and a positive academic or career pursuit.** The quotes below captured these beliefs about the MESA community and its impact.

"I definitely think so because I feel like the main purpose for the Saturday Academy is to encourage students to learn more about these types of jobs that mainly aren't very well known. And they are pushing us towards those jobs and showing us what the benefits are and what... that it's actually fun. You know? That it's not all just test tubes and plankton samples. It's entertaining to some extent."

"I think MESA has really helped me. Especially even before high school I knew I wanted to study of biology. So, with MESA I've done Marine biology the time I was there, It's kind of helped me learn the different kinds of different topics in biology that I could ... that shows me what I am actually passionate about and that criteria so..."

"I feel like MESA helped me a lot in this program because. Especially in this program because I didn't, when they came here, like I said I didn't know anything about computers. At the beginning I was just frustrated because I couldn't do anything and the volunteers, they were all coming and helping me like you how you saw up there. I

> couldn't finish my plane. I feel like it's a success…They sit down with me and they teach me different ways of doing it. So after they teaching me I started trying to play around with it and see what I can do. If I still need help I just ask and they come help me."

Overall, the survey data and focus group responses showed students held a positive disposition about their intelligence and ability to grow their intelligence. The environment was attributed as a major factor to student's beliefs about their ability to grow intelligence. Ethnicity and race were also salient influences on students' beliefs about mindset. Most students appeared to be able to recalibrate when presented with an academic challenge and indicated mindset did impact their ability to be resilient in the face of challenges. In turn, students made the connection that mindset does impact their academic behaviors even though responses varied for what specific behaviors are manifested. It was evident student understood the connection between effort and competence and were able to see the value of MESA in their life and after high school. While responses from the survey indicated students identified with growth mindset questions there were mixed responses when responding to fixed mindset questions. This pattern also held true for academic mindset questions. Finally, there were gender differences in at least eight of the survey questions. In the next section, data from the semi structured interviews with MESA teachers and staff are discussed and compared to the perspectives shared by students.

4.7 Director and WSM Administrator Sample and Data Collection

The Director of Seattle MESA and a WSM Administrator (both individuals will be referred to as WSMA in the following section) were asked similar questions to those addressed in the student focus groups (with a few additional questions) and Seattle MESA teacher semi structured interviews. The findings from the MESA teacher interviews will be discussed in a later section of this chapter.

The rationale for asking similar questions was to see how administrators in decision making roles, aligned or diverged in their thinking on the topics of growth versus fixed mindset and academic mindset. In addition, the researcher aimed to understand what their thoughts and opinions might mean for future programming, policy and or practice. Administrators had similar responses to those of students. One administrator believed you can grow intelligence, and the other indicated individuals are born with it but can grow it. Both attributed environmental factors as a having an impact on mindset. These beliefs are captured in the quotes below:

> "I believe that everybody is born with intelligence. I think that's just a human condition. However, I think some of us grow more than others. I think in another time, I talked to you about skills versus abilities. I think we have abilities. I think we have intelligence. All of us have intelligence, and we have the intelligence enough to learn. We can learn about STEM. We can learn about how to be a success in the world."

> "And then the fact that students often or not, especially in public school systems, are not necessarily engaged in STEM or inquiry-based learning activities unless they're in some kind of career in technical education, so these students learn from their teachers or they learn from industry partners. Once they learn from industry partners, we see the results like at the design challenge. Or even before the design challenge, on what we call MESA Day, we see students who don't have this knowledge base or, you say, before they started, to the extent that they learned. So those are two examples to me where intelligence is not fixed. It's about access. It's about learning. It's about trial and error as well."

When asked why some of their students believed intelligence was fixed while others believed it could be developed, and why they thought students varied in their responses (upbringing, positive or negative messages they receive in the environment, support/no support), administrators aligned with student responses. One WSMA stated,

> "I think a combination of all three (enviro, people, experiences). I think it is, number one, first the environment. What actually cultivate[s] students' love of learning actually is directly tied to who is actually leading that learning experience. Then in some cases parents have a role in that early on, but then teachers and any other learning environments have also a great role, because students tend to spend more time in learning environments than they do any other area. So, to me students' perceptions of themselves, especially girls, often are developed by the learning experience and what they see and whom they run into..."

Another WSMA spoke to the word “failure” when they said, “It's what we strive to do in MESA. **We strive to let them know that failure doesn't mean that you bombed out** and you're never going to be okay again. It means you need to approach it from a different way”.

When asked how mindset plays into how their students approach an academic challenge or when they are presented with an academic challenge, administrator responses somewhat aligned with those of students. One WSMA response aligned more with students, they were coded as “it encourages them to keep going, not give up”. The other administrator whose response was coded as “other” believed students must be in environments where they are academically challenged before they can learn to approach an academic challenge, as indicated in the following quote:

> “The question is, is like first of all, where are the opportunities? And in a system of K-12 education, those opportunities become narrow in middle school. In middle school and high school, the more kids get opportunities to get into more challenging opportunities for math and science, the more they feel better at or competing in this space. So, to me students, you almost have to be intentional about, especially as an instructor, and I'm a teacher. Again, it goes back to, I expect to challenge my students, I expect it not to be hard. I mean, not to be easy, and I expect you learn perseverance by constant struggle with things that are not easy for you. I always, also just in my own ... As a part of your growth and development, if it's too easy, then I hold you accountable because some kids, they love a easy, they call a easy teacher, where they don't learn. They said, "Oh, it's easy," but I expect them to be actively engaged in challenge it.”

One of the concepts the researcher was exposed to while previously working in an academic STEM program, was “fail forward” versus “fail”, especially as the concept relates to academic challenges. This concept was raised by the researcher because they felt like it tied to the previous question. How do people with mindsets think about the idea of failure? Is failure a learning opportunity or is it an indicator a student lacks ability? The researcher wanted to know how MESA students and administrators thought about this concept, and did MESA teach content

to help students be resilient when they were faced with failure and challenges within an academic context? One administrator explained,

> "I know that 25 years ago, we always said [to] the students, "You can do this, you can do this. Get back up, dust yourself off. You can do this." We were not real specific like you're talking about failing forward. For the past few years now, we have specifically said the word failure. We were always afraid don't put failure out there in front of the child because then they'll think that they are a failure, but I think that was a disservice. I think that if we want them to be engineers we have to tell them engineers fail. They fail all the time, but they used that failure in their next design. There's nothing wrong with failing if you correct the failure. Especially the older students, the high school students that we're working with. Now, we tell them, "We want you to keep a science notebook for this project. Every time you have a failure, you need to tell why you think it didn't work and how you're gonna change the next iteration of this project." It's so much more practical and it's a part of life, real life. In the time that I've been with MESA, I have seen a change by saying to students, "There's nothing wrong with failing. It's giving up after you fail," is what's wrong."

When asked how a students' mindset impacts their academic behavior (e.g. wanting to go to class, doing homework), the responses from administrators mirrored some of the MESA student responses including "other" and "they are more engaged in the classroom". One administrator mentioned students "participate in more MESA activities" which was not cited by students. An administrator explained,

> "Coming on Saturdays, you're looking at students that have a mindset of wanting to learn more and believe that by engaging…it will make them better. I think sometimes, though, students need some guidance on how it's connected. I mean, what does this really help? So, we don't only connect ... like, say you're just in the MESA design challenge. Well, how does this help you get a job? First of all, there are different levels of jobs, so even when you track what jobs students have ... For example, some of our students are only familiar with service jobs. Therefore, McDonald's and things like that. Whereas, they don't see that there are some internships that would pay you twice as much just by you being, say, in a MESA club or just by you learning project-based or just by you learning how to program robots and sensors, solutions that they are trying to work on now that people don't have the answers to."

While one administrator talked about students who showed up to participate in additional MESA activities like Saturday Academy, and students being more engaged in the classroom, a second

administrator focused on academic community as influencing academic behavior. This line of thought was not initially captured in the a priori codes. The administrator shared an explanation of the influence of academic community as follows:

> "We still very much believe that all of our students have the ability. They may not have a completely open mindset but if we connect them with one another, it has a couple of different … I call them advantages. One of them is those students form a community of learners. Once they're a community, they feel a responsibility to one another and they don't wanna let down their peers and they strive harder. It opens up, I think the mindset. It's like I have to do this because I am part of the community. We're either gonna succeed or we're gonna fail so we all have to put in. The other thing is they may not believe at first that they can do it and so they are a little bit as Treisman found out particularly underrepresented minority students are uncomfortable with letting someone else know what they don't know.....Everybody else will know that I'm not smart or they'll think that I'm not smart. There's no room for that in the MESA model because you're all integrated together. You're all a group. You all go up to a whiteboard together and you have a challenge problem and nobody sits up in front of you, and lectures you. You just all contribute what you do know to the group."

Administrators were also asked about their view of whether effort and competence (knowledge, skill) are related. While most of the students agreed that "the more effort the more competence," one administrator focused on a different aspect which was not identified as an a priori code by the researcher. The point raised by the respondent was also not necessarily reflected in the Farrington et al. model (2012). The respondent said,

> "I think we're talking about two different things. There's competence and then there's the perception of competence. A student could be very competent but they have no confidence. They don't participate with others. They don't join the group, or they don't speak up in class. I don't know what environment they grew up with that made them afraid or took away their confidence. They can be smart as a whip and they could know everything, but they never, ever would … You would never know because they don't speak up, they don't participate. In our educational system, those are things that are very important, so we really have to make sure that we address those things so our students who are competent begin to gain confidence."

The idea was also raised that students may not always immediately understand the connection between effort and competence, particularly at earlier stages in their academic careers. There

was the suggestion that as students progress, the connections become more salient. One respondent explained:

> "I think (MESA) influences them at the very deepest level too, because they may not know why they're doing it when they're in fifth grade but I think it becomes very clear by the time they're seniors. It's amazing how many people … If I wear an old MESA Day t-shirt somewhere, and I'm out at Lowe's getting stuff for the garden, it's amazing. You know, here in Seattle and the surrounding areas of Seattle … Even in Spokane area, it's amazing how many people will walk up to me and say, "MESA? I was in MESA." Then they'll tell me where they are now and what they're doing. You can see that there's such a … It's a deep emotional connection on their face when they talk to you. You can tell that as a MESA alum, they're still so connected. I believe that those young people … Some of them are not young people anymore."

