The Narratives of Latina Students who have Participated in Invention Education

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THE NARRATIVES OF LATINA STUDENTS WHO HAVE PARTICIPATED IN INVENTION EDUCATION

by

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A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of Learning Science and Educational Research in the College of Community Innovation and Education at the University of Central Florida
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ABSTRACT

Less than 2% of patent holders in the United States identify as Latina. This statistic is problematic considering the increasing Latinx population and the empirical evidence which indicates the benefits of drawing on diverse perspectives in the invention ecosystem. In an effort to increase diversity among inventors and patent holders, K-12 programs have been created to provide opportunities for students to participate in the iterative and recursive processes of inventing. One example is the emerging field of invention education. Invention education is an educational approach which teaches students how to identify and solve problems within their communities. Little is known about the experiences of Latina students who have participated in invention education and have begun developing identities as inventors. Through narrative methodology, I analyze how the life experiences of three Latina students who participated on a high school invention team contribute to their identity development as inventors. Applying Yosso’s Community Cultural Wealth theory as a framework, I also explore the different types of cultural capital the young inventors draw on throughout the development of their identities. Analysis indicates participation in extracurricular invention education activities contributes to the development of an inventor’s identity. Major findings include the role of educators and families, specifically siblings, as valuable sources of cultural capital. I also identify two additional types of cultural capital the participants drew on throughout the development of their inventor identities. The first is risk taking capital, which I define as the willingness to take risks and say yes to opportunities that could provide benefits. The second form of cultural capital I identify is hustle.
capital, which I conceptualize in an academic sense, as effort and energy exerted to learn or achieve a goal.
I dedicate this dissertation to Magnolia, the first Latina inventor I encountered in my life. Magnolia was the inspiration for this dissertation and the reason I chose to study the lives of Latina inventors. She is the most innovative and resourceful woman I know. I am forever grateful for the example she set for me and for the privilege of getting to know her and her children, Iraissa and Allan.
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# TABLE OF CONTENTS

LIST OF FIGURES ........................................................................................................... x

LIST OF TABLES .............................................................................................................. xi

CHAPTER ONE: INTRODUCTION ....................................................................................... 1

What is Being Done? Increasing Diversity Among Inventors and Patent Holders .......... 3

Research Questions ........................................................................................................ 5

Purpose ........................................................................................................................... 6

Potential .......................................................................................................................... 6

CHAPTER TWO: LITERATURE REVIEW ............................................................................. 7

Part One: Invention in the United States ........................................................................ 8

Definitions of Invention and Innovation ......................................................................... 8

Who Holds Patents in the United States? ....................................................................... 9

What is Being Done to Increase the Number of Diverse Inventors? ............................. 13

Invention Education and Studies in the Field .................................................................. 14

Part Two: Latina Engineering Identity Development .................................................... 20

Latinas in Engineering .................................................................................................... 21

Conceptual Framework ................................................................................................... 30

Implications of Applying a Community Cultural Wealth Lens ...................................... 32
CHAPTER THREE: METHODOLOGY ................................................................. 33

Rationale for Research Approach ........................................................................ 33

Site and Participant Selection .............................................................................. 35

Context of the InvenTeam™ ............................................................................. 35

Criteria and Recruitment ..................................................................................... 36

Access .................................................................................................................. 38

Procedures .......................................................................................................... 38

Data Analysis ....................................................................................................... 43

Trustworthiness .................................................................................................... 45

Positionality Statement ....................................................................................... 46

CHAPTER FOUR: NARRATIVES OF IDENTITY DEVELOPMENT ..................... 48

Ximena Nava Diaz, The Critical Thinker .............................................................. 48

Ximena’s Story ..................................................................................................... 49

Lesly Rojas, The Aspiring Engineer ..................................................................... 63

Lesly’s Story ......................................................................................................... 64

Isabel Mejia, The People Person .......................................................................... 79

Isabel’s Story ....................................................................................................... 79

Synthesis of Chapter Four ................................................................................... 94

CHAPTER FIVE: THEORY INFORMED FINDINGS ......................................... 98
Deductive Analysis .................................................................................................................. 100

Social Capital .......................................................................................................................... 100

Resistant Capital ....................................................................................................................... 110

Aspirational Capital ................................................................................................................ 114

Navigational Capital ............................................................................................................... 117

Linguistic Capital ..................................................................................................................... 120

Familial Capital ........................................................................................................................ 121

Inductive Analysis ..................................................................................................................... 126

Risk Taking as a Form of Cultural Capital .............................................................................. 126

Hustle as a Form of Cultural Capital ....................................................................................... 132

Synthesis of Chapter Five ....................................................................................................... 136

CHAPTER SIX: CONCLUSION .................................................................................................. 139

Multifaceted Inventor Identity Shaped by Individual, Axiological, and Sociocultural
Contextual Influences ............................................................................................................... 140

Individual Factors ................................................................................................................... 140

Axiological Factors as a Bridge between the Individual and Sociocultural Contexts ............ 141

Sociocultural Factors ............................................................................................................... 143

Community Cultural Wealth and the Assets Latinas Bring to Invention ............................... 148
Invention Education as an Opportunity to Engage Students in Problem Solving and Inventing .................................................................................................................................................. 150

Implications .......................................................................................................................................................................................... 151

Implications and Future Directions for Policymakers ......................................................................................................................... 152

Implications for Educators .................................................................................................................................................................. 153

Implications for Latina Students ....................................................................................................................................................... 154

Implications for Researchers ............................................................................................................................................................ 155

APPENDIX A: IRB APPROVAL ....................................................................................................................................................... 157

APPENDIX B: CONSENT FORM ....................................................................................................................................................... 159

APPENDIX C: INTERVIEW GUIDES .............................................................................................................................................. 163

REFERENCES ..................................................................................................................................................................................... 167
LIST OF FIGURES

Figure 1: Concept map of themes developed from Ximena’s narrative ........................................ 51
Figure 2: Concept map of themes developed from Lesly’s narrative .......................................... 66
Figure 3: Concept map of themes developed from Isabel’s narrative ........................................... 82
LIST OF TABLES

Table 1 Time Spent on Each Interview with the Participants .......................................................... 40
Table 2 Data Analysis Process ..................................................................................................... 44
Table 3 Types of Cultural Capital Demonstrated by the Participants ........................................ 99
CHAPTER ONE: INTRODUCTION

Recent scholarship calls for more diversity among inventors in the United States (Bell et al., 2019; Wisnioski et al., 2019). Studies also indicate innovation and invention require new ideas and different ways of thinking (Ashcraft & Breitzman, 2012). Authors argue it is necessary to draw on the valuable skills and knowledge of individuals from varied backgrounds in order to solve the complex problems communities face (Samuelson & Litzer, 2016; Yosso, 2005). Although researchers provide evidence of the benefits of drawing on diverse ideas throughout the invention process, the majority of inventors who hold patents in the U.S. are White, middle-aged males with graduate degrees in science, technology, engineering, and mathematics (STEM) fields (Bell et al., 2019; Nager et al., 2017). Researchers who study invention and innovation have associated gaps in patenting based on gender and ethnicity with the lack of diversity in STEM disciplines, specifically engineering and technology, the two fields which generate the most patents (Cook, 2019; Couch & Estabrooks; 2020; Sanders & Ashcraft, 2019).

Considering one in four students in the U.S. school system identifies as Latinx and by 2050, one in three Americans will identify as Latinx (Excelencia in Education, 2019), it is important to draw on the rich cultural knowledge which can be found within Latinx communities throughout the United States (Samuelson & Litzer, 2016). The term Latinx refers to those individuals of Hispanic/Latin American descent of all genders. While Latinx students are entering higher education at increasing rates, they continue to be underrepresented in earned STEM degrees and in the STEM workforce (Excelencia in Education, 2015). The Latinx population accounts for 19% of the U.S. population (U.S. Census, 2021); however, they account for only 3% of Ph.D.s earned in STEM fields and 3% of the patent holders in the United States.
Latinas, specifically, account for only 2% of engineering jobs (National Science Board [NSB], 2020). This disparity is problematic considering the well-established link between innovation and STEM fields (NSB, 2020).

Given the underrepresentation of Latinas in STEM and the need for a more diverse STEM workforce, a growing body of literature focuses on the experiences of Latinas in STEM. Studies in the field have found developing a strong STEM identity contributes to resilience and persistence (Carlone & Johnson, 2007; Rincon & Rodriguez, 2021). While many studies focus on STEM-specific identities, namely engineering identity, no studies explore the identity development of Latina inventors. For this reason, I draw on scholarship which focuses on the engineering identity development of Latinas. While I recognize that not all inventors are engineers and vice-versa, over half of the patents which exist in the United States relate to either electrical or mechanical engineering (Nager et al., 2017). Additionally, at just under 2% of the population, the rate of Latina patent holders in the United States closely resembles the rate of Latina engineers (USPTO, 2018).

Scholarship in the field of engineering identity emphasizes the relationship between learners and institutions, arguing that both are shaped by interactions between the two (Tonso, 2005). If the majority of the students who attend engineering institutions are White or Asian males, the institution will reflect the norms and culture of dominant groups. If an institution does not reflect the norms and cultures of underrepresented minorities, it can affect students' development of a strong engineering identity which is critical to their persistence and resilience in the field (Tonso, 2005). While this is an issue for the field of engineering, the limited number of institutions which offer invention education (IvE) is even more problematic for the field of
invention. Considering the limited number of organizations which provide invention education, I suggest that opportunities to develop an inventor’s identity are structurally limited.

**What is Being Done? Increasing Diversity Among Inventors and Patent Holders**

In an effort to increase diversity among inventors and patent holders in the U.S., K-12 programs have been created to provide opportunities for students to participate in the iterative and recursive processes of inventing (Invention Education Research Community [IvERC], 2019). One example is the emerging field of invention education (IvE). IvE is an educational approach which teaches students how to identify and solve problems within their communities (IvERC, 2019). Little is known about Latinas who participate in IvE experiences. Learning about the life experiences of Latina K-12 students who have participated in IvE can provide insight into the contextual elements of their lives. If researchers gain a deeper understanding of the contextual elements of their lives, they have an opportunity to examine how Latinas develop identities as inventors. Examining the life experiences of young Latina inventors also provides an opportunity to illuminate how identities are developed and constructed over time. By studying the stories of young Latina inventors, I also analyzed how Latina students draw on their rich cultural capital (Yosso, 2005) in IvE settings.