Administrators were asked how they thought students' participation in MESA provides value for life beyond high school. They were coded as "other" and "they learn the necessary skills to persist". While one student was coded as "they learn the necessary skills to persist", more students tended to be coded as "they understand STEM majors and careers". One administrator said:

> "What I think for one, problem solving and compartmentalizing is a indirect skill that students learn,…honestly, students learned to use their team members and their strengths to share the work. It was kind of interesting on that, and we didn't give them anything. It's just that, when you hear these students speak, or if you would have come to MESA Day, you would have seen how the students say, "Okay, she was better at code. This person was better at building. This is better at technical writing." So one of the things they learned is how to use their team's strength to get to an end goal."

When asked how MESA (staff, mentors, volunteers, peers) communicated with students about the idea of growing their intelligence, respondents indicated "it was not explicit, but they modeled behaviors." This response directly aligned with student responses. One administrator spoke specifically about the role of teachers and board members as role modeling behaviors,

> "I do give teachers the credit. The teachers have to have the disposition of willing to learn and willing to fail, so teachers to me are the leaders of the environment and can create the environments in which students' failure is not perceived as a negative, but rather a opportunity to learn. So, I like in terms of where people don't know all the answers that come from a predetermined knowledge base, a predetermined disposition, because it also

> puts them in the position to not know all the answers, so they too are learning. So, by them learning, and the environment is we all are learning, so if the teacher is willing to be vulnerable, then students could learn also that learning over time, learning new things takes practice, but at the same time it's not fixed."

When asked if and how MESA encourages students to lean on others for help/support, the response from one administrator was similar to student focus group participants with response of "yes". While students were mixed about how this message was communicated, the administrative response was focused on group dynamics to informally communicate the value of leaning on others for help and support.

> "We try to do things in a group. **We try to form a community so that students work together,** so everybody is responsible to each other. Students feel a responsibility to each other. They know that they're going to study together, and maybe I don't know it, but [Johnnie] knows it or maybe [Sara] doesn't know it, so I'm going to help [Sara] figure that out. Students go up to the whiteboard together. They do it together. It's a group accomplishment. At the same time, everybody feels good because they were a part of the accomplishment, so it builds ... It opens that belief, "Oh, I could do this. My friends and I did this together, but I'm stronger." You know this ..."

The researcher also inquired about whether and how MESA teaches students strategies for overcoming academic challenges. All students indicated "yes" with most student focus group participants indicating the strategy included "how to access networks". The administrator who responded was coded as "yes" but focused more on the role of tutoring as a strategy**.** They explained:

> "We always provide tutoring but in the past several years, we've done a lot to provide students with mentors in the afterschool programs, in MESA centers. We bring in mentors who might be retired Boeing engineers. Girls who code have young women who love to come and hangout with young women who are interested in computer science. A field that's still hugely male but these gals come and they'll hang out with our female students and talk to them about coding and show them little coding games and things that keep them engaged...They're also very instrumental when we do work days or academies. Not necessarily Saturday academies but academies for our students that are working on STEM projects because they work side by side with the students, they question them. They ask them, "Why are you doing in that way? Why did you put this here? Why are you using that kind of glue? Then if it fails, if the project fails which we expect projects to fail the first … Maybe even the first couple times around. They're then able to work

> with the student to say why do you think that failed? What do you think about the nose of this plane, of this glider? Why did the nose go down so much when you launched it? How about trying something different on the nose? What would you do if you were gonna do this again?" Those are things where we don't say, "Oh, you failed." We say, What could you do differently the next time around?"

When asked about the relationship between effort and competence, and more specifically how they talked about this, both administrators were coded as "yes". Students did not respond to this question (due to time limitation). One administrator talked about helping students make the connection between effort and competence but then going a step further to help students articulate their experiences.

> "I would say some of our students do see that. Some of our students may not see that, but just by being in it. We try to be intentional about making sure that we explain the importance of why and how. In our career, in college readiness, in college readiness discussions I really focus on the how this is impactful, and if you do a service, okay, what jobs current students have? I do this sometimes. I intentionally ask them what they have. Okay, so say for instance you work at McDonald's, so what position do you have? So I try to even get them to process like, what is your desire? Your desire is not necessarily to work always for McDonald's. The desire is, okay, what can McDonald's do for me as I further my career, like go to college? So do they offer scholarships? So I'm going to be more intentional about choosing jobs that actually will get me from point A to point B, and so how does being a part of MESA actually helps that? For number one, you learn how to collaborate. You learn how to demonstrate leadership. You learn how to find a solution. At our center we take it a step further, in that we really help them frame their experiences when they develop their resume, or they develop their ... we help to frame, take their experiences and help them articulate it. We believe, by doing that, then they will know how it's a pattern then for moving forward."

> "I think that's a chronological experience. I don't think that those 5th graders that we do the engineering design competitions or engineering design in the classroom, they just know it's a lot of fun and the teacher is not standing up there talking and putting something on the board, giving them a worksheet. I think that they start to understand that more by the time they're in middle school because part of Mesa's work is to help them understand that they need to do these kinds of classes to go to college and we also touch on their career aspirations. We try to give them a complex, well-rounded idea of we do these things for a reason and if they understand the reason … If it's relevant to them then they can feel more motivated to stay on."

When discussing two questions: 1) given the potential impact a growth oriented mindset and academic mindset can have on students are there ways MESA can enhance current practices

or policies to strengthen these mindsets and 2) how can they help MESA staff (at all levels) enhance how they help students develop and strengthen their mindsets, one administrator noted a familiarity with Dweck's work and believed the mindset curriculum could be implemented within the MESA structure. This administrator said,

> "Absolutely. Number one, they can either adopt Dweck's work. I mean, I was familiar with Dweck's work all the time. I taught with that mindset when I was a teacher, and I was unapologetic about, it's the difference between sympathy and empathy. So you have to have empathy, but sympathy keeps people where they are. Empathy means, okay, I understand, but this is where you need to be, so what is it going to take for you to get there? I think some people don't, because of their own experiences, don't know how to cultivate that, so I think anything around develop or cultivating a kind of knowledge and attitude would be great."

A second administrator discussed the need for more research on the MESA program. This line of thinking aligned with pre-college and college access challenges outlined in the chapter two literature review. They stated,

> "Unfortunately, one of the thing MESA has not done well is we have not done real hard research like what you're doing or what we did with the community last year. We always put on all of our pamphlets and all of our stuff, MESA works. We know MESA works, but we really need to be more mindful about finding out why it works. When I talk to doubters, again, without any research, I am always very forceful in telling them do not confuse skills with ability. These kids have ability, we just need to give them the skills."

4.8 Teacher Sample and Data Collection

There were two Seattle MESA teachers who were selected to participate in the semi structured interviews. These interviews were held separately so as not to influence interviewees' responses. Teachers were from High School 1 and High School 4. The following section highlights teacher responses from similar questions asked of MESA students and WSMA.

Teacher responses aligned with students, who indicated individuals can grow intelligence over time, and the environment has a direct impact on intelligence. The following quote from a MESA teacher supports intelligence as a malleable entity,

> "My understanding is that students are born with certain intelligences, and then their exposure to different activities, or types of classes only enhance their other intelligences, but naturally they might be stronger in one. I do believe that when they are exposed to it, they can learn to have a STEM intelligence, or at least they might not come with any skills like problem solving or working with people in a group, but with tools over time, I've seen personally that and the resources that we've had, that they learn how to take a problem, dissect it and then approach it like an engineer, because they were taught over time this is the way I should approach a problem."

This teacher cited a group of students in their program as an example of growing intelligence over time. The teacher indicated,

> "The project was specifically dealing with coding and about 100% of my girls entering Mesa had no experience beforehand, so they also had to learn circuits. They hadn't understanding batteries, understanding connections and stuff. By the end of the project on particular group there was a girl that first day she's like I don't even know what wire goes to what why does it go there, but then at the end of the project they were able to see why say an LED light was not blinking because they found because this is not sending power to it, because it's not plugged in here. They learned that type of information through the class" (Seattle MESA Teacher). One interesting insight provided by another Seattle MESA teacher was related to trauma. They stated, "I think students that have had a lot of trauma have a hard time learning things. They may be possible to help with that, but certainly, by the time we get to 9th grade and 10th grade, kids are learning things at vastly different rates. I guess I see that the most with math skills and math learning."

Another teacher talked about the hierarchy of needs and the relation between growing intelligence while trying to attend to basic needs,

> "I don't think it stops you from growing. I mean just imagining if you're stressed out, if you're not feeling safe in your current situation that how can you possibly open your mind as fully to new learning and especially something that doesn't seem like it's an immediate ... Solving your immediate needs at the moment."

MESA teachers were asked to reflect on the following question: some of your students believe intelligence is fixed others believe it can be developed-why do you think students vary in their responses? Teachers identified the environment as influential on student mindset. Teachers' responses were like those of students. One teacher stated, "I think it's probably a combination of all of that [referring to upbringing, environment, support or no support]. The teacher continued:

> "As great as my school is, there is a limited amount of classes that really puts them in the model that is used as well. Everything is very structured, and I think sometimes it's too structured, that it leads them to believe if my teacher doesn't at the end of the quarter make me feel I can do this, or my grade isn't to this level, then that means I'm just not strong, and you hear it often with math students, oh my parents weren't good at it, so therefore I'm not good at it. I think it's upbringing and also the type of exposure they've had in school up to this point."

When asked how mindset plays into how students approach an academic challenge or when they are presented with an academic challenge, one teacher responded to this question and was coded as "it helps them realize they need to reassess strategy". One student shared similar coding to that of the Seattle MESA teacher. The more common response was "it encourages them to keep going and not give up". As part of the 2017/18 MESA curriculum there was a design challenge. This topic came up in every focus group or semi structured interview. Students were frustrated about being given an open-ended design challenge. In college or a professional work environment, university students and or employees might be given a problem to solve and know how to seek out resources, ask questions and draw from existing knowledge. For high school students, a project of this nature may seem overwhelming. The Seattle MESA Teacher spoke to this phenomenon and the need to change strategy when they realized the students were struggling to grasp the project,

> "I can speak to this here, because [it's] the first time we're having this structure for the Mesa challenge. The hard thing was that a lot of the accountability was held on their end. They've never up to this point have had a class where here the requirements you must come up with it from beginning to end yourself. I, as an instructor, it was also a struggle, because I knew from a college standpoint, once you're given all the info you just go right along. They're in high school, and they're so used to worksheets, reading material, I must get it, and there was no hard deadline until everything needs to be done. They didn't know how to even, where to even start and that's when I realized I need to take a step back and actually coach them about how to approach projects like this. I even had one student tell me, I've never had a class structured like this before, but I've actually learned more because of it."

When asked how students' mindsets impacts their academic behavior (e.g. wanting to go to class, doing homework), responses for teachers were similar to students. However, one teacher who was coded as "other" stated,

> "These aren't things that I've interviewed kids about, so I have to somewhat guess. I can imagine if a student doesn't feel like they can change and they always get low grades, what's the point of trying? I see that all the time, kids starting to give up as early as freshman year. It can be like a slow motion dropout, some of these kids and you just see. They don't see it usually. They're not going to do the work, but they don't see the connection between like, "Yeah, they're really starting to fade away from school."

Another teacher discussed how students "show up to class". The quote below supports the teacher's view that mindset impacts student behavior, specifically showing up to class.

> "I think that there's a strong connection there, because unlike my math classes where the moment you walk in it's like we're getting straight to work, and that kind of environment with my Mesa students, there's a lot of opportunities to get each other both students and students to teachers, their instructor to get to know each other as individuals. If they feel like I support them, and I'm there for them, and if they're struggling that I'm going to do what I can. This year there was a lot of struggle and a lot of frustration on their end, and I totally understand why, but a majority of them continue to show up because they felt like if I don't show up, then I know I'm not only going to let myself down, but the people in my group that also depend on me." \

When asked about how MESA staff communicate with students regarding the idea of growing one's intelligence, teachers were similar to students in that "its not explicit but they model behaviors". One teacher spoke about the role of discussions, projects and staff interactions to facilitate student thinking on "growing intelligence". This teacher said:

> "It's hidden as in yeah, you might be the first one in your family to have reached this far, or you might be the first one to go to college, but through the opportunities and the things that they learn through the different projects, we try to make sure to emphasize what they're capable of, so that in the end they start thinking about where you want to go with these skills that you already came in with and also have learned, and building goals for their future. Seattle Mesa does visit my class frequently, at least maybe twice a month, which has been more than any other year in the past, and I know through their personal conversations with the students, they hear it from multiple sources about you guys can do this, you can do this."

Both teachers agreed that MESA encouraged students to lean on each other for help and support, and their responses mirrored that of students. Only one teacher elaborated on how this message is communicated and was coded as "other". The teacher provided the following detail on how MESA communicates this message:

> "The way that I try to build that connection with them is the first week that they come in I have specific challenges that has them work with different sets of people that are group challenges, so they have to learn to lean on each other, to complete a task, and I constantly have them work with different people to learn how to work with different people that maybe are their friends, or maybe they are not, or maybe have different styles of approaching a problem. We do that throughout the year before we start the big Mesa project. They throughout the year learn I must."

In a similar vein, a second teacher remarked, "Yeah. I think that MESA helps kids really find that support with each other and really building community."

Teachers were split in their responses when asked if MESA teaches students strategies for overcoming academic challenges and how and what do they teach. One firmly agreed, while the other teacher stated it wasn't formal. Students also indicated "yes" to this question. How strategies where carried out differed by respondents. One teacher talked about the role of grade checks as a strategy for overcoming academic challenges,

> "I think in previous years I have emphasized that more than this year to be honest. I used to have grade checks, like what athletes do, but for my Mesa students, because they're supposed to be college bound students, so I want to make sure that they're getting their grades and their classes in for, and what they would do is they get the grade checks that would have teacher comments on them, why their grade is the way it is. So for the ones that are failing, they turn it into me, and I read those comments and then we have discussions about what can you do to raise this grade. Okay, it's A, B, C, okay so how are we going to get this done."

Another teacher seemed to suggest while MESA does not formally teach strategies for overcoming academic challenges, the projects that are part of the MESA curriculum lend themselves to naturally allow students to fail, practice and learn from their mistakes,

> "Kids have a lot of practice in failing and persisting because you're building these things. Most of the time, it doesn't work and then it works and kids are able to ... I think a big part of resistance or a lack of resistance is kids don't have an idea before they do something like MESA or do some of the project of what it feels like to be successful at the end. I do see a big difference after doing a lot of projects with kids that they're willing to try something and have a network for multiple days."

One teacher acknowledged that the role of reflection and discussion related to the previously mentioned MESA challenge project, was lacking this year (dislike of the MESA challenge project was reiterated in the student focus groups). The idea of reflection and connecting effort and competence becomes important as it provides a space where students can see how the two concepts relate. The mindset literature talks about people who subscribe to a positive mindset even in challenging circumstances, can always find the silver lining or the lesson. The growth happens in the experience itself and reflection, compared to focusing only on the result (e.g. final grade, did the student win the competition). The teacher recognized their role in helping to facilitate this process, stating,

> "Okay, I think I can do a better job in that area, because the project we just finished [I] know a lot of them learned a lot, but the fact that I've never really had us as a class, or in groups really take some time to explicitly define what are those skills that they came out with, so that is something that I don't do enough if at all to be honest, and that's a really good point, I think I should do that. I want to say that they internally see that they've learned a lot as far as working with groups of people and what their strengths in working with different groups of people, but I think more discussions in class would probably need to happen in order to successfully define okay my students learned these specific skills. I think I would be assuming too much right now what they learned, because I haven't had those conversations with them."

The teacher also indicated the need for feedback as well as students when they mentioned,

> "…for next year I'm going to make it a point to have those conversations, because another thing as a teacher I never get feedback as well. This is the first year that I've actually received rubrics back from the Mesa judges on how every team did according to the different requirements that they had to get done. There was a report, a poster, a presentation, a demo, I mean and I would never get those forms back. So, the students would say, "I think I did well, I think I did well." And it was always based on assumption."

When discussing ways in which MESA can enhance current policies to strengthen growth-oriented and academic mindset, both administrators offered ideas for improvement, as did one teacher, while the other teacher was not sure. One teacher talked about increasing opportunities for cross sharing among MESA sites as a way to learn what others are doing related to this topic, saying:

> "We meet with others as a Mesa cohort I guess or as a center twice a year. Once during the summer, once during the fall, and maybe once during the winter. We're all learning more specifics about whatever that project or challenge is for that year… I never hear, "Hey, so and so is doing this maybe you should try that." Or I never get any handouts about I saw this at another high school, I saw it work successfully I'm going to give it to you maybe you might want to try it as well. A lot of it is me having to figure it out by myself."

Another avenue of discussion in the teacher interviews was focused on whether a co-delivery model of teaching content while simultaneously helping students foster their mindset is being implemented. One teacher responded to this question, and indicated while a co-delivery model might be helpful, "to be honest, nothing has been given to me in that category. As far as respect to the question, it's always done just one on one, or conversations that just happen in that moment. That's definitely an area that I could use more support to make it better."

Finally, during the interviews, respondents were asked about how they can help students develop and strengthen their mindsets and do so with fidelity, and whether they taught students about "failing forward" and working through challenges. In the theories grounding this dissertation, the environment has an impact on students including the people who make up the environment. Thus, when volunteers work with the MESA program, they have the power to influence students. One teacher focused on having the right number and combination volunteers/mentors:

> "I think what I try to do first of all is make sure that I have the right number of volunteers to be able to meet with smaller sets of students so that way they can understand what

> might be the struggles that they then can help with and to not direct them, but more guide them. We just finished a project for example with Boeing and we had five engineers from different backgrounds and from different countries. They were able to also talk about themselves at the same time as they were helping the students, and say look this is what we deal with, but this is the way we would approach it, do you think that maybe you would want to approach it that way, or what do you see as the issue. I have made it more of a purpose to get people that have the right, rather than just a presenter in the class, but someone who really cares about reaching out to the students and the way that they're guiding them, but not telling them what's right and what's wrong."

A second teacher talked about changing the MESA model to offer credit to entice students to participate in the program and then there might be more of an opportunity to influence mindset.

> "Maybe that's part of it is maybe we need to be getting kids credit. If we're going to say, "Oh, come do extra academic work for fun after school," I'm probably going to get the kids who really like academic work. That's real and that's not happening next year, but my plan is after next year to teach it to the class. I think that, that's one thing we could do. It would be awesome if it was still after school, but they got credit."

Overall stakeholders believed intelligence was malleable and they attributed environmental factors as a having an impact on mindset. Across multiple focus group questions there was general alignment. Differences were mostly attributed to responses that were coded "other". It is important to note while the goal was to ask all of the focus group and semi structured interview questions to each stakeholder group, this did not happen in practice due to time limitations (particularly with teachers) and questions that received more conversation during the focus group or semi structured interviews. Drawing on the literature, theories, Farrington's framework (chapter two) and results (highlighted in chapter four), the next section will focus on conclusions and implications for practice.

Chapter 5. CONCLUSIONS AND IMPLICATIONS OF PRACTICE

5.1 INTRODUCTION

Research question one sought to **understand how minority and female students participating in a MESA program described their growth oriented and academic mindset**. Overall, most students trended toward a positive affiliation with a growth oriented and academic mindset. From the survey data that assessed growth mindset, it was evident most respondents held a positive disposition about their intelligence and ability to grow their intelligence despite challenges. More importantly, when presented with a challenge, respondents would ask for and seek out help. This affinity for a growth and academic mindset is beneficial for MESA teachers and staff to know and understand: students are working from an asset orientation and not a deficit. Given students tended to identify with both growth and academic mindsets, MESA can then begin to find opportunities to support students in other areas of the Farrington et al. model.