Cultural capital is traditionally defined as the assets and resources that one accumulates through socialization and education which are deemed valuable by White, middle-class society (Bourdieu, 1986). Bourdieu (1986) explains that cultural capital can be objectified through tangible objects, including dress and style. Cultural capital may also be embodied through language and manners demonstrated through interactions with others. Traditional cultural capital
can also include degrees and job titles (Bourdieu, 1986). Yosso challenges this dominant conception and posits that communities of color possess assets and valuable cultural capital which have been long overlooked and undervalued (Yosso, 2005). Yosso (2005) describes six forms of cultural capital students of color possess: navigational, linguistic, aspirational, social, resistant, and familial. As opposed to focusing on what students of color lack in school, Yosso (2005) encourages scholars to acknowledge the rich cultural capital students bring to formal educational settings from their own communities.

Focusing on young inventors who participated in IvE in the K-12 setting provides the opportunity to examine how identity is constructed over time through repeated identity work (Kelly et al., 2013; Calabrese-Barton et al., 2013; Couch et al., 2018; Kelly et al., 2013). Exploring the life experiences of young Latina inventors also provides the opportunity to capture how early and consistent exposure to STEM and invention affects identity development (Couch et al., 2018). Additionally, gaining insight from underrepresented students who have experienced K-12 IvE provides varied perspectives on IvE and how it connects to their lives outside of school and the cultural capital they bring to inventing and problem solving.

This study is a narrative study which explores the experiences of three Latina students who participated in a yearlong IvE project during their sophomore year of high school. By taking a narrative methodological approach, my goal was to understand the contextual elements of the participants’ lives, from childhood to the present day and explore how those elements have contributed to the development of an inventor’s identity. Scholars posit identities are constructed through storytelling and identities are the stories individuals tell themselves and others about themselves (Kim, 2016; Riessman, 2008). Given the connection between the construction of
identity and life stories, I chose narrative as the methodology for my study. Taking a narrative approach allows me to examine and analyze how young Latinas describe their life experiences and connect to their identities as inventors. Narrative methodology also provides the opportunity to examine how young Latinas might recognize and draw on their cultural capital throughout their experiences. The data for this narrative study was generated through individual, video-recorded interviews via Zoom with three participants over a period of six months. I conducted three interviews with each participant and engaged in continuous member checked of analysis I constructed from their narratives.

**Research Questions**

1. What are the life experiences of young Latina inventors which contribute to the development of an inventor’s identity?

2. What cultural capital do young Latinas draw on as they develop as inventors?
   - 2a: What are the different types of cultural capital described in Yosso’s (2005) Community Cultural Wealth theory that young Latina inventors draw on throughout their development of an inventor's identity?
   - 2b: What additional forms of Community Cultural Wealth do young Latina students draw on throughout their development of an inventor’s identity?
Purpose

The purpose of this narrative study was to examine the life stories of three Latina students who participated in IvE while in high school. By examining their stories, I gained a deeper understanding of how their life experiences contributed to the development of an inventor’s identity. An additional purpose of this study was to examine what types of cultural capital young Latina inventors draw throughout their lives and experiences as inventors.

Potential

My study has the potential to create opportunities for young Latinas in invention and STEM by highlighting the assets they possess. Re-constructing life stories also provides an opportunity for the participants to be recognized for their knowledge and experience while also becoming examples for young Latina girls in inventing and STEM. This study also has the potential to contribute to cultural capital theories because I extended Yosso’s CCW theory and identified additional forms of cultural capital Latina students draw on as they develop and construct their identities as inventors. Revealing and understanding the experiences of Latina students who participate in IvE may inform policymakers on how to improve access to IvE and STEM opportunities for underrepresented minority students, in turn increasing diversity in the STEM workforce and among inventors and patent holders. Understanding how and why Latina students take up an inventor identity may also inform other stakeholders and policymakers of the importance of exposing students to IvE opportunities early and often.
CHAPTER TWO: LITERATURE REVIEW

The literature review for this dissertation draws on scholarship from two main bodies of literature. For the first section of the review, I searched for literature that addresses the need for more inventors from diverse backgrounds in the United States. These studies, book chapters, and reports positioned a need for diversity among inventors as a central focus. Included in the first section of the review are studies that referenced the terms “invention education” or framed the need to develop more and diverse inventors as an economic and social imperative. To conclude part one and connect to the second section of the literature review, I discuss the scholarship on identity and agency in invention.

In the second section of the review, I draw on literature from the field of engineering identity development in Latina students and those studies which use Community Cultural Wealth (CCW) theory as a framework for the study of identity development in Latina engineering students. Through my initial search, I found no literature that focuses specifically on the identity development of Latina inventors. Although no studies explicitly address the identity development of Latina inventors in the United States, a call to increase the participation of women and underrepresented minorities in STEM fields is a consistent thread throughout the literature on invention (Couch & Estabrooks, 2020; Fletcher & Shapanka, 2018; IvERC, 2019). Given the prevalence of patents from engineering fields, inventors with engineering backgrounds, and the overlap between engineering and invention, I made the decision to include the research on engineering identity development in Latinas for the second section of my literature review.
Part One: Invention in the United States

Innovation drives economic growth. In addition to the economic benefits, inventions have the ability to improve the day-to-day quality of life and the health and well-being of individuals and the communities in which they live in. Comedy (2014) argues that because inventions are deeply intertwined with our everyday existence, not enough attention is paid to invention and inventors. She describes invention as the invisible hero, essential, yet rarely celebrated. Comedy (2014) is not alone in her call to illuminate inventors and their inventions. Given the critical role that invention plays in the success of a society, scholars have become increasingly interested in who invents in the United States (Bell et al., 2019; Nagar et al., 2017). Scholars exploring who invents in the United States provide evidence that the disparities in the innovation ecosystem are tied to the environmental factors of individuals and not based on an innate ability to innovate (Bell et al., 2019; Root-Bernstein et al., 2019). Below, I review literature which explores the demographics of patent holders in the United States and the efforts to increase diversity among inventors.

Definitions of Invention and Innovation

The Committee for Invention (2004) defines invention as “the process of devising and producing by independent investigation, experimentation, and mental activity, something that is useful and that was not previously known or existing” (p.12). Inventiveness is defined as the creativity that leads to an invention (Committee for Invention, 2004). Based on these definitions, inventors are those individuals who take part in creating something that did not previously exist. Innovation is defined as “the complex process of introducing novel ideas into use or and includes
entrepreneurship as an integral part” (p. 13). Inventions are the foundation and source of innovation (Cook, 2019). Invention without innovation and widespread use does not benefit society (Committee for Invention, 2004).

Cook (2019) explains that the innovation ecosystem has three distinct levels. The first is preparation and education, the second is invention, and the third and final step is innovation, which includes the commercialization of inventions. Similarly, the National Science Board (2020) explains that invention is the development of unique and novel creations, while innovation refers to the implementation of those ideas. While gaps based on gender and ethnicity occur at all three stages of the innovation ecosystem, in this section I focus on those individuals in the final stage of the ecosystem who have commercialized inventions and hold patents, which is one measure of diversity among inventors.

Who Holds Patents in the United States?

Researchers who explore who innovates in the United States have found major gaps exist among patent holders based on race and/or ethnicity, class, gender, and education level (Bell et al., 2018; Milli et al., 2017). Nager and colleagues (2016) report that 88% of patent holders are White or Asian males with advanced degrees in STEM fields and that the average age of inventors in the United States is 47. Below I break down the underrepresentation of patent holders by gender, race and/or ethnicity, socioeconomic status, and level of education.

Women as Inventors

The search generated more literature on the underrepresentation of women as inventors than any other subgroup. Recent reports indicate that only 12% of patent holders in the United
States are women (Cook, 2019) and only 5.5% of patents are held by women (Fletcher & Shapanka; 2018). Only 4% of patents in industry settings are earned by all-female teams or by sole female inventors. In terms of patents granted, there is a 1:4 ratio when comparing all-female teams and sole women inventors with all-male teams and sole male inventors (Ashcraft & Breitzman, 2012). In 1976 women made up 37% of mixed-gender industry teams seeking patents but in 2016 women only represented 29% of mixed-gender teams. Couch and Estabrooks (2020) report that when women participated in mixed-gender teams, they were more likely to be named co-inventor. The decrease in mixed-gender teams is problematic considering research indicates that mixed-gender teams produce the most patents (Ashcraft & Breitzman, 2012).

Scholars who focus on the underrepresentation of women as patent holders argue that women participating in innovation would improve the national economy (Couch & Estabrooks, 2020; Fetchner & Shapanka, 2018; Sanders & Ashcraft, 2019). Reports also indicate if the U.S. reached gender parity in patents, the gross domestic product (GDP) would increase approximately 3% (Couch & Estabrooks, 2021; Hunt et al., 2012). Couch and Estabrooks (2020) authored a discussion paper which addressed policy initiatives needed to engage more women in invention. The authors argued that providing more women with an opportunity to innovate also provides them with an opportunity to accumulate economic capital.

Milli and co-researchers reported (2016) Asian women and women of multiple races apply for the greatest number of patents, however, they were still less likely to apply for patents than their male counterparts. Women of color were particularly underrepresented among patent holders. Milli et al. (2016) report that Hispanic men patent at five times the rate of Hispanic women and Black men patent at 2.6 times the rate of Black women (2016). Researchers have
found that the underrepresentation of women as inventors is related to the underrepresentation of women in STEM fields (Hunt et. al., 2012; Milli et al. 2016), particularly in technology (Sanders & Ashcraft, 2019) and engineering (Cook, 2019).