While respondents most often identified with growth mindset questions, it is important to mention that at least four of the fixed mindset questions indicated mixed responses (Q12, Q15, Q18, Q19). The same pattern was true of academic mindset questions. While most students identified with positive attributes of this mindset there were four academic mindset questions (Q21, Q23, Q29, Q31) where responses were mixed, highlighting possible areas where MESA may enhance programmatic offerings to address student concerns, lack of belief in self, or explore phenomenon that might have influenced these responses. While the survey captured quantitative data related to the first research question, the qualitative focus group data allowed the researcher to expand on themes identified in the first research question. Some insights gathered from comparing results from teachers, administrators, and students included:

a) One administrator believed you could grow intelligence, and the other indicated individuals are born with it but could grow it. Both attributed environmental factors as a having an impact on mindset. Teacher responses aligned with students, who indicated individuals can grow intelligence over time, and the environment has a direct impact on intelligence.

b) Teachers, administrators and students identified the environment as influential on student mindset.

c) When asked how mindset plays into how students approach and academic challenge or when they are presented with an academic challenge, students tended to identify with "mindset encourages them to keep going and not give up". Administrator responses somewhat aligned with those of students. One WSMA response aligned more with students, they were coded as "it encourages them to keep going, not give up". The other administrator whose response was coded as "other" focused on stating that students must be in environments where they are academically challenged before they can learn to approach an academic challenge. One teacher responded to this question and was coded as "it helps them realize they need to reassess strategy".

d) When asked how students' mindset impacts their academic behavior (e.g. wanting to go to class, doing homework), the responses from administrators mirrored some of the MESA student responses including "other" and "they are more engaged in the classroom". One administrator mentioned students "participate in more MESA activities" which was not cited by students. Responses from teachers were coded similar to the majority of student responses of "other" and "they show up to class".

e) When discussing whether effort and competence are related, one administrator focused on a different aspect which was not identified as an a priori code by the researcher. The point raised by the respondent was also not necessarily reflected in the Farrington et al. model (2012). The administrator made a distinction between competence and the *perception* of competence. The idea was also raised that students may not always immediately understand the connection between effort and competence, particularly at earlier stages in their academic careers.

The second research question sought to understand **if there were gender differences in growth oriented and academic mindset as reported by students. If so, what types of differences exist?** The survey data suggested there were gender differences. There were more males who responded to the survey than females (56%/N=20 to 44%/N=16); however, not

knowing the overall gender breakdown of Seattle MESA participants hampered the ability to determine if the response rates were proportional to the gender representation in the overall population. Out of 28 questions, eight questions (Q6, 8, 9, 10, 12, 18, 21, 23) highlighted areas of difference across gender. Including "being born a math person", "giving up when frustrated by a math concept they do not understand", and "only caring about the grade on the test". Given gender differences and some of the highlights presented in the literature relative to gender, MESA could 1) think about more specialized programming for female identifying students; and 2) explore why the differences exist as to enhance program offerings.

Research question three focused on **the ways the Seattle MESA environment fostered a growth oriented and academic mindset for students. What strategies were used, and what was the rationale provided for these strategies?** Overall there were multiple ways the MESA program attempted to foster a growth and academic mindset environment; however, how they did this was not always explicit or obvious across stakeholders. This highlighted the need for additional training, evaluation of program offerings and the explanation for program offerings. As mentioned in chapter two, the MESA program is prescriptive in nature. There may be an opportunity to re-evaluate the components within the program and more coherently explain to all stakeholders how and why certain components are included within the program structure. Also, as new theories, models and research are developed, it will be key to connect practice to current literature. Below were insights gathered from the data.

a) All respondents agree that MESA communicated with students that their intelligence can be grown, but also stated that this communication was not explicit. Instead, MESA "modeled behaviors" that communicated this message.

b) Does MESA encourage students to lean on others for help/support? If so how do they communicate this? While students were mixed about whether MESA encouraged

students to lean on others for help, the administrative response was focused on group dynamics to informally communicate the value of leaning on others for help and support. Both teachers agreed that MESA encouraged students to lean on each other for help and support.

c) When asked if MESA teaches strategies for overcoming academic challenges, all students agreed, with most student focus group participants indicating the strategy included "how to access networks". The administrator who responded focused more on the role of tutoring as a strategy. Teachers were split in their responses. One firmly agreed, while the other teacher stated it wasn't formal. One teacher talked about the role of grade checks as a strategy for overcoming academic challenges. Another teacher seemed to suggest that while MESA does not formally teach strategies for overcoming academic challenges, the projects that are part of the MESA curriculum lend themselves to naturally allow students to fail, practice and learn from their mistakes.

d) Both administrators agreed that MESA talks about the relationship between effort and competence. One administrator talked about helping students make the connection between effort and competence but then going a step further to help students articulate their experiences. A second administrator talked more about students growing to understand the relationship between effort and competence as time progressed. They also mentioned going a step further to help students make the connection to why they need experiences for college and life. One teacher spoke about the need to do a better job in this area.

e) Students overwhelmingly agreed that the work they are doing in MESA has value. When it came to articulating "how they knew what they had learned in MESA would have value after they leave high school" their responses varied.

f) An estimated 86% of survey respondents saw themselves as majoring in college in a STEM discipline and 72% saw the connection between the work they were doing now in MESA and life after high school. Focus group responses mirrored survey responses with most believing there was a positive impact or a direct link to positive academic or career pursuits.

Finally, research question four focused on **implications of this inquiry for policies and practices used in implementing a MESA high school program.** Insights gathered from semi structured interviews are recaptured below.

a) Both administrators agreed that MESA can enhance current practices and policies to strengthen students' mindsets. One administrator noted a familiarity with Dweck's work

and believed the mindset curriculum could be implemented within the MESA structure. A second administrator discussed the need for more research on the MESA program.

b) When asked about whether one can teach content while simultaneously helping students foster their mindsets, one teacher indicated while this might be helpful, "to be honest, nothing has been given to me in that category. As far as respect to the question, it's always done just one on one, or conversations that just happen in that moment. That's definitely an area that I could use more support to make it better."

c) When asked how MESA staff and volunteers can be helped to support students strengthen their mindsets, one administrator believed the mindset curriculum could be implemented within the MESA structure. One teacher focused on having the right number and combination of volunteers/mentors. A second teacher talked about changing the MESA model to offer credit to entice students to participate in the program and then there might be more of an opportunity to influence mindset.

5.2 Implications for Practice

After reflection and analysis on the data gathered through multiple methods, combined with a robust literature review, and consideration for the theories outlined in chapter two, there are several suggestions for policies and practices in the MESA high school program. Three broad areas for consideration are discussed below: (1) professional development regarding classroom management and practice, (2) research to practice, and (3) reflection and evaluation.

5.2.1 Professional Development Regarding Classroom Management and Practice

a) *Behavior and Perseverance.* Both Dweck and Farrington et al. account for behavior and perseverance in their respective theories and framework. Dweck and Farrington would argue behaviors can be a signal of mindset particularly when failure is involved (e.g. not passing a test the student then stops handing in homework). Therefore, creating opportunities to train MESA staff at all levels on how to discern particular behaviors and probe with mindset questions may help ascertain a student's mindset and provide necessary support.

b) *Praise and Success.* Praise is a valuable part of program and classroom management; however, certain kinds of praise can actually lead to a fixed mindset. Dweck asserts "instant praise" (e.g. great job) can have a deleterious effect because the praise is short term and faced with a challenge a student may have a hard time persisting. Dweck would say MESA staff should focus on praising students for the effort they expend on a project versus their ability. For example, "I saw the effort your team put into the competition by showing up to study after school, delegating work, asking critical questions of one another, it paid off with a great win" versus "your MESA team is great you are high flyers for winning the competition". Training MESA staff and volunteers to be aware of language that praises ability vs. effort is one key step to building a more robust growth and academic mindset culture.

c) *Mindset Curriculum.* After decades of research, the company Mindset Works (with which Dweck has an association) has a two-year curriculum focused on creating a mindset culture. This curriculum was referenced by one of the administrators during the semi structured interviews. Part of the curriculum assesses staff and teachers' mindsets. What happens if half of the staff or teachers prescribe to a fixed mindset? What is the impact on students? Understanding the mindsets of MESA staff, teachers and volunteers may provide insight into training opportunities.

d) *Teaching Strategies for Success*. Dweck and Farrington et al. talk about the need for strategies particularly in the face of challenges. Farrington et al. goes further to specify the role of social skills and includes learning strategies as a part of their model. When asked if MESA teaches students strategies for overcoming academic challenges, the strategies discussed by participants were not robust in nature. That is, they were limited to tutoring, grade checks, and accessing networks. Consequently, it is important to consider whether these identified strategies can be enhanced or expanded. For example, in the Mindset Works Leader Resource Kit, the curriculum talks about the significance of teaching about "effective effort" as a strategy for success and mindset development. This is particularly important as we think about the hierarchical learning that is needed as students progress in their academic trajectory. Given the significance of having a robust

set of strategies, is this an area the MESA team may spend time cataloguing and determining the type of strategies they are purposefully helping students develop.

e) *Teach Students about Their Own Brains*. Yeager and Dweck (2012) cite an article (Blackwell et al., 2007; Yeager, Trzesniewski et al., in press) about the significance of teaching students the science behind growth mindset. It was evident during focus group and semi structured interviews this current practice was not explicitly carried out within the MESA program.

5.2.2 Research to Practice

a) *Gender and Race.* As highlighted in chapter two, there are multiple reasons why minorities and women do not persist through the STEM continuum. One of these reasons is stereotype threat and unwelcoming climates. The idea of an unwelcoming climate was discussed by focus group participants who were in higher level courses (e.g., AP courses) at their school. Dweck conducted a study of women in a calculus course over a semester and found those who identified with a growth mindset were able to persist despite stereotypes versus those in a fixed mindset, "the stereotype of low ability was able to invade them-to define them-and take away their comfort and confidence" (Dweck, 2006, 2016, p. 77). Thus, it may be useful for MESA to consider introducing Dweck's mindset curriculum into the program.

b) *Across Subject Matter*. Mindset theory indicates individuals lean toward a particular mindset, but they can move towards another based on environmental factors and other variables. Individuals can also have a mixed mindset where they have a growth mindset in science but a fixed mindset in their artistic ability. If we know this about individuals, how do we assess students to determine where they may have a growth or fixed mindset across subject matter or in specific areas that may enhance or detract from their academic performance? This was evident in the survey data as students tended to lean toward growth mindset and academic mindset questions yet there were questions throughout the

survey where responses were mixed. An example including “being born a math person”, and “giving up when frustrated by a math concept they do not understand”.