**Minorities and Immigrants as Inventors**

Few studies, reports, or books focus on the underrepresentation of minorities as inventors or innovators. In the 2018 *Technology and Innovation* special issue focused on the gender gap among inventors, Fletcher and Shapanka (2018) addressed the disparity in invention based on gender, race, and income. Most of the scholarship that does exist focuses specifically on the underrepresentation of Black inventors and their participation within the innovation ecosystem (Cook, 2019; Slanton, 2010). Only half of one percent of patent holders are Black while 13% of the U.S. population identifies as Black (Cook, 2019). Similarly, only 3% of patent holders are Latinx despite making up 17% of the U.S. population (NSB, 2020). In a 2017 report titled *Demographics of Innovation in the U.S.* Nager and colleagues documented that less than 8% of inventors are minorities born in the United States. Researchers have also found that White and Asian students are more likely to become inventors than their Black and Latinx peers (Bell et al, 2018, Hunt et al., 2012).

Much of the diversity that does exist among patent holders can be attributed to inventors born abroad. One-third of inventors were born outside of the U.S and 10% of inventors born in the United States have at least one parent born in another country (Nager et al., 2017). Over two-thirds of inventors born abroad have a Ph.D. in a STEM subject. Of U.S. patent holders, 17% are not U.S. citizens (NSB, 2020).
Socioeconomic Class and Educational Background

While few studies address the connection between socioeconomic class and patent holders, scholarship indicates that socioeconomic status plays a role in who becomes an inventor. Bell et al. (2018) found that individuals from the top 1% income bracket are 10 times more likely to become an inventor compared to those who are from the middle class or lower. Individuals who are exposed to invention and innovation in their everyday lives are also more likely to become inventors (Bell et al., 2018). Bell and colleagues (2018) found that students begin with equal levels of inventiveness, but as time progresses students from lower socio-economic backgrounds fall behind.

The educational background of inventors in the United States provides a link between invention and the STEM fields. Nager et al. (2017) found that 90% of inventors in the United States majored in a STEM field and that 50% majored in some form of engineering. The same study also reports 55% of inventors have a Ph.D. in a STEM subject and four-fifths have earned at least one advanced degree. Nager et al., (2017) also found that more inventors hold degrees from the Massachusetts Institute of Technology than any other college or university in the country.

Researchers who examine who becomes an inventor in the United States provide evidence that exposure to innovation during childhood increases the likelihood that an individual becomes an inventor (Bell et al., 2019). For example, Bernstein and colleagues (2019) examined the early lives of successful STEM professionals and found that art, design, and craft activities played a fundamental role in contributing to an individual's inventiveness (Root-Bernstein et. al, 2019). Given these findings, along with the underrepresentation of women and minority groups
as inventors and the link between STEM degrees and parents, scholars argue more attention and effort must be placed on increasing STEM initiatives at the K-12 level. Federal initiatives have funded STEM initiatives, but efforts have yielded little success in terms of measurable results (Magee, 2021).

**What is Being Done to Increase the Number of Diverse Inventors?**

The need to increase inventiveness in the United States is not a new idea. Wisnioski (2019) and colleagues explain that in the 1960s programs designed to develop innovators began to emerge. The federal government, namely partnerships between the National Science Foundation (NSF) and the Department of Commerce, supported efforts to increase innovation. Much of the early efforts focused on preparing students at the university level through entrepreneurship programs that bridged science and/or technology and the development of small businesses (Wisnioski, 2019). In the 1990s, responding to increased international economic competition with Europe, China, and Japan, the private sector also answered the call to increase the number of inventors in the United States. For example, in 1992, prolific inventor Jerome Lemelson founded the Lemelson Foundation which funds programs throughout the United States, including the Lemelson-MIT Program and the Smithsonian (Lemelson Foundation, 2021).

Given the growing body of literature that provides evidence inventiveness can be developed through early, repeated exposure, there has been an increase in K-12 STEM and innovation programs. In addition to the federal grants that address STEM or engineering more
broadly, there is a growing movement in the United States that focuses on providing students with IvE. Lemelson-MIT is spearheading the K-12 IvE initiative in the United States.

Invention Education and Studies in the Field

In the following section, I define IvE and review the studies that explicitly use the term invention education and/or explore the experiences of the individuals who participate in IvE. The authors of these studies position IvE as a response to the lack of diversity among inventors (Couch, et al. 2018; Couch et al, 2019b; Zhang et al., 2019). Much of the growing body of research literature that uses the term “invention education” is facilitated and/or funded by the Lemelson-MIT program. In 2019 a White Paper organized by the Lemelson-MIT program, lead authors Skukaukaite, Couch and Flynn, with support from the larger IvE community explored available research on IvE (IvERC, 2019).

Invention Education

Invention education calls for early and frequent exposure to the iterative and recursive process of inventing (Committee for the Study of Invention 2004, Couch et al. 2019a). A fundamental principle guiding the IvE movement is that inventiveness can be developed (Bell et al. 2019; IvERC, 2019). Additionally, supporters of the IvE movement believe that individuals from varied backgrounds have valuable skills and knowledge to contribute to the innovation ecosystem (Couch et. al, 2019a; IvERC, 2019). IvE is open-ended and learner centered. While IvE can be taken up individually, IvE is typically team-based and takes place in small groups. IvE draws on the knowledge of the community by involving mentors from the community to assist in the invention process and provide expertise when needed (IvERC, 2019; Skukauskaite et
Zhang and colleagues (2019) explain that the first stage in the IvE process is the problem discovery phase, in which students identify the problem they will address through their invention. Open-ended, problem-based learning which focuses on solving problems students have identified in their own communities has proven effective in engaging students who are traditionally marginalized by formal science settings (Cambell & Lubben, 2000).

IvE is interdisciplinary, which provides multiple entry points for students of all ages, from varied backgrounds with diverse skill sets (IvERC, 2019). Invention education is one way to develop more inventors from diverse backgrounds. The problem is because IvE is not embedded within the school day, access to IvE programs is limited. Without access to IvE, students miss out on opportunities to develop their identities as inventors and apply the content area knowledge and skills needed to invent. Supported by the evidence that indicates the benefits of open-ended, problem-based learning (Merrit et al., 2017), advocates continue to make the case for IvE and its potential to develop future inventors and problem-solvers from communities throughout the United States.

Supporters of Invention Education

One of the main supporters of IvE is the Lemelson-MIT program (Lemelson-MIT, 2019) provides curriculum, professional development, and grants to increase access to IvE for students throughout the United States. One of their most notable programs is their InvenTeam™ grants which provide a year of funding and support for 15 high-school invention teams nationwide (Lemelson-MIT, 2019). In the past, LMIT has also provided JV InvenTeam™ grants for middle school students (Lemelson-MIT, 2019). LMIT is also responsible for producing a growing body
of literature that examines who participates in and supports IvE and in what ways (IvERC, 2009).

Another national organization that supports IvE efforts is the STEM Innovator program at the University of Iowa. The STEM Innovator program assists educators in creating IvE activities and provides access to curriculum resources (IvERC, 2019). The program also provides a portfolio assessment tool to assess students’ changes in knowledge, mindset, and skills over time (Flynn et al., 2016). A research team from the University of Iowa recently explored the impacts of students who experienced IvE embedded in their school day through the STEM Innovator program. Flynn and colleagues (2016) found that IvE mindsets of nondominant groups in STEM increased significantly throughout their participation in the program, providing evidence that IvE should be embedded in the school day (IvERC, 2019).

Georgia Institute of Technology (Georgia Tech) is also highly involved in the IvE movement. The university hosts an annual Invention Convention which awards a K-12 Inventure™ Prize (IvERC, 2019; Moore et al., 2019). Researchers who have examined teachers’ perceptions of their students’ learning and growth through participation in the K-12 Inventure™ program indicate that teachers find the IvE experience to be positive for their students. In Moore and colleagues’ study, teachers also indicated that students improved their abilities to work in teams and also learned about entrepreneurship and its connection to engineering design (Moore et al., 2019).

The Henry Ford organization (Henry Ford, 2021) is another example of an entity that has invested heavily in the IvE movement by providing programs for students in grades K-12 from around the world. They facilitate the STEMIE Coalition which teaches students problem solving
skills by linking IvE with entrepreneurship (Henry Ford, 2021). The two main functions of STEMIE are providing a free curriculum and hosting an annual National Invention Convention.

Studies in the Field of Invention Education

Studies supported by Lemelson-MIT have primarily been conducted with high-school students who participate in their InvenTeam™ program (Couch et al. 2019b, Couch et al., 2020) although recently researchers have also conducted studies at the middle-school level (Zhang et al., 2019). The studies involving InvenTeams™ have directly addressed the lack of diversity among patent holders (Couch et al., 2018). Researchers have examined differences based on gender in how students self-report their experiences (Couch et al., 2020). Scholars found that when female students receive support in IvE, even with little background in STEM the support can encourage them to choose a STEM career path (Couch et al., 2018). Researchers have also explored the supports and constraints that young women participating in a year-long invention project experienced (Couch et al., 2018). Young female inventors cited personal values, various relationships/resources, and the structure of the invention project as supports. The girls shared that their constraints were time, lack of prior experience with invention activities, and stereotypes. Based on their findings, Couch and colleagues (2018) called for policy initiatives that specifically address the need to engage more females and people from diverse backgrounds in the invention ecosystem.

Studies in IvE have also explored the perspectives of teachers who have implemented IvE within the school day (Zhang et al., 2019). Zhang and colleagues found that from the teacher’s perspective, students benefited from the multiple access points offered by IvE. The teacher also
noted the challenges of implementing IvE, including classroom management, encouraging creativity, and the mandatory standards. More studies are also needed in IvE to provide research and policies on how to expand and scale existing programs. Increasing research in IvE also would provide opportunities to capture evidence of the benefits of repeated exposure to invention throughout K-12 education (IvERC, 2019).

**Connecting Invention and Identity**

Calabrese-Barton describes invention as socially linked and recursive. She critiques definitions which assign invention as a solitary act and “to the realm of mysterious genius” and argues this “masterfully conceals invention as a social act.” (Calabrese-Barton, 1998, p. 5). Calabrese-Barton’s conceptualization of invention as embodied agency connects invention to identity which illuminates the role life experiences play in inventing. In her 1998 study, Calabrese-Barton explored how children self-identify in science through invention. Studying children who were homeless and who participated in an afterschool science program, Calabrese-Barton (1998) presented two case studies which captured the students’ inventive experiences as embodied and socially constructed agency. One of the participants in the study invented soup and the other participant invented a purse. Calabrese-Barton argues their inventions were developed in response to their own experiences of living in urban poverty, where resources were scarce. Her study highlights the role of individual agency that children demonstrated throughout the invention process. By understanding invention as intricately connected to one’s identity and life experiences, the ownership of science and technology shifts from something students are
attempting to acquire to something they themselves have the capacity to develop and affect (Calabrese-Barton, 1998).

Researchers who address an inventor’s identity in IvE frame identity from a social constructionist perspective (Couch et al., 2019b). Identities are not static, but rather evolve and are constructed through language in use at a particular time and over time (Bloome et al., 2009; Kelly, 2017). In a 2019 study, Couch and colleagues (2019b) made visible the contextual elements of students’ lives that affected their identity choices. The participants in the study were high school students who were part of the Lemelson-MIT’s InvenTeams™ program. Couch and co-researchers found out-of-school contexts and prior experience with STEM influenced student identity choices. Their findings suggest that diverse students have more opportunities to self-identify as an inventor if they have continued and consistent access to problem-based STEM education, along with opportunities to see themselves as inventors within their own communities (Couch et al, 2019b).

For the second section of my literature review, I include literature from the field of engineering identity in Latina students. I made this decision with the intention of emphasizing the importance of increasing opportunities for students to develop identities as inventors through frequent exposure and participation in the invention process. By drawing on parallel literature, I also demonstrate how scholars can build on the work of researchers in related fields.
Part Two: Latina Engineering Identity Development

In Part Two of this literature review, I focus on seminal scholarship in the field of engineering identity and studies by authors who position the identity development of Latinas in engineering or STEM as the focus. As I explained in Chapter One, because no studies focus on the identity development of Latina inventors, I draw on parallel literature from the field of engineering identity development of Latina students. Hazari and colleagues (2013) found that of all racial/ethnic minority subgroups, Latinas face the greatest amounts of disempowerment in regard to their STEM identities. Researchers who focus on engineering identity have documented the difficulties Latina students may encounter while developing their professional identities (Banda, 2020; Rodriguez et al., 2019a). Further, Camacho and Lord (2013) found that an inability to self-identify as an engineer can drastically hinder one's persistence in the field.

Given the critical role identity plays in the success of engineering students, more attention has been placed on understanding how Latinas develop and construct engineering identities (Rodriguez et al. 2021; Villa, 2016). The majority of the scholarship in the field includes participants who are in college, although an increasing number of studies examine identity development at the K-12 level. In this section, I include literature from K-12 through college. I begin by presenting the landscape of literature on Latina participation in engineering. I also review the scholarship which discusses the multiple intersecting identities Latinas in engineering experience. I also include studies in which authors identified factors contributing to identity development and resilience of Latinas in engineering. I conclude by discussing research that has connected the identity development of Latina engineers with cultural capital and Yosso’s (2005) CCW.
Latinas in Engineering

As an aggregated group, Latinx are slowly increasing their involvement in engineering. Between the years 1995 and 2014, the representation of Latinx engineers increased from 5.76% to 9.56%. At 10% of earned bachelor’s degrees, Latinx are the largest minority group within U.S. engineering schools (NSB, 2020). However, male Latino students are twice as likely to receive engineering degrees than their Latina counterparts (National Center for Educational Statistics [NCES], 2017). Latina students are awarded only one out of every five engineering degrees received by the Latinx population (NSB, 2020). While a growing body of literature addresses the experiences of all Latinx students in engineering, Rodriguez et al. (2018) calls for the experiences of Latinas in engineering to be examined independently from Latino students. Recognizing the unique set of challenges Latinas in engineering face based on the intersectionality of ethnicity and gender, an increasing number of scholars focus specifically on understanding the experiences of Latinas in engineering (Banda, 2020; Hall, 2018; Villa, 2019).

Most of the research that disaggregates Latina and Latino students focus more broadly on Latinas in STEM as they are the least represented group in STEM fields (National Science Board, 2020). A recent report found the majority of Latinas who participate in STEM earned degrees in biology or biomedical science (NCES, 2017). The same report indicated that only 18% of Latinas participating in STEM fields hold degrees in engineering. Also, only 2% of working engineers in the United States are Latina (NSB, 2020). Latinas are underrepresented as engineers, just as they are underrepresented as patent holders.

Authors describe the experiences of Latinas in engineering as one “on the borderlands” (Camacho & Lord, 2013). Latinas who participate in engineering are not the norm in the
engineering settings, just Latina engineers are not the norm within their own communities. Citing the increasing Latinx population in the U.S., Camacho and Lord (2013) explain that involving Latinas in engineering has the potential to solve problems within our communities. The authors also explain that because engineering settings are typically dominated by White, male elites, the presence of Latinas in engineering is a positive disruption and offers a new, underutilized perspective. I argue that the same is true for invention.

While few studies explicitly focus on Latinas within the invention ecosystem, Camacho and Lord’s 2013 book makes the case for increasing Latina participation in engineering as a means to address the complex problems communities face. The book relies on the work of Mackenzie & Wajcman (1999) who argue that too often technological advancement and innovation are conceptualized as a process separate from everyday social interactions. The authors posit that too much attention and research is dedicated to examining how people adapt to technological advancement and innovation, as opposed to how the identity and agency of the inventors themselves shape their inventions. Given the increasing Latinx population in the United States and the underrepresentation of Latinas as engineers and inventors, understanding how Latinas influence invention and engineering is important (Saenz & Skukauskaite, in press).

**Engineering Identity**

Much of the growing body of work on engineering identity, both quantitative and qualitative, cite Gee’s (2008) seminal work on identity. Gee defines identity as the kind of person that one ‘is seeking to be and enact in the here and now” (Gee, 2000 p. 13.). Identity is constantly evolving and reformulating through interactions with others (Gee, 2000). Tonso
(2006) defines engineering identity development as engineering students' abilities to negotiate their role within engineering communities and to incorporate into the larger professional community of engineers.

The majority of the work on engineering identity is derived from work on science identity. In their seminal work on science identity in women of color, Carlone and Johnson (2007) posit that exploring identity provides an opportunity to examine how and why students become disengaged and marginalized within engineering settings. Asserting that race, gender, and ethnicity affect one's science identity, authors provide a model that consists of the three dimensions of a science identity: performance, recognition, and competence.

In another seminal paper on engineering identity, Rodriguez et al. (2018c) presented a systematic literature review which detailed how engineering identity development is applied within higher education. Authors found that many studies in engineering identity development focus on experiences of underrepresented groups, specifically women and minorities. Rodriguez and colleagues (2018) also report that few studies in the field address the multiple, intersecting identities college students manage in addition to an engineering identity. Understanding how underrepresented students develop identities as engineers is important so institutions and educators can establish environments which foster the identity development of students who have not been considered in the past.

Identity Work in Engineering

Identities are not static (Carlone et al., 2014). Identities are constructed over multiple time scales and certain aspects of identities become more stabilized or grow thicker over time
(Calabrese Barton, et al., 2013). Scholars who conceptualize identity in this way have used the term “identity work” in their research (Calabrese-Barton et al., 2013; Kelly et al., 2017; Tan et al., 2013). Identity work is the actions individuals take in addition to the relationships they form (Calabrese Barton et al., 2013) “in a given moment, with the available resources, constrained by the sociohistorical norms, rules, and expectations” (p. 38). Studies which focus on identity work seek to understand how the resources an individual cultivates in one setting can be drawn on to support developing identities in engineering settings (Calabrese-Barton, et. al, 2013; Carlone et al. 2018).

Kelly and colleagues (2017) write that engineering identity work occurs on two different levels, the epistemological and the ontological. As students study engineering, they become familiar with the disciplinary knowledge of engineering which contributes to an epistemological identity. Kelly and colleagues explain that to become a member of the engineering community, understanding and knowing engineering is not enough. One must also self-identify as an engineer, or inventor, which occurs on the ontological level. Ontological identities, as Kelly and coauthors explain, develop over time through discourse, interaction, and disciplinary practice within epistemological communities. Taking part in the practices of engineers through identity work provides opportunities for students to engage in engineering while also seeing themselves as engineers and co-collaborators in the learning process. By providing underrepresented students with the opportunities to engage in identity work on both the epistemological and ontological levels, institutions actively recognize the importance of developing strong identities as engineers (Calabrese-Barton et al., 2013; Kelly et al., 2013)
The Multiple, Intersecting Identities of Latina Engineers

How students engage in engineering is influenced by students' perceptions of self and whether or not they see themselves as a person who participates in engineering (Carlone & Johnson, 2007; Kelly et al., 2017). While more scholarship in the field is needed, researchers who focus on the engineering identity of Latina students acknowledge the multiple, intersecting identities that Latinas in engineering construct and negotiate (Banda, 2020; Rodriguez et. al, 2019a). Tate and Linn (2005) emphasized the multiple identities of women of color in engineering. Their work presents identity through three different lenses: academic, intellectual, and social. Tate and Linn (2005) posit academic identities are shaped by engagement in academic environments, including study groups and tutoring while intellectual identities are made visible through to the reasons the participants decided to pursue engineering. Reasons for participating in engineering included a strength in math and a desire to engage in problem solving. Authors found students drew on different identities based on the context of the interaction and that students made the distinction between their academic and social lives (Tate & Linn, 2005).

Latina students are marginalized in engineering as both women and as members of the Latinx community, which increases the complexity of their identity development as engineers (Tate & Linn, 2005; Rodriguez et al., 2019a). Understanding the multiple intersecting identities of race, gender, and socioeconomic class is critical in understanding how Latina students develop their identities as engineers. Latina students may experience tensions between their engineering identities and other identities (Banda, 2020; Rodriguez et al., 2019b, Villa, 2016). For example, Rodriguez and colleagues (2021) found that while families may offer critical support for the
identity development of Latinas in STEM, Latina students may also experience conflict between expectations associated with stereotypical gender roles within their home and their STEM identities. Latina students report a conflict between being a “good daughter” and their development of STEM identities (Rodriguez et al., 2021).