5.2.3 Reflection and Evaluation

Dweck would support the idea of providing MESA students with “stretch projects”, where students may experience a lack of comfort because the material is new or difficult. However, support is critical. Part of this support structure is providing time for reflection and a space where students can see how their effort and competence are related within a specific project output. The growth happens in the experience itself and in reflection on the experience, compared to focusing only on the end result (e.g. final grade, did the student win the competition). This point is key to developing a growth mindset, yet it was highlighted during the qualitative data collection that one of the signature MESA projects (MESA Day Competition) did not involve reflection time or discussion to check for understanding between student effort and content learned. Ideally, MESA curriculum should move to include a reflection space moderated by a teacher or volunteer to help students process these concepts. This was highlighted in the teacher response below.

> “ Okay, I think I can do a better job in that area, because the project we just finished [I] know a lot of them learned a lot, but the fact that I've never really had us as a class, or in groups really take some time to explicitly define what are those skills that they came out with, so that is something that I don't do enough if at all to be honest, and that's a really good point, I think I should do that. I want to say that they internally see that they've learned a lot as far as working with groups of people and what their strengths in working with different groups of people, but I think more discussions in class would probably need to happen in order to successfully define, okay, my students learned these specific skills. I think I would be assuming too much right now what they learned, because I haven't had those conversations with them.”

The teacher also indicated the need for feedback for teachers as well as students:

> “…for next year I'm going to make it a point to have those conversations, because another thing as a teacher I never get feedback as well. This is the first year that I've

> actually received rubrics back from the MESA judges on how every team did according to the different requirements that they had to get done. There was a report, a poster, a presentation, a demo, I mean and I would never get those forms back. So, the students would say, "I think I did well, I think I did well." And it was always based on assumption."

5.2.4 Future Research

Overall Seattle MESA high school minority and female students had an affinity for a growth mindset. They overwhelming believed intelligence was malleable. Students also identified with the four academic mindsets identified in the Farrington et al. model: I belong in this academic community, my ability and competence grow with my effort, I can succeed at this, and the work has value for me. While the research primarily focused on mindset, there are opportunities to expand on this study to better understand mindset and other factors in the Farrington et al. model (2012). For example, how does mindset impact academic perseverance that in turn impacts academic behavior? Farrington et al. acknowledged while their robust literature review informed the design of their model, the model is more correlational than causal. The authors know there are relationships among the various factors, but more testing of the model and additional related research is needed.

There is also an opportunity to draw on the work of Bronfenbrenner to inform future work. First, because MESA is a k12 and post-secondary program (Washington State has partnerships with some of the community colleges), it would be illuminating to understand if greater exposure across increased years of participation in the MESA program saw students who experienced different outcomes relative to mindset. Students in this study were primarily juniors and seniors and had only 1-2 years of participation in the program. Second, Bronfenbrenner's theory talked about the dynamic systems individuals are a part of. Students are at the center but operating around them are family, programs, schools, cities, and beyond.

Part of what was highlighted in the literature review was the need for more research on mindset across dimensions of time (Blackwell, Trzesniewski & Dweck (2007). There was also limited discussion in the literature and research about mindset from one context to another (what happens when a student leaves MESA and enters another classroom or environment). Many studies seemed to focus on a snapshot in time (e.g. seventh grade, a semester-long math class). It would be important to explore whether a growth or academic mindset follows a student from junior high school to college and from college to career.

Finally, while students had an affinity for both a growth and academic mindset, there were a handful of questions where responses varied. These included questions were there were gender differences. MESA might explore why students responded the way they did to questions and consider specific messaging and or targeted interventions based on gender.

Dweck's research and the Farrington et al. model complement one another well. The content is easily accessible to practitioners given the linear nature of how the various attributes build on one another. While it was evident why the MESA programming mattered given the STEM challenges highlighted in chapter two, it was not clear MESA had a stated theory of action that informed their work. The Farrington et al. model (informed by Dweck's research on mindset) may assist MESA staff at all levels to better conceptualize and connect the "why", "how" and "what" of their work. Because mindset is considered a foundational attribute that impacts long term persistence and performance, it is recommended MESA consider more training and development on this subject.

5.2.5 Limitations of the Study

There were limitations of this study. Given the qualitative nature of the study it was sometimes difficult to align calendars and schedules with MESA staff for data collection purposes. The

design and scope of the study also changed multiple times due to responsiveness, location of the sites, and actual number of participants in the program. Finally, there was limited publicly available literature and data on the MESA program to inform the study. Future research on the MESA program may help contribute to building MESA's capacity to improve and respond to the needs of students, especially for minority and female students.

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APPENDICES

APPENDIX A: STUDENT SURVEY

The first five questions were focused on gathering demographic information. The goal for the remining questions was to have questions 6-19 address growth-oriented mindset and questions 20-33 address academic mindset. The questions were developed by drawing on Dweck's theory, definitions and characteristics of growth-oriented mindset and Farrington's model and description of the characteristics associated with an academic mindset. All questions are likert items that provide for the following responses: Strongly Agree, Somewhat Agree, Disagree, Strongly Disagree.

1. School name
2. Please indicate your gender.
3. Please indicate your ethnicity (check all that apply).
4. Please indicate your current grade level.
5. Length of time you have participated in MESA (can include middle or elementary school participation).
6. Intelligence is a fixed trait that cannot be changed.
7. I thrive when presented with a challenge.
8. When I do not know the answer to a question I do not ask for help because this would show weakness.
9. I am not afraid to ask for help when I need it.
10. If I fail a task then I give up.
11. I enjoy the process of learning as much as the end result.
12. I hide my shortcomings and deficiencies from others.
13. I have the power to change my intelligence.
14. I seek out help with I need it.
15. I usually don't try new things because I might fail.
16. I pride myself on learning new material.
17. Even when I fail I try again.
18. I only care about the result.
19. It is important for me to prove I am smart and talented to others.
20. I can learn new academic information if I try hard enough.
21. I was born with the ability to be a math person.
22. When I get a low score on my science test I seek out help to prepare for the next one.
23. When presented with a math concept I do not understand I get frustrated and give up.
24. When presented with an academic challenge I get excited about the opportunity to succeed at the challenge.
25. My MESA academic community is a group I go to for support.
26. If I put in more effort I will see better results on my homework.
27. I do not see myself succeeding as a STEM major in college.
28. The work I am doing now in MESA has no connection to life after high school.

29. When I have an academic setback, I go into a downward spiral.
30. When I get a good grade on an assignment I am motivated to keep trying harder.
31. If I get a poor grade on an exam then I feel like I am not smart.
32. I feel like I am part of the MESA academic community.
33. When I put in more effort to my academic studies I learn more.

*All questions are Likert items that provide for the following responses: Strongly Agree, Somewhat Agree, Disagree, Strongly Disagree

APPENDIX B: STUDENT SEMI STRUCTURED FOCUS GROUP QUESTIONS

Students will be read a short overview of what a mindset is based on the literature cited in chapter two.

Focal Question 1: How do minority and female students participating in a MESA program describe their growth oriented and academic mindset?

a. Talk about the concept of intelligence (born with it, can you grow it, are some students just smarter, does the environment or access to resources enhance or detract from intelligence). Why do you believe this to be true or false-example to support your claim?
b. Some of your peers believe intelligence is fixed others believe it can be developed-why do you think people vary in their responses (upbringing, positive or negative messages they receive in the environment, support/no support)
c. How does mindset play into how you approach an academic challenge or when you are presented with an academic challenge?
d. How do you think a student's mindset impacts their academic behavior (e.g. wanting to go to class, doing homework)?
e. From your point of view how is effort and competence (knowledge, skill) related/are they related?
f. How do you think your participation in MESA provides value for life beyond high school?

Focal Question 2: In what ways does the MESA environment foster a growth oriented and academic mindset for students? What strategies are used, and what is the rationale provided for these strategies?

a. How does MESA (staff, mentors, volunteers, peers) communicate with you about the idea of growing your intelligence?
b. Does MESA encourage you to lean on others for help/support? If so how do they communicate this?
c. How does MESA support you as a student when you struggle academically?
d. Does MESA teach students strategies for overcoming academic challenges, how and what do they teach students?

e. Does MESA talk about the relationship between effort and competence? How do they talk about this? Can you talk about a time when you were in MESA and saw how effort translated into competence?
f. Do you think the work you are doing in MESA has value? How do you know that what you are learning in MESA will have value after you leave high school?
g. What do you think about your MESA community and its relation to your academic/career pursuits (does it encourage you to take on challenges, support you, positive or negative message about your ability, do staff and mentors talk about mindset related to persistence)?

APPENDIX C: MESA TEACHER SEMI STRUCTURED INTERVIEW QUESTIONS

Focal Question 1: How do minority and female students participating in a MESA program describe their growth oriented and academic mindset?

a. Talk about the concept of intelligence (born with it, can you grow it, are some students just smarter, does the environment or access to resources enhance or detract from intelligence). Why do you believe this to be true or false-example to support your claim?
b. Some of your students believe intelligence is fixed others believe it can be developed-why do you think students vary in their responses (upbringing, positive or negative messages they receive in the environment, support/no support)
c. How does mindset play into how your students approach an academic challenge or when they are presented with an academic challenge?
d. How do you think your students' mindsets impacts their academic behavior (e.g. wanting to go to class, doing homework)?
e. From your point of view how is effort and competence (knowledge, skill) related/are they related?
f. How do you think your students 'participation in MESA provides value for life beyond high school?

Focal Question 2: In what ways does the MESA environment foster a growth oriented and academic mindset for students? What strategies are used, and what is the rationale provided for these strategies?

a. How does MESA (staff, mentors, volunteers, peers) communicate with students about the idea of growing your intelligence?
b. Does MESA encourage students to lean on others for help/support? If so how do they communicate this?
c. How does MESA support students when they struggle academically?
d. Does MESA teach students strategies for overcoming academic challenges? How and what do they teach students?

e. Does MESA talk about the relationship between effort and competence? How do they talk about this? Can you talk about a time when you saw how effort translated into competence?
f. Do you think the work students are doing in MESA has value? How do you know that what they are learning in MESA will have value after they leave high school?
g. What do you think about the MESA community and its relation to students' academic/career pursuits (does it encourage them to take on challenges, support them, positive or negative message about their ability, do staff and mentors talk about mindset related to persistence)?