Through examining STEM identities and the overlap between other identities that students construct, researchers suggest increasing the visibility and recognition of Latinas within engineering programs could improve Latina students’ sense of belonging within engineering institutions (Banda, 2020; Rodriguez & Blaney, 2021). Sense of belonging refers to students’ sense of being accepted within an academic setting (Goodenow, 1993). Scholars have found that students who feel a strong sense of belonging are more likely to succeed academically than those without a strong sense of belonging (Goodenow, 1993; Rodriguez & Blaney, 2021). Researchers also argue for more awareness and consideration for the intersecting identities Latina in engineering face and the need for Latina students to develop a sense of belonging in engineering institutions (Banda, 2020; Rodriguez & Blaney, 2021).

Identity as a Source of Persistence and Resilience in Engineering

The underrepresentation of Latinas in engineering has prompted scholars to study the experiences of Latinas who have persisted in engineering to better understand their experiences with the goal of increasing participation (Rincon & Rodriguez, 2021; Rodriguez et al., 2019). Authors who study Latinas in engineering have found that developing a strong engineering identity contributes to persistence and resilience in the field. Scholars who explore the identity development of Latinas in engineering have found that developing a strong professional identity
can contribute to academic persistence (Carlone & Johnson, 2007; Rodriguez et al. 2019).
Persisting in engineering for Latinas also requires that they see themselves as the type of people who can do engineering, while simultaneously feeling as though they can succeed in engineering (Rodriguez et al., 2019; Verdin, 2021). Building on the work of Carlone and Johnson (2007), Rodriguez and colleagues (2019) emphasize the role of both inside and outside recognition in the development of STEM identities for Latina students as contributing factors to their persistence.

Rodriguez and Blaney (2021) explain that while Latina students report feeling marginalized in engineering and STEM settings, they resist and persist by describing themselves as “trailblazers” and by joining STEM identity-based organizations on campus. Additional studies in the field have also demonstrated the role of student support groups and campus organizations (Banda, 2020; Villa, 2020). Having supportive faculty and role models, specifically Latinas who have been successful in engineering, also provides an opportunity for Latina students to claim intersecting identities simultaneously (Verdin & Goodwin, 2018). Authentic connections with peers and faculty and the presence of a support system that represents a feeling of familismo were also shown to support the development of an engineering identity in Latina students (Rodriguez et al., 2021). Family support has also been identified as a contributing factor to the development of an engineering identity for Latinas in STEM (Rodriguez et al., 2019b; Villa, 2020). Scholars suggest that with supportive mentors and family, along with access to engineering organizations, students’ engineering identities have opportunities to develop and thicken.
Assets-based Approach to Latinas in Engineering

There is a growing body of literature which focuses on the experiences of Latinas in STEM. Until recently, much of the literature approached the topic from a deficit-based perspective. Deficit-based approaches focus on what Latinas in STEM lack when compared to the standard White, male majority (Gonzalez et al., 2021; Yosso, 2005). When scholars and educators focus on what student’s lack, the knowledge, perspectives, and interdisciplinary know-how of many students are overlooked (Gonzalez et al., 2021). In contrast with deficit-based views of minorities in education, assets-based approaches emphasize the value and skills diverse students bring to the learning environment. Unlike the deficit-based explanations of Latinas’ underrepresentation in STEM, asset-based approaches position the valuable and rich cultural capital and funds of knowledge (Gonzalez et al., 2005; Moll et al., 1992) Latinas bring to inventing and STEM as the foundation for their contributions and achievement in STEM and innovation.

In recent years, researchers in the field have taken on an assets-based approach to the study of Latinas in engineering and STEM (Denton, et al. 2020; Gonzalez et al., 2021, Moll et al., 1992). Many employ CCW (Yosso, 2005) or Funds of Knowledge (Gonzalez et al., 2005; Moll et al., 1992) as the conceptual frameworks for their studies. These studies focus on the valuable cultural capital and assets Latina students contribute to STEM settings.

Community Cultural Wealth and the STEM Identity Development of Latina Students

Community Cultural Wealth theory is one framework utilized by scholars who take on an assets-based approach to the study of Latinas in STEM. In their 2005 CCW theory, Yosso
introduced 6 interconnected forms of cultural capital students from communities of color possess which are navigational, aspirational, social, linguistic, resistant, and familiar. Scholars who employ CCW as an analytic lens for the identity development of Latina students have found students draw on their cultural capital throughout their development of STEM identities (Coronella, 2021; Rincon & Rodriguez, 2021). For example, by synthesizing the findings of two qualitative studies, Rincon and Rodriguez (2021) reported young Latina students were able to benefit from the support of their families and communities while simultaneously achieving their goals in STEM and strengthening their STEM identities. The authors also found students who drew on CCW had more success navigating the various challenges they encountered, including the resistance of oppressive tendencies of STEM institutions (Rincon & Rodriguez, 2021).

In her mixed-method dissertation, Mercédez (2015) merged STEM identity and CCW frameworks by arguing that each element of cultural capital described in Yosso’s theory is linked to the development of STEM identities. Mercédez (2015) explains because family and CCW play a critical role in the persistence and resilience of Latinas in STEM, both must be considered simultaneously when examining STEM identity development. Mercédez (2015) states that “the shaping of science identity cannot stand alone” (p.87) without considering the influence of families and communities and the cultural capital Latinas bring to STEM.

Coronella (2021) explains that in addition to the six types of cultural capital described by Yosso, Latina students possess an additional type of capital known as pluriversal, a term conceptualized by Rendón and colleagues (2020). Pluriversal refers to Latina students' ability “to hold multiple meanings and consciousness simultaneously” (Coronella, 2021, p. 126) and take on multiple perspectives at once, which is an asset in invention and problem solving.
Authors have also found students’ emergent resistant capital enabled them to resist challenges in engineering settings (Rincon et al., 2020; Revelo & Barber, 2018). Students accomplished this through acting as role models in the community and joining together with other students to collectively resist (Revelo & Barber, 2018). Latinx students also made intentional “moves” to rely on their cultural capital as forms of resilience which contributed to their persistence in STEM. For example, one student drew on her linguistic capital to establish connections with the Latinx workforce which would benefit her future employment (Rincon et al., 2020). My study contributes to the growing body of literature that aligns Latina identity development in STEM from an assets-based perspective and provides a bridge to the existing literature on IvE and the need for more diverse inventors.

**Conceptual Framework**

Yosso’s (2005) Community Cultural Wealth (CCW) theory offers a critical approach to traditional conceptualizations of cultural capital regarding who holds the power in society (Bourdieu, 1986). The theory challenges the notion that the only valuable cultural capital in society belongs to the dominant White, middle-class, majority and posits that communities of color possess unique resources that have been long overlooked and undervalued (Yosso, 2005). Community Cultural Wealth theory is an asset-based approach that is grounded in Critical Race Theory (CRT) (Delgado & Stefancic, 2001; Yosso, 2005). Yosso (2005) argues that instead of focusing on and identifying what students from communities of color lack in formal educational settings, institutions and educators should shift their own ideologies to acknowledge the rich cultural capital that students bring to academic settings.
In her 2005 article, Yosso explains that CCW theory was developed based on the notion that communities of color possess six interconnected forms of cultural capital. The six types of capital Yosso describes are navigational, linguistic, aspirational, social, resistant, and familial. Aspirational capital is defined as the ability to stay positive and believe in one’s dreams and hopes for the future, even when facing real or perceived barriers. Linguistic capital are the skills that individuals develop through communicating in one or more languages or communication styles (Yosso, 2005). Navigational capital refers to “the skills of maneuvering through social institutions such as schools, the job market, healthcare, and judicial systems” (Yosso, 2005, p. 79). Social capital is the community resources and networks of people available to an individual. Yosso explains that familial capital is “the cultural knowledges nurtured among familia (family/kin) that carry a sense of community, history, memory, and cultural intuition” (Yosso, 2005, p. 79). Finally, resistant capital refers to the skills that people from communities of color develop through challenging inequality and social injustice. The six forms of capital are not mutually exclusive but rather interwoven in the experiences of individuals (Yosso, 2005).

Scholars have identified additional forms of cultural capital which students from communities of color possess. For example, building on the work of Yosso (2005), Jimenez (2020) argues that an additional type of capital exists that is known as migration capital. Jimenez (2020) describes migration capital as the “sensibilities, and skills cultivated through the array of migration/immigration experiences to the United States or its borderlands” (p. 799). His theory focuses on the experiences of Latinx communities who have immigrated from Latin America via the U.S and Mexico border.
Implications of Applying a Community Cultural Wealth Lens

There is a growing body of research that incorporates CCW as a theoretical lens in STEM education (Denton et. al. 2019). By adopting CCW as the theoretical lens, I acknowledged the rich cultural capital that Latinx students bring to STEM settings. Given that CCW is grounded in CRT (Delgado & Stefancic, 2001), it is important to discuss the foundational tenets of CRT in education and how using a theory grounded in CRT affected my research study.

Solórzano et al. (1998) described five tenets that encompass the foundational principles of CRT as applied in the field of education. The first implication of adopting CCW is that I am signaling to readers that I believe that racism is a central and fundamental element of society in the United States (Solórzano et al., 1998; Yosso, 2005). By taking on CCW as a theoretical lens, I also made the choice to challenge dominant ideologies and question deficit-based approaches that position non-dominant groups in STEM as “without” or “less than” (Yosso, 2005). Additionally, my conceptual framework makes clear that increasing the participation of Latinx in STEM is rooted in a commitment to social justice (Yosso, 2005).

Using CCW as a theoretical framework also implies a transdisciplinary perspective, recognizing that the issues of Latinx in STEM are not isolated to schools or STEM settings. By referring to a transdisciplinary perspective, Solórzano (1998) explained that issues of race transcend socially constructed disciplinary and institutional boundaries. Another implication of relying on CCW as a theoretical lens includes placing value on the experiential knowledge of Latinx in STEM (Yosso, 2005). This value placed on experiential knowledge gained through life experiences is a salient reason CCW complements narrative research, which is the methodology for this study.
CHAPTER THREE: METHODOLOGY

Narrative inquiry is the methodological approach of this study. The goal of this study was to gain a deeper understanding of the life experiences and identity development of young Latina inventors. By generating and examining the life stories of young Latina inventors, I analyzed how the contextual elements of their lives contributed to the development of an inventor’s identity. Examining the life stories of young Latina inventors also provided an opportunity to understand how the participants drew on cultural capital in the development of their identities as inventors.

Rationale for Research Approach

Riessman (2008) describes narrative inquiry as a collaborative process between participant and researcher that takes place over time. Together with the researcher, participants (re)construct their lived experiences through stories. These stories are the foundation of narrative inquiry. As a methodology, narrative inquiry is used across disciplines. While most frequently used within the social sciences, it is also gaining popularity in other fields, such as business and law (Kim, 2019). Narrative inquiry challenges dominant knowledge paradigms with the goal of reshaping views through an understanding of people’s lived experiences (Clandinin & Connelly, 2000; Kim, 2011). In narrative inquiry, researchers seek to illuminate the unique and contextual elements of the participants' lives. It is within the contextual elements of the participants' lives that their narratives are embedded (Clandinin, 2013).

Narrative inquiry provides an opportunity for participants to make meaning of their past experiences while providing the researcher and readers with the opportunity to create their own
meaning of the stories which the participants have shared. The goal of sharing temporal, particular, and local stories is to invite the readers on a journey of problem finding, not problem solving (Kim, 2011). Readers of narrative inquiry are given the opportunity to vicariously experience the events described by the participants by engaging in their own meaning-making of the experiences (Kim, 2011).

I chose narrative as the methodology for my study because the goal of narrative is to gain a deeper understanding of the life experiences of human beings through their stories (Riessman, 2008). Narrative researchers contend an individual’s story is powerful because individual stories are inherently social (Chase, 2003). Therefore, the unique story of one individual has the ability to reflect larger social patterns (Kim, 2019). Kim (2011) explains that an individual story can serve as a metaphor to connect to others with similar experiences whose stories have not yet been heard.

There are multiple forms of narrative methodology. My study is a bildungsroman (Kim, 2019). Kim (2019) explains that bildungsroman narratives focus on participants' individual growth and identity development. Bildungsroman is a German word that loosely translates to an educational novel. Utilizing bildungsroman provided me the opportunity to examine the journey of inner development of the participants, their persistence and resilience, and the intricacies of their life experiences (Kim, 2019).

Riessman (2008) argues that narrative inquiry has the power to act as a mobilizer for progressive social change. Bildungsroman, specifically, provides an opportunity to enhance the personal development and growth of the participants, readers, and researchers (Kim, 2019). Major social movements of the last century were ignited by individuals sharing their stories
about discrimination. Examples include the civil rights movement, the LBGTQ movement, and the feminist movement. The commonalities among the stories of individuals are what provided a catalyst for collective action (Riessman, 2008). In my study, through the narratives of three young Latina inventors, I hope to catalyze an increased awareness of the assets and CCW Latina students contribute to invention.

Site and Participant Selection

The participants for this study were members of the 2018-2019 McKay High School InvenTeam™. McKay High School is a Title 1 high school located in Salem, Oregon. McKay is not a pseudonym. I used the actual name of the high school because the participants wanted McKay to be recognized. In 2018, the team from McKay was selected to participate in a national invention challenge. I selected this team because I was exposed to the McKay InvenTeam™ through my work as a research assistant on a previous study funded by the Lemelson Foundation. In the study, our research team, in collaboration with the teacher and the student-historian from the McKay InvenTeam™, examined the networks supporting the team.

Context of the InvenTeam™

The InvenTeam™ is a yearlong, out of school, invention project sponsored by the Lemelson-MIT (LMIT) Program, which is one of the programs funded by the Lemelson Foundation. Up to fifteen teams throughout the nation received $10,000 grants from LMIT to fund their InvenTeam™ project. Katrina Hull, who was a math and engineering teacher at McKay, submitted the application and became the faculty leader of the team. Katrina was also the leader of the McKay chapter of the mathematics, engineering, science, and achievement
(MESA) club, which is also sponsored by the Lemelson Foundation. The InvenTeam™ meetings took place after school and the team met many times on weekends.

There were eleven members on the McKay InvenTeam™ with eight students identifying as Latinx, seven of whom identified as Latina and one who identified as Latino. One student on the team identified as an Asian female, and two students identified as white males. The members of the team each had designated roles at the start of the InvenTeam year, however, as the year progressed, the roles and responsibilities shifted and were shared among the team. The McKay High School InvenTeam™ invented an adaptable cup for individuals who suffer from dysphagia. At the end of the InvenTeam™ year, the team traveled to Boston to present their invention at MIT with the other InvenTeams™ from across the country. Based on the definition provided in Chapter One, the participants of the InvenTeam™ are considered inventors because they identified a problem then devised and produced something through trial and experimentation that is useful and did not previously exist (Committee for Invention, 2004).

Criteria and Recruitment

The criteria for the participants in my study were being tenth grade Latina students on the McKay High School InvenTeam™ during the 2018-2019 academic year. Two of the Latina students on the InvenTeam™ were 12th graders during the InvenTeam™ year and five were in the 10th grade. The five Latina students who were in 10th grade during the InvenTeam™ experience met the criteria for my study. I was interested in the experiences of students who had two years of high school remaining after their participation on the InvenTeam™. Of the five who met the criteria, I selected three to recruit for my study. I made the decision based on the records
I reviewed through my work as a research assistant on the previous study with the InvenTeam™ and through conversations with the InvenTeam™ leader and teacher at McKay high school, Katrina Hull. The three participants I recruited are currently first year college students.

The variation in the amount of formal STEM exposure the participants had outside of school prior to the InvenTeam™ experience was an additional criterion for participation in this study. I recruited one participant who had no formal experience with STEM, one who had some exposure to formal STEM through a family member; and one who participated consistently in out-of-school STEM activities starting in middle school. Lesly began participating in MESA (mathematics, engineering, and science achievement) club in seventh grade and was the participant who came to the InvenTeam™ with the most experience with formal engineering and inventing. Ximena had an older sister who had earned a degree in chemical engineering, which provided Ximena with some exposure to Latinas in engineering. Isabel had no formal experience with engineering or STEM beyond her math and science classes at school. No immediate family members of Isabel worked in STEM or engineering. It was important for me to include participants who had varying degrees of familiarity with STEM and inventing prior to the InvenTeam™ because it allowed me to examine the role the InvenTeam™ experience and exposure to invention education had on the development of their identities as inventors.

Each participant has her own unique narrative and life experiences, and although I asked the participants many of the same questions, each girl focused on different aspects of their lives when they shared their stories. For example, when asked to share about her life and experiences, Ximena focused the least on her experience on the InvenTeam™. While Ximena shared that her experience on the team did contribute to the development of an inventor’s identity, she spoke
more about her own character traits, strength as a problem solver, and the strengths and traits of her family members as “natural engineers”. Isabel, on the other hand, spoke about the InvenTeam™ as a life changing experience through which she developed confidence and found her voice. Finally, for Lesly, the team was a continuation of her immersion in after school STEM activities which began for her in middle school. Although each participant’s narrative is unique, all three of the young women shared examples of drawing on CCW throughout their life experiences and while participating on the InvenTeam™.

Access

As I stated above, through my work as a research assistant on a previous study, I was introduced to the McKay High School InvenTeam™. As part of my work on the previous study, I indexed a dataset which included video records compiled by the McKay InvenTeam™. Through watching the videos in an attempt to gain a deeper understanding of who or what supported the team, I became interested in the experiences of the young Latina inventors. This prompted an interest in their fuller life stories and how they developed identities as inventors while drawing on the rich cultural capital they brought to the team.

Procedures

I sought IRB approval from the University of Central Florida Office of Research and Commercialization before making contact with participants and prior to any data being generated. After I received IRB approval, I reached out to the three participants to gain consent for their participation in the study. Before the formal interview process, I requested to meet with all three of the participants together via Zoom to explain the goals of the study. The initial Zoom
call provided the opportunity for them to ask questions or voice concerns. The only participant to ask questions was Ximena. She wanted to know where my interest in the topic came from. I explained I became interested in the life stories of the three participants when I saw the video records of the InvenTeam™ through my work as a research assistant. During the first Zoom call, I reviewed the minimal risks associated with participating in the study. I also reviewed informed consent with each participant and reassured them that they had the right to opt out of the study at any point. All three young women expressed interest in participating in the study. Once students agreed to participate, I emailed the participants a copy of the informed consent for their own records.

I explained that the participants had the option to use their own names or maintain confidentiality through the use of a pseudonym of their choice. All three girls expressed their desire to use their own names. They are proud of their stories and know others will be reading their narratives and learning more about their lives. When the young inventors in my study mentioned their siblings, I asked the participants to check with their siblings to see if their siblings would like to use their own names or pseudonyms. All siblings elected to use their own names as well. The only pseudonyms used were for Ms. Sanchez and Perla because they were from Ximena’s elementary school experiences. Katrina Hull, the participants’ math teacher and InvenTeam™ leader from McKay High School is not a pseudonym.

Narrative research is a collaborative process between participants and researchers that takes place over time (Kim, 2019; Riessman, 2008). Interviews are the primary mode of generating records and life stories in narrative inquiry. The interviewing took place over three months. I met with the participants individually three times over the initial three-month period.
The time spent with each participant varied between 27 minutes and 75 minutes. The first two interviews were longer than the third interview, which served mainly as a member-checking opportunity. All interviews took place via Zoom. Each interview recording was password protected and stored on an external hard drive. Below, in Table 1, I break down the time spent on each of the three individual interviews with the participants and provide an average time based on the three interviews.