Focal Question 3: What are the implications of this inquiry for policies and practices used in implementing a MESA high school program?

a. Knowing the potential impact a growth oriented mindset and academic mindset can have on your students, are there ways you believe MESA can enhance current practices/polices to strengthen theses mindsets?
b. Literature indicates it is important to teach both content while simultaneously helping students foster their mindsets-can you talk about current practices and do you know if this co-delivery model is being implemented?
c. How can you help your MESA teachers, mentors and volunteers enhance how they can help students develop and strengthen their mindsets?

APPENDIX D: MESA DIRECTOR SEMI STRUCTURED INTERVIEW QUESTIONS

Focal Question 1: How do minority and female students participating in a MESA program describe their growth oriented and academic mindset?

a. Talk about the concept of intelligence (born with it, can you grow it, are some students just smarter, does the environment or access to resources enhance or detract from intelligence). Why do you believe this to be true or false-example to support your claim?
b. Some of your students believe intelligence is fixed others believe it can be developed-why do you think students vary in their responses (upbringing, positive or negative messages they receive in the environment, support/no support)
c. How does mindset play into how your students approach an academic challenge or when they are presented with an academic challenge?
d. How do you think your students' mindsets impacts their academic behavior (e.g. wanting to go to class, doing homework)?
e. From your point of view how is effort and competence (knowledge, skill) related/are they related?
f. How do you think your students' participation in MESA provides value for life beyond high school?

Focal Question 2: In what ways does the MESA environment foster a growth oriented and academic mindset for students? What strategies are used, and what is the rationale provided for these strategies?

a. How does MESA (staff, mentors, volunteers, peers) communicate with students about the idea of growing your intelligence?
b. Does MESA encourage students to lean on others for help/support? If so how do they communicate this?
c. How does MESA support students when they struggle academically?
d. Does MESA teach students strategies for overcoming academic challenges, how and what do they teach students?
e. Does MESA talk about the relationship between effort and competence? How do they talk about this? Can you talk about a time when you saw how effort translated into competence?
f. Do you think the work students are doing in MESA has value? How do you know that what they are learning in MESA will have value after they leave high school?
g. What do you think about the MESA community and its relation to their academic/career pursuits (does it encourage them to take on challenges, support them, positive or negative message about their ability, do staff and mentors talk about mindset related to persistence)?

Focal Question 3: What are the implications of this inquiry for policies and practices used in implementing a MESA high school program?

d. Knowing the potential impact a growth oriented mindset and academic mindset can have on your students, are there ways you believe MESA can enhance current practices/polices to strengthen theses mindsets?
e. Literature indicates it is important to teach both content while simultaneously helping students foster their mindsets-can you talk about current practices and do you know if this co-delivery model is being implemented?
f. How can you help your MESA teachers, mentors and volunteers enhance how they can help students develop and strengthen their mindsets?

APPENDIX E: MESA ADMINISTRATOR SEMI STRUCTURED INTERVIEW QUESTIONS

Focal Question 1: How do minority and female students participating in a MESA program describe their growth oriented and academic mindset?

a. Talk about the concept of intelligence (born with it, can you grow it, are some students just smarter, does the environment or access to resources enhance or detract from intelligence). Why do you believe this to be true or false-example to support your claim?

b. Some of your students believe intelligence is fixed others believe it can be developed- why do you think students vary in their responses (upbringing, positive or negative messages they receive in the environment, support/no support)
c. How does mindset play into how your students approach an academic challenge or when they are presented with an academic challenge?
d. How do you think your students' mindsets impacts their academic behavior (e.g. wanting to go to class, doing homework)?
e. From your point of view how is effort and competence (knowledge, skill) related/are they related?
f. How do you think your students 'participation in MESA provides value for life beyond high school?

Focal Question 2: In what ways does the MESA environment foster a growth oriented and academic mindset for students? What strategies are used, and what is the rationale provided for these strategies?

a. How does MESA (staff, mentors, volunteers, peers) communicate with students about the idea of growing your intelligence?
b. Does MESA encourage students to lean on others for help/support? If so how do they communicate this?
c. How does MESA support students when they struggle academically?
d. Does MESA teach students strategies for overcoming academic challenges, how and what do they teach students?
e. Does MESA talk about the relationship between effort and competence? How do they talk about this? Can you talk about a time when you saw how effort translated into competence?
f. Do you think the work students are doing in MESA has value? How do you know that what they are learning in MESA will have value after they leave high school?
g. What do you think about the MESA community and its relation to students academic pursuits (does it encourage them to take on challenges, support them, positive or negative message about their ability, do staff and mentors talk about mindset related to persistence)?

Focal Question 3: What are the implications of this inquiry for policies and practices used in implementing a MESA high school program?

a. Knowing the potential impact a growth oriented mindset and academic mindset can have on your students, are there ways you believe MESA can enhance current practices/polices to strengthen theses mindsets?
b. Literature indicates it is important to teach both content while simultaneously helping students foster their mindsets-can you talk about current practices and do you know if this co-delivery model is being implemented?
c. How can you help your MESA teachers, mentors and volunteers enhance how they can help students develop and strengthen their mindsets?

APPENDIX F: SURVEY RESULTS

Q1 - School Name

High School 1	In-class Model	75% N= 27
High School 2	After School Club	11.11% N=4
High School 3	After School Club	11.11% N=4
High School 4	After School Club	0%
High School 5	Saturday Academy	2.78% N=1
		36

Q2. Please indicate your gender

#	Field		Choice Count
1	Male	55.56%	20
2	Female	44.44%	16
3	Other	0.00%	0
			36

Showing Rows: 1 - 4 Of 4

Q3 - Please indicate your ethnicity/race (check all that apply).

#	Field		Choice Count
1	African American/Black	20.51%	8
2	Asian	5.13%	2
3	Caucasian	10.26%	4
4	Hispanic/Latino	61.54%	24
5	Native American/Alaskan Native	2.56%	1
6	Pacific Islander	0.00%	0
			39

Showing Rows: 1 - 7 Of 7

Q4. Please indicate your current grade level.

#	Field		Choice Count
1	9th	2.78%	1
2	10th	16.67%	6
3	11th	44.44%	16
4	12th	36.11%	13
			36

Showing Rows: 1 - 5 Of 5

Q5. Length of time you have participated in MESA (can include middle or elementary school participation).

#	Field		Choice Count
1	1 year or less	72.22%	26
2	2-3 years	25.00%	9
3	4-5 years	2.78%	1
4	More than 5 years	0.00%	0
			36

Showing Rows: 1 - 5 Of 5

Q6. Intelligence cannot be changed, you are born intelligent of not.

#	Field		Choice Count
1	Strongly Agree	8.33%	3
2	Somewhat Agree	22.22%	8
3	Disagree	33.33%	12
4	Strongly Disagree	36.11%	13
			36

Showing Rows: 1 - 5 Of 5

Q7. I get excited when presented with a challenge.

#	Field		Choice Count
1	Strongly Agree	41.67%	15
2	Somewhat Agree	44.44%	16
3	Disagree	13.89%	5
4	Strongly Disagree	0.00%	0
			36

Showing Rows: 1 - 5 Of 5

Q8. When I do not know the answer to a question I do not ask for help because this would show weakness.

#	Field		Choice Count
1	Strongly Agree	8.33%	3
2	Somewhat Agree	13.89%	5
3	Disagree	52.78%	19
4	Strongly Disagree	25.00%	9
			36

Showing Rows: 1 - 5 Of 5

Q9. I am not afraid to ask for help when I need it.

#	Field		Choice Count
1	Strongly Agree	55.56%	20
2	Somewhat Agree	36.11%	13
3	Disagree	5.56%	2
4	Strongly Disagree	2.78%	1
			36

Showing Rows: 1 - 5 Of 5

Q10. If I fail a task then I give up.

#	Field		Choice Count
1	Strongly Agree	5.56%	2
2	Somewhat Agree	16.67%	6
3	Disagree	38.89%	14
4	Strongly Disagree	38.89%	14
			36

Showing Rows: 1 - 5 Of 5

Q11. I enjoy the process of learning information that will be on my test as much as the letter grade I might receive on that test.

#	Field		Choice Count
1	Strongly Agree	19.44%	7
2	Somewhat Agree	63.89%	23
3	Disagree	13.89%	5
4	Strongly Disagree	2.78%	1
			36

Showing Rows: 1 - 5 Of 5

Q12. When I do not succeed and fail, I hide this from others.

#	Field		Choice Count
1	Strongly Agree	13.89%	5
2	Somewhat Agree	25.00%	9
3	Disagree	55.56%	20
4	Strongly Disagree	5.56%	2
			36

Showing Rows: 1 - 5 Of 5

Q13. I have the power to change my intelligence.

#	Field		Choice Count
1	Strongly Agree	63.89%	23
2	Somewhat Agree	33.33%	12
3	Disagree	2.78%	1
4	Strongly Disagree	0.00%	0
			36

Showing Rows: 1 - 5 Of 5

Q14. I seek out help when I need it.

#	Field		Choice Count
1	Strongly Agree	41.67%	15
2	Somewhat Agree	47.22%	17
3	Disagree	11.11%	4
4	Strongly Disagree	0.00%	0
			36

Showing Rows: 1 - 5 Of 5

Q15. I usually don't try new things because I might fail.

#	Field		Choice Count
1	Strongly Agree	5.56%	2
2	Somewhat Agree	33.33%	12
3	Disagree	33.33%	12
4	Strongly Disagree	27.78%	10
			36

Showing Rows: 1 - 5 Of 5

Q16. I pride myself on learning new material.

#	Field		Choice Count
1	Strongly Agree	55.56%	20
2	Somewhat Agree	41.67%	15
3	Disagree	2.78%	1
4	Strongly Disagree	0.00%	0
			36

Showing Rows: 1 - 5 Of 5

Q17. Even when I fail I try again.