Table 1

<table>
<thead>
<tr>
<th>Participant</th>
<th>Interview 1</th>
<th>Interview 2</th>
<th>Interview 3</th>
<th>Average Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ximena</td>
<td>49 minutes</td>
<td>48 minutes</td>
<td>31 minutes</td>
<td>43 minutes</td>
</tr>
<tr>
<td>Lesly</td>
<td>65 minutes</td>
<td>75 minutes</td>
<td>29 minutes</td>
<td>56 minutes</td>
</tr>
<tr>
<td>Isabel</td>
<td>50 minutes</td>
<td>41 minutes</td>
<td>27 minutes</td>
<td>39 minutes</td>
</tr>
</tbody>
</table>

Narrative interviewing is used to generate rich, detailed accounts of the experiences of the participants as opposed to short answers or general statements (Riessman, 2008). Unstructured interviews were the primary method of data collection. The interviews were conversational and did not have a formal question-answer format (Skukauskaite & Sullivan, 2023). The goal of the narrative interviews was to gather detailed accounts of specific events from their childhoods the participants have experienced (Riessman, 2008) and deemed important in shaping who they were, were becoming, and what they did. Understanding the early experiences students had with family, friends, and community members was important in understanding how students developed their identities as inventors. Acknowledging that
identities are constructed and (re)constructed over time (Riessman, 2008), beginning with young childhood provided the opportunity to examine factors from the participants earliest experiences in school.

I asked probing, straightforward, and open-ended questions. Other than the interview with Isabel, whom I had already met because she was a participant in a pilot study I conducted in my second year at UCF, I started the interviews with, “Tell me about yourself”. The participants and I were both active participants in the interview process (Riessman, 2008). Although I initiated the questions, the participants were the trail guides through the interview process, and I was the follower. While the interview guides (see Appendix C) provided the general outline of the questions I asked, the questions I asked depended on the responses of the participants. For example, in our first interview, I asked Ximena if she participated in any extracurricular STEM activities prior to the InvenTeam™. Ximena told me she had not, and said that because she participated in sports in middle school, she had little time for other extracurricular activities. I followed up by asking her what sports she participated in. I attempted to relinquish as much control as possible in the interviews (Riessman, 2008) so that the participants could share their stories, regardless of my areas of interest as a researcher.

The goal of the first interview was to develop rapport and trust with the participants (Kim, 2019). As I explained above, I had already met Isabel through a pilot study, but I met Lesly and Ximena for the first time on the introductory Zoom call. During the interviews, I built on the introductions and relationships established through the first group meeting. During the first interview, I asked questions pertaining to their InvenTeam™ experience and what brought the girls to InvenTeam™. I also asked them to describe their roles and experiences on the team.
In the second interview, I focused more on the second research question and inquired about the family background of the participants. All three participants brought up their families in the first interview and I revisited the topic in the second interview. The final interview followed up on major themes or (co)constructed areas of interest generated through the first two interviews. The third interview also served as the first member checking opportunity in which I shared preliminary findings with the participants. After sharing the final analysis with the participants, each of the young women were happy with how I presented their narratives and felt they were represented accurately.

In addition to the three unstructured interviews, I also created a text messaging group chat, which included the three participants and myself. I used the group chat as an on-going member check with the participants. I utilized the group chat to update the participants on the progress of the study. I also texted the participants individually throughout the study for individual member checks and to clarify questions I had throughout the analysis process. I also emailed two drafts of the analysis to the participants; one was sent before the final interview and one was sent after. The participants used the group chat and individual text messages to correct certain typos or mistakes I made which they noticed in the drafts I emailed to them.

Narrative transcription is an interpretive process, which is why I edited each of the automatically Zoom-generated transcripts word by word. Editing the transcripts word by word allowed me to correct each of the transcriptions. Following each video-recorded interview and editing of the Zoom transcript, I separated the transcript into sequence units (Skukauskaite, 2014). I selected sequence units because they signal a topic that is being constructed through multiple linked interactions units (Skukauskaite, 2014). Separating the transcripts into sequence
units allowed me to create a timeline of events and focus on events the participants signaled as important.

Once I formatted the transcriptions into sequence units in order to gain a general understanding of the stories of the participants, I selected excerpts of the interviews to transcribe into information units. Information units are message units that are tied together, signaling information to the listener (Skukauskaite, 2014). The goal of transcribing excerpts of the interviews into information units was to allow me to focus specifically on what the participants were sharing about their experiences. Although all narratives are co-constructed, my interaction with the participants was not the focus of the transcription. Instead, the focus of the transcription was capturing what the participant shared about their lives, so that the data could be analyzed thematically (Riessman, 2008). Therefore, my focus was on capturing what was said, rather than the how and the discursive moves connecting the interview. Sequence units enabled me to construct the overall picture of what participants described in the interviews. Information units enabled me to delve deeper into how the participants inscribed and described their life experiences and the cultural capital they drew on throughout the development of identities as inventors.

Data Analysis

After I transcribed the interviews and separated the transcriptions into sequence units and information units (Skukauskaite, 2013), I analyzed the data using a two-pass process; both passes were multi-step. Below, in Table 2, I present a table of the two-pass, multistep, process I utilized to analyze the data generated through the interviews in my study.
Table 2
Data Analysis Process

<table>
<thead>
<tr>
<th><strong>Pass One</strong></th>
<th><strong>Pass Two</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Created a chronological timeline of major events</td>
<td>Deductively analyzed the transcription based on the 6 types of CCW</td>
</tr>
<tr>
<td>2. Determined which events contributed to the development of inventor’s identity</td>
<td>Inductively analyzed the transcription to identify additional forms cultural capital</td>
</tr>
<tr>
<td>3. Inductively developed themes based on individual life stories</td>
<td></td>
</tr>
</tbody>
</table>

The first step of the first analytic pass was to create a general chronological timeline to gain an understanding of the events in the participants' lives. The second step of pass one was to analyze which experiences shared by the participants contributed to the development of an inventor’s identity. For the final step of pass one, I inductively developed themes based on the experiences which contributed to the development of an inventor’s identity in the participants (Riessman, 2008). Analysis for step one is represented in Chapter Four of this study. Consistent with narrative inquiry, I analyzed each of the narratives individually and established unique themes based on each of the participants life experiences. I did not establish themes across and among narratives. However, after the final step of pass one, I determined commonalities among the life experiences of the participants and the twelve different themes I developed through inductive analysis in step one. I present and discuss the commonalities in the synthesis of Chapter Four.

For the second pass, I identified the different types of cultural capital the participants described and inscribed in the development of their inventor’s identity. Step one of the second
pass was to deductively analyze the interviews based on the six types of cultural capital presented in Yosso’s (2005) CCW. Step two of the second pass included an inductive analysis of the interviews for additional forms of cultural capital not identified in previous literature. The analysis for pass two is represented in Chapter Five.

Trustworthiness

To ensure trustworthiness, I was transparent by providing a detailed logic of inquiry throughout the analysis. As I will show in the next chapter, I sought to guide the reader through my own thought process in developing themes through analysis. I also reviewed my analysis on an ongoing basis with my dissertation chair, thus receiving feedback and an additional perspective. The perspectives and feedback of my dissertation chair challenged me to think about the data in new ways and consider alternative interpretations. For example, as I discussed the participants saying yes to various opportunities, my chair made the connection between saying yes and taking risk, which I had not previously considered.

Getting to know the participants over the course of six contributed to the credibility of my study. I met with each of the participants four times, once as a group and three times individually. The first two individual interviews were focused on generating data. The final individual interview was for member checking. Having worked on the previous dataset from the McKay InvenTeam™ adds to the strength of this study because I had a general understanding of the InvenTeam™ structure and what the experience entailed. In working with the video recordings from the previous study, I also had the opportunity to see the participants in a different context.
While the themes I developed through inductive analysis of the three participants’ narratives were unique to each participant’s narrative, I also compared the themes and general life experiences of the participants with each other’s narratives as an additional method of building trustworthiness of my study. By comparing and contrasting across narratives, I identified commonalities and patterns among the three narratives. I also used both inductive and deductive analytic processes. By utilizing multiple analytic processes, I provided multiple forms of evidence to corroborate my findings (Anfara et al., 2002).

During interviews, I re-voiced the participant’s responses. In re-voicing the participants’ responses, I provided the opportunity for the participants to correct me if I misunderstood or misinterpreted the information they shared with me. I also sent a draft of my dissertation to the participants before I shared the dissertation with my committee. I then met with each participant for the member check and to receive feedback from the participants. By meeting with each participant and ensuring they felt comfortable with how I presented their narrative, I increased the trustworthiness of the study.

Positionality Statement

I am a self-identifying Latina who grew up in Orlando, Florida. My father is Colombian and was raised in Bogota. My mother is American and was raised in Birmingham, Alabama. I have no background in STEM. I was an elementary school teacher for 5 years before pursuing my Ph.D. in Elementary Education with an emphasis on Inclusive STEM. There are no inventors or patent holders in my family. I have two women who identify as Latinas in STEM in my family, a paternal aunt who was a dentist in Bogota and a first cousin, who was raised in
Colombia and works as a nurse in Houston, Texas. I have struggled with my own ethnic identity throughout my life. Growing up, I never felt fully American, but also never felt “Colombian enough” to identify as Latina. My continual journey to develop and understand my own identity is one source of my interest in this topic. I became interested in Latina inventors as I reflected on my own life and realized the most innovative and resourceful women I knew were Latina, specifically those with limited access to financial resources.
CHAPTER FOUR: NARRATIVES OF IDENTITY DEVELOPMENT

In Chapter Four, I present a thematic analysis of each of the participants’ narratives to answer Research Question One, *What are the life experiences of young Latina inventors which contribute to the development of an inventor’s identity?* For Chapter Four, I analyzed the three participants’ narratives individually. I began by organizing the life events of the participants chronologically to gain a general understanding of their life stories. I then identified which of the participants’ life experiences connected to the development of their identities as an inventor. Through inductive analysis, I developed themes based on the life experiences the three young women shared with me throughout the interview process. For each of the participants’ narratives, I identified four unique themes which contributed to their identity work. I developed a total of 12 themes. Chapter Four is organized into the three narratives of the participants. I begin each participant’s narrative with a brief introduction of the young inventor and an overview of her story. I follow each introduction with a thematic analysis the participant's narrative. In the synthesis of Chapter Four, I present the commonalities I established through comparing across the narratives of the three participants.