#	Field		Choice Count
1	Strongly Agree	55.56%	20
2	Somewhat Agree	41.67%	15
3	Disagree	2.78%	1
4	Strongly Disagree	0.00%	0
			36

Showing Rows: 1 - 5 Of 5

Q18. I only care about the grade I receive on my test.

#	Field		Choice Count
1	Strongly Agree	16.67%	6
2	Somewhat Agree	33.33%	12
3	Disagree	41.67%	15
4	Strongly Disagree	8.33%	3
			36

Showing Rows: 1 - 5 Of 5

Q19. It is important for me to prove I am smart and talented to others.

#	Field		Choice Count
1	Strongly Agree	36.11%	13
2	Somewhat Agree	47.22%	17
3	Disagree	16.67%	6
4	Strongly Disagree	0.00%	0
			36

Showing Rows: 1 - 5 Of 5

Q20. I can lean new academic information if I try hard enough.

#	Field		Choice Count
1	Strongly Agree	66.67%	24
2	Somewhat Agree	33.33%	12
3	Disagree	0.00%	0
4	Strongly Disagree	0.00%	0
			36

Showing Rows: 1 - 5 Of 5

Q21. I was born with the ability to be a math person.

#	Field		Choice Count
1	Strongly Agree	25.00%	9
2	Somewhat Agree	30.56%	11
3	Disagree	19.44%	7
4	Strongly Disagree	25.00%	9
			36

Showing Rows: 1 - 5 Of 5

Q22. When I get a low score on my science test I seek out help to prepare for the next one.

#	Field		Choice Count
1	Strongly Agree	36.11%	13
2	Somewhat Agree	47.22%	17
3	Disagree	11.11%	4
4	Strongly Disagree	5.56%	2
			36

Showing Rows: 1 - 5 Of 5

Q23. When presented with a math concept I do not understand I get frustrated and give up.

#	Field		Choice Count
1	Strongly Agree	19.44%	7
2	Somewhat Agree	16.67%	6
3	Disagree	44.44%	16
4	Strongly Disagree	19.44%	7
			36

Showing Rows: 1 - 5 Of 5

Q24. When presented with an academic challenge I get excited about the opportunity to succeed at the challenge.

#	Field		Choice Count
1	Strongly Agree	25.00%	9
2	Somewhat Agree	61.11%	22
3	Disagree	11.11%	4
4	Strongly Disagree	2.78%	1
			36

Showing Rows: 1 - 5 Of 5

Q25. My MESA community is a group I go to for support.

#	Field		Choice Count
1	Strongly Agree	33.33%	12
2	Somewhat Agree	44.44%	16
3	Disagree	16.67%	6
4	Strongly Disagree	5.56%	2
			36

Showing Rows: 1 - 5 Of 5

Q26. If I put in more effort I will see better results on my homework.

#	Field		Choice Count
1	Strongly Agree	80.56%	29
2	Somewhat Agree	19.44%	7
3	Disagree	0.00%	0
4	Strongly Disagree	0.00%	0
			36

Showing Rows: 1 - 5 Of 5

Q27. I see myself majoring in college in Science, technology, Engineering or Math (STEM).

#	Field		Choice Count
1	Strongly Agree	61.11%	22
2	Somewhat Agree	25.00%	9
3	Disagree	8.33%	3
4	Strongly Disagree	5.56%	2
			36

Showing Rows: 1 - 5 Of 5

Q28. The work I am doing now in MESA has no connection to life after high school.

#	Field		Choice Count
1	Strongly Agree	8.33%	3
2	Somewhat Agree	19.44%	7
3	Disagree	41.67%	15
4	Strongly Disagree	30.56%	11
			36

Showing Rows: 1 - 5 Of 5

Q29. When I have an academic setback in my class, I tend to not want to engage in coursework anymore.

#	Field		Choice Count
1	Strongly Agree	5.56%	2
2	Somewhat Agree	36.11%	13
3	Disagree	41.67%	15
4	Strongly Disagree	16.67%	6
			36

Showing Rows: 1 - 5 Of 5

Q30. When I get a good grade on an assignment I am motivated to keep trying harder.

#	Field		Choice Count
1	Strongly Agree	72.22%	26
2	Somewhat Agree	25.00%	9
3	Disagree	2.78%	1
4	Strongly Disagree	0.00%	0
			36

Showing Rows: 1 - 5 Of 5

Q31. If I get a poor grade on an exam then I feel like I am not smart.

#	Field		Choice Count
1	Strongly Agree	11.11%	4
2	Somewhat Agree	38.89%	14
3	Disagree	36.11%	13
4	Strongly Disagree	13.89%	5
			36

Showing Rows: 1 - 5 Of 5

Q32. I feel like I am part of the MESA community.

#	Field		Choice Count
1	Strongly Agree	41.67%	15
2	Somewhat Agree	52.78%	19
3	Disagree	2.78%	1
4	Strongly Disagree	2.78%	1
			36

Showing Rows: 1 - 5 Of 5

Q33. When I put in more effort to my academic studies I learn more.

#	Field		Choice Count
1	Strongly Agree	71.43%	25
2	Somewhat Agree	28.57%	10
3	Disagree	0.00%	0
4	Strongly Agree	0.00%	0
			35

Showing Rows: 1 - 5 Of 5

APPENDIX G: CROSS-TABULATION OF GENDER AND SURVEY RESPONSES

		Please indicate y our gender.			
		Male	Female	Other	Total
Please indicate your ethnicity/race (check all that apply).	African American/Black	2	6	0	8
	Asian	0	2	0	2
	Caucasian	0	4	0	4
	Hispanic/Latino	18	6	0	24
	Native American/Alaskan Native	0	1	0	1
	Pacific Islander	0	0	0	0
	Total	20	16	0	36
Please indicate your current grade level.	9th	1	0	0	1
	10th	0	6	0	6
	11th	12	4	0	16
	12th	7	6	0	13
	Total	20	16	0	36
Length of time you have participated in MESA (can include middle or elementary school participati...	1 year or less	14	12	0	26
	2-3 years	6	3	0	9
	4-5 years	0	1	0	1
	More than 5 years	0	0	0	0
	Total	20	16	0	36
Intelligence cannot be changed, you are born intelligent or not.	Strongly Agree	2	1	0	3
	Somewhat Agree	6	2	0	8
	Disagree	6	6	0	12
	Strongly Disagree	6	7	0	13
	Total	20	16	0	36
I get excited when presented with a challenge.	Strongly Agree	9	6	0	15
	Somewhat Agree	7	9	0	16
	Disagree	4	1	0	5
	Strongly Disagree	0	0	0	0
	Total	20	16	0	36

When I do not know the answer to a question I do not ask for help because this would show weakness.	Strongly Agree	3	0	0	3
	Somewhat Agree	0	5	0	5
	Disagree	11	8	0	19
	Strongly Disagree	6	3	0	9
	Total	20	16	0	36
I am not afraid to ask for help when I need it.	Strongly Agree	14	6	0	20
	Somewhat Agree	6	7	0	13
	Disagree	0	2	0	2
	Strongly Disagree	0	1	0	1
	Total	20	16	0	36
If I fail a task then I give up.	Strongly Agree	0	2	0	2
	Somewhat Agree	2	4	0	6
	Disagree	6	8	0	14
	Strongly Disagree	12	2	0	14
	Total	20	16	0	36
I enjoy the process of learning information that will be on my test as much as the letter grade I...	Strongly Agree	3	4	0	7
	Somewhat Agree	14	9	0	23
	Disagree	2	3	0	5
	Strongly Disagree	1	0	0	1
	Total	20	16	0	36
When I do not succeed and fail, I hide this from others.	Strongly Agree	3	2	0	5
	Somewhat Agree	3	6	0	9
	Disagree	12	8	0	20
	Strongly Disagree	2	0	0	2
	Total	20	16	0	36

I have the power to change my intelligence.	Strongly Agree	13	10	0	23
	Somewhat Agree	6	6	0	12
	Disagree	1	0	0	1
	Strongly Disagree	0	0	0	0
	Total	20	16	0	36
I seek out help when I need it.	Strongly Agree	10	5	0	15
	Somewhat Agree	8	9	0	17
	Disagree	2	2	0	4
	Strongly Disagree	0	0	0	0
	Total	20	16	0	36
I usually don't try new things because I might fail.	Strongly Agree	1	1	0	2
	Somewhat Agree	6	6	0	12
	Disagree	7	5	0	12
	Strongly Disagree	6	4	0	10
	Total	20	16	0	36
I pride myself on learning new material.	Strongly Agree	13	7	0	20
	Somewhat Agree	6	9	0	15
	Disagree	1	0	0	1
	Strongly Disagree	0	0	0	0
	Total	20	16	0	36
Even when I fail I try again.	Strongly Agree	13	7	0	20
	Somewhat Agree	7	8	0	15
	Disagree	0	1	0	1
	Strongly Disagree	0	0	0	0
	Total	20	16	0	36

I only care about the grade I receive on my test.	Strongly Agree	5	1	0	6
	Somewhat Agree	6	6	0	12
	Disagree	7	8	0	15
	Strongly Disagree	2	1	0	3
	Total	20	16	0	36
It is important for me to prove I am smart and talented to others.	Strongly Agree	7	6	0	13
	Somewhat Agree	9	8	0	17
	Disagree	4	2	0	6
	Strongly Disagree	0	0	0	0
	Total	20	16	0	36
I can learn new academic information if I try hard enough.	Strongly Agree	13	11	0	24
	Somewhat Agree	7	5	0	12
	Disagree	0	0	0	0
	Strongly Disagree	0	0	0	0
	Total	20	16	0	36
I was born with the ability to be a math person.	Strongly Agree	7	2	0	9
	Somewhat Agree	7	4	0	11
	Disagree	2	5	0	7
	Strongly Disagree	4	5	0	9
	Total	20	16	0	36
When I get a low score on my science test I seek out help to prepare for the next one.	Strongly Agree	6	7	0	13
	Somewhat Agree	9	8	0	17
	Disagree	3	1	0	4
	Strongly Disagree	2	0	0	2
	Total	20	16	0	36

When presented with a math concept I do not understand I get frustrated and give up.	Strongly Agree	2	5	0	7
	Somewhat Agree	2	4	0	6
	Disagree	12	4	0	16
	Strongly Disagree	4	3	0	7
	Total	20	16	0	36
When presented with an academic challenge I get excited about the opportunity to succeed at the c...	Strongly Agree	5	4	0	9
	Somewhat Agree	12	10	0	22
	Disagree	2	2	0	4
	Strongly Disagree	1	0	0	1
	Total	20	16	0	36
My MESA community is a group I go to for support.	Strongly Agree	8	4	0	12
	Somewhat Agree	8	8	0	16
	Disagree	4	2	0	6
	Strongly Disagree	0	2	0	2
	Total	20	16	0	36
If I put in more effort I will see better results on my homework.	Strongly Agree	16	13	0	29
	Somewhat Agree	4	3	0	7
	Disagree	0	0	0	0
	Strongly Disagree	0	0	0	0
	Total	20	16	0	36

I see myself majoring in college in Science, Technology, Engineering or Math (STEM).	Strongly Agree	13	9	0	22
	Somewhat Agree	5	4	0	9
	Disagree	1	2	0	3
	Strongly Disagree	1	1	0	2
	Total	20	16	0	36
The work I am doing now in MESA has no connection to life after high school.	Strongly Agree	2	1	0	3
	Somewhat Agree	3	4	0	7
	Disagree	8	7	0	15
	Strongly Disagree	7	4	0	11
	Total	20	16	0	36
When I have an academic setback in my class, I tend to not want to engage in coursework anymore.	Strongly Agree	1	1	0	2
	Somewhat Agree	8	5	0	13
	Disagree	8	7	0	15
	Strongly Disagree	3	3	0	6
	Total	20	16	0	36
When I get a good grade on an assignment I am motivated to keep trying harder.	Strongly Agree	14	12	0	26
	Somewhat Agree	5	4	0	9
	Disagree	1	0	0	1
	Strongly Disagree	0	0	0	0
	Total	20	16	0	36
If I get a poor grade on an exam then I feel like I am not smart.	Strongly Agree	2	2	0	4
	Somewhat Agree	5	9	0	14
	Disagree	10	3	0	13
	Strongly Disagree	3	2	0	5
	Total	20	16	0	36
I feel like I am part of the MESA community.	Strongly Agree	10	5	0	15
	Somewhat Agree	9	10	0	19
	Disagree	0	1	0	1
	Strongly Disagree	1	0	0	1
	Total	20	16	0	36
When I put in more effort to my academic studies I learn more.	Strongly Agree	12	13	0	25
	Somewhat Agree	7	3	0	10
	Disagree	0	0	0	0
	Strongly Agree	0	0	0	0
	Total	19	16	0	35

APPENDIX H: A PRIORI CODES

Theme number	Question									
Focal Question 1: How do minority and female students participating in a MESA program describe their growth oriented and academic mindset?										
Q1A	Talk about the concept of intelligence (born with it, can you grow it, are some students just smarter, does the environment or access to resources enhance or detract from intelligence). Why do you believe this to be true or false-example to support your claim?	Born with it	Can grow it	Cant change it	Environmental factors	Other				
Q1B	Some of your peers/students believe intelligence is fixed others believe it can be developed-why do you think students vary in their responses (upbringing, positive or negative messages they receive in the environment, support/no support)	Environ. Factors	Other	Not Sure						
Q1C	How does mindset play into how your students/you approach an academic challenge or when they are presented with an academic challenge?	It Doesn't	It encourages them to keep going, not give up	Helps them realize they need to reassess strategy	Encourages them to lean on MESA resources other resources	other				
Q1D	How do you think your students'/your mindsets impacts their academic behavior (e.g. wanting to go to class, doing homework)?	It Doesn't	When they have a mindset that they can do something they are more	They show up to class	They are more engaged in the classroom	They participate in more MESA activities	other			
Q1E	From your point of view how is effort and competence (knowledge, skill) related/are they related?	They are not related	Not sure	The more effort the more competence	other					
Q1F	How do you think your/you students' participation in MESA provides value for life beyond high school?	No	They know how to apply to college	They understand STEM majors and careers	They learn necessary skills to persist	other				
Focal Question 2: In what ways does the MESA environment foster a growth oriented and academic mindset for students? What strategies are used, and what is the rationale provided for these strategies?										
Q2A	How does MESA (staff, mentors, volunteers, peers) communicate with students about the	They don't	They explicitly talk about it	Its not explicit but they model behaviors	Not sure	Workshops on subject matter	other			
Q2B	Does MESA encourage students to lean on others for help/support? If so	No	Yes	Somewhat	Students just know	MESA verbally tells students	other			
Q2C	How does MESA support students when they struggle academically?	Tutoring	Strategies for Studying	How to ask Questions	Other	Positive message (you can do it)				
Q2D	Does MESA teach students strategies for overcoming academic challenges? How and what do they teach	Yes	No	Not formally	How to access networks	Organ. skills	other	Mindset Wrksp	Study skills	Metacog.
Q2E	Does MESA talk about the relationship between effort and competence? How do they talk about this? Can you talk about a time when you saw	Yes	No	Workshops	Via mentor or guest speakers	Informally	other			
Q2F	Do you think the work students are doing in MESA has value? How do you know that what they are learning in MESA will have value after they leave high school?	Yes	No	They tell me	They have a success e.g. get into college	Based on my own personal experience I know they will have success (teacher/admin only)	other			
Q2G	What do you think about the MESA community and its relation to students' academic pursuits (does it encourage them to take on challenges, support them, positive or negative message	Its positive	Its negative	Has a direct link to positive academic or career pursuits	other					

Focal Question 2: In what ways does the MESA environment foster a growth oriented and academic mindset for students? What strategies are used, and what is the rationale provided for these strategies?										
Q2A	How does MESA (staff, mentors, volunteers, peers) communicate with students about the	They don't	They explicitly talk about it	Its not explicit but they model behaviors	Not sure	Workshops on subject matter	other			
Q2B	Does MESA encourage students to lean on others for help/support? If so	No	Yes	Somewhat	Students just know	MESA verbally tells students	other			
Q2C	How does MESA support students when they struggle academically?	Tutoring	Strategies for Studying	How to ask Questions	Other	Positive message (you can do it)				
Q2D	Does MESA teach students strategies for overcoming academic challenges? How and what do they teach	Yes	No	Not formally	How to access networks	Organ. skills	other	Mindset Wrksp	Study skills	Metacog.
Q2E	Does MESA talk about the relationship between effort and competence? How do they talk about this? Can you talk about a time when you saw	Yes	No	Workshops	Via mentor or guest speakers	Informally	other			
Q2F	Do you think the work students are doing in MESA has value? How do you know that what they are learning in MESA will have value after they leave high school?	Yes	No	They tell me	They have a success e.g. get into college	Based on my own personal experience I know they will have success (teacher/admin only)	other			
Q2G	What do you think about the MESA community and its relation to students' academic pursuits (does it encourage them to take on challenges, support them, positive or negative message	Its positive	Its negative	Has a direct link to positive academic or career pursuits	other					

Focal Question 3: What are the implications of this inquiry for policies and practices used in implementing a MESA high school program?										
Q3A	Knowing the potential impact a growth oriented mindset and academic mindset can have on your students, are there ways you believe MESA can enhance current	Yes	No	Not sure	More trainings	Use of Mindset curriculum	Explicitly discuss mindset			
Q3B	Literature indicates it is important to teach both content while simultaneously helping students foster their mindsets-can you talk about current practices and do you know if	Yes	No	Not sure	Was not aware of this practice	This is currently happening through XXX				
Q3C	How can you help your MESA teachers, mentors and volunteers enhance how they can help students develop and strengthen their mindsets?	Additional Training	Unsure	Be more explicit about mindset	other					

VITA

Dr. Stephanie R. Gardner is passionate and unwavering in her belief that all students are entitled to a quality education. She has remained a steadfast champion for underrepresented populations as it relates to educational opportunities, persistence and graduation. During her almost 20 years of professional service, Dr. Gardner has focused on post-secondary education, diversity work, STEM, college readiness, community and public relations, systems change, international initiatives, retention and education policy.

Dr. Gardner has been active in both her local community, the region and with national initiatives. She has presented at a number of conferences including: WSSDA, GEAR UP Regional WEST, AP Symposium, NACEP Western Regional, AACU, ASEE, LSAMP National Conference, and ACE. She has also been selected to participate in a number of committees or programs, including the Washington STEM Racial Equity Roundtable (competitive-24 selected from across Washington State), the Alice Manicur Symposium for Women Aspiring to Become Vice Presidents in Student Affairs (competitive admission 80 selected from across the U.S.), and selection to the 2016 Leadership Tomorrow cohort (competitive admission only 71 participants selected in Washington State, year-long intensive civic leadership program). She is a former member of the National Association for Student Affairs Administrators (NASPA) in Higher Education and served on the national board for the African American Knowledge Community (AAKC) as the Conference Social Chair, and the Best Practices Spotlight Chair. She previously volunteered with the organization as a NASPA Region V Awards Reviewer and 2014 NASPA Western Regional Conference Reviewer. Local boards have included the Technology Access Foundation, Urban League Young Professionals (service as the Educational Chair), and UW Brotherhood Initiative Steering Committee.

Dr. Gardner has been recognized for her leadership and service. She was featured on the Office of Minority Affairs & Diversity (OMAD) Homepage (*Doctoral Student and LSAMP Director Helps Diversity STEM Workforce, December 2015 and University of Washington*), and University of Washington, College of Education webpage, (December 2015 https://education.uw.edu/news/student-leads-initiative-diversify-stem-workforce,). She was previously nominated and selected as UW Pangaea International staff study abroad award recipient to Paris, France in 2008, and received a certificate of recognition for the OMA&D Outstanding Contribution Award in 2007.

Dr. Gardner is a three-time University of Washington alumnae. She earned her B.A. in Communications and her M.Ed. and Ed.D. in Educational Leadership and Policy. She also holds a certificate from Harvard University's Graduate School of Education, Management Development Program.