**Ximena Nava Diaz, The Critical Thinker**

Ximena is currently 19 years old and a first year student at Oregon State University. Of the three participants, I knew the least about Ximena at the start of my dissertation. I had seen her in the video records from the previous research study, but beyond that, I only knew she was a Ford Scholarship recipient and a member of the McKay InvenTeam™. In the initial Zoom call with the three participants all present, Ximena was serious, inquisitive, and asked more questions.
than the other two girls. She wanted to know why I was interested in the topic, and why it was important to me. I was impressed by her questions and even more impressed with her poise. She presents herself as confident and independent. Ximena is a self-described critical thinker. She explained that her position as the youngest of five children contributed to her independence at a young age and affected her perception of the world around her.

Ximena’s Story

Ximena was born in Ixtapan de la Sal, Mexico and immigrated to the United States when she was seven years old. Her father left Mexico to find work in the U.S. when her oldest sister was born, while the rest of the family remained in Mexico. When her father first came to the U.S., he worked in the fields. He would return to Mexico periodically between jobs. When Ximena was three years old, her oldest sister left their small hometown in Mexico to attend college in Toluca, a city approximately a one-hour drive from Mexico City. The following year her older sister and brother, the second and third children in birth order in the Navar Diaz family, joined her father in the U.S. to attend high school. Her mother remained in Mexico with Ximena and her brother closest to her in age, until they were able to legally move to Salem, Oregon, and reunite with her father and siblings. Ximena shared that moving to the U.S. without their mother was difficult on her older siblings, yet, despite the challenges, both graduated from McKay High School. Both of Ximena’s older sisters graduated from college, one in Mexico and one in the U.S. Her older sister who attended college in Mexico graduated with a degree in chemical engineering. Her sister who moved to the U.S. while in high school went on to receive her
master’s in education and currently works as a math teacher in the Salem area. As Ximena put it, “She is the one who has gone the farthest of all of us”.

Ximena shared multiple life experiences which contributed her development of an inventor’s identity. Through inductive analysis, I established four major themes from her narrative. The first theme I established was Ximena’s growth mindset, which was instrumental in her development and identify work as an inventor. Ximena also traced her identity as an inventor to her strength in math. The encouragement of Ximena’s teacher, Katrina Hull, was also a theme which impacted Ximena’s identity as an inventor. The final theme I identified in Ximena’s narrative which contributed to her identity as an inventor was her positioning of her family members as natural engineers and problem solvers. In Figure 1, I include a concept map which provides a visual of the different themes I identified from Ximena’s narrative. Below, I describe and provide evidence for each of the themes.
Possessing a Growth Mindset and the development of Ximena’s identity as an inventor

Ximena faced her own challenges when she moved to the United States as a child. She was in the second grade when she left Mexico, however, the elementary school she attended in Salem, OR, suggested she finish the school year in a first-grade classroom because she did not speak English. When I asked her what it was like to move to the U.S. without knowing the language, Ximena described the struggle of trying to learn English as a child in a new country and the support her mother offered during that time. Ximena’s transition to the United States captures her determination and growth mindset which is a recurring theme throughout her narrative. Dweck (2006) defines a growth mindset as the belief that one’s abilities can be developed through hard work and dedication. Woven throughout Ximena’s narrative are

Figure 1: Concept map of themes developed from Ximena’s narrative
examples of her commitment to her goals and her willingness to work hard to accomplish those goals, including her participation in cross country and track, as well as her participation on the InvenTeam™. The first example of her growth mindset is captured in her acquisition of the English language.

Even as a young child, Ximena was determined to work towards her goal of reading English on grade level by the end of her second-grade year. “I remember I was so eager to learn English just because I really wanted to be at where everyone else was at.” She recalled being “so eager” to learn and “really wanting” to be at the same level as her peers. At a young age, Ximena recognized what it would take to accomplish her goals.

I just remember there were some different groups for levels of reading. I was in the lowest one and it took me a few months to elevate to the second and then a few other months to elevate to the third, but it was the little accomplishments that I had. My teacher made sure to celebrate them because everyone recognized that I didn't speak any English. I was really committed to learning English because I saw how behind I was, so I really wanted to learn. By the time I got to third grade, I was where I was supposed to be.

In the above quote, Ximena positioned herself as a member of the lowest reading group in her class and expresses that over time, she improved and moved up levels. Rather than giving up when she recognized she was in the lowest level, Ximena worked to “elevate” to the second level and continued to work for “another few months” to get to the third level, through “little accomplishments”, step by step. When Ximena stated, “I was committed to learning English because I saw how behind I was” she demonstrates her awareness of growth potentials in how she reflects on her own position and goals. When she “saw how behind” she was with her English, she made a commitment to grow and continued to work through the challenge. The belief she was someone who was “supposed” to be reading on level pushed her to continue to move up levels and reach her goal through little accomplishments over time.
Ximena’s acquisition of English when she arrived in the United States captures her determination and growth mindset. Ximena’s growth mindset continued to contribute to her identity as an inventor as she progressed through school. I describe how her participation in track and cross country also provide an example of Ximena’s growth mindset.

When I asked Ximena if she had experience with extracurricular STEM activities prior to the InvenTeam™, she told me her main focus in middle school was sports; therefore, she did not have time to participate in other activities. She began cross country and track when she was in the sixth grade. Her description of her experiences with running and track capture Ximena’s growth mindset.

I value running so much because of how much it taught me. It taught me to have a growth mindset mentality. It taught me, if I had a hard workout today, I will push through it. I will be okay, and I look forward to it and then afterwards I know I will feel really proud of myself for doing it, so let's do it.

When Ximena expressed running “taught me to have a growth mindset mentality” she traces the development of her growth mindset to her participation in track and cross country. In the above quote, she explained running taught her to “push through” challenges and discomfort, knowing there would be reward for the hard work and knowing she would “feel really proud for doing it”. She explained even through moments of struggle, she knew she would be “okay”. Ximena embraced the challenges and she “looked forward to it”. She positioned herself as an individual who was able to persevere through the difficult moments, knowing she would feel a sense of pride in herself upon completion. She continued:

It just built a lot of confidence in myself and helped me develop a lot as a person. I apply that to pretty much anything in my life now. I think with the MIT thing, there were times when I felt like giving up or when I wouldn't really want to show up, but it's that goal in my head that keeps me pushing through.
For Ximena, running “built a lot of confidence” which she could “apply to pretty much anything” in her life. She acknowledged throughout her experience on the InvenTeam™, she “felt like giving up at times” however, running had taught her wanting to give up at times is all part of the process when on the path to accomplishing a goal. Running also “helped her to develop as a person” who approached experiences knowing there will be challenges and times you feel “like giving up.” Ximena’s growth mindset was strengthened by her participation in running and track and contributed to the development of an inventor’s identity by allowing her to draw on lessons she learned about progress and growth during her InvenTeam™ experience.

Ximena’s growth mindset contributed to the development of an inventor’s identity because it affected the way she took on a challenge. Even as a young child, she recognized through hard work her goal of learning could be accomplished. Her growth mindset is also captured in her narrative through her participation in cross country and track and on the InvenTeam™.

Katrina’s Contribution to the Development of an Inventor’s Identity for Ximena

In our first interview, one of the first questions I asked Ximena was what brought her to the InvenTeam™. She explained that her math teacher, Katrina Hull, encouraged her to join the team. Ximena had never heard of MIT before Katrina introduced the InvenTeam™ project at the end of her first year of high school. Despite Ximena’s own questions of whether she belonged on the InvenTeam, Katrina reassured her she was in the right place.

She would often tell me, ‘You’re an inventor; you’re an engineer. You have the mind of a critical thinker. You have the potential to be here.”’ I remember thinking, I’m not an inventor, but if she sees it in me, then maybe I should give it a chance.
Katrina’s positioning of Ximena as an engineer and an inventor encouraged Ximena to give the InvenTeam™ “a chance”. She acknowledged her own self-doubt regarding her identity as an inventor and remembers thinking “I’m not an inventor,” but because Katrina “sees it in me”, Ximena was willing to take the risk of saying yes to the InvenTeam™ opportunity.

Before the start of the InvenTeam™ experience, Ximena recalls asking Katrina what engineering was. She explained, “I remember asking her what the definition of engineering was, and she said, Oh it’s pretty much inventing things and having the power to do things with it”. The above quote captures Ximena’s uncertainty surrounding engineering and her referring to Katrina to gain clarity of its definition. The definition of engineering Katrina provided as “pretty much inventing things” established a link between engineering and inventing for Ximena. Throughout Ximena’s narrative, she used the words engineering and inventing interchangeably and connected them both to problem solving. I return to this topic in the following section and in the synthesis of Chapter Four.

Ximena explained throughout high school, even after her participation on the InvenTeam™, Katrina continued to tell her that she saw Ximena as an engineer, which encouraged her to continue exploring engineering. Ximena’s explanation of the role Katrina played before, during, and after the InvenTeam, captures the potential teachers and educators have in shaping the identity of students. Although Ximena was uncertain of what engineering was or if she belonged on the team, Katrina’s reassurance that she was an inventor and an engineer led Ximena to take the risk of pursuing the InvenTeam™, which played a role in the development of her inventor’s identity. Below, I expand on Ximena’s perception of herself as an inventor.
Ximena’s Perception of Herself as an Inventor

I include Ximena’s perception of herself as an inventor in the section on “Katrina’s Contribution to the Development of her Inventor’s Identity” because Ximena described Katrina explicitly telling her “You are an inventor”. As with all the participants, I asked Ximena if she considers herself an inventor. Ximena responded by telling me:

Yes and no. I would say I am because there are some things I have invented to help me solve things but I am not an inventor to the extent where I can say, oh yeah, to anybody and everybody that I am an inventor. It’s not one of the first words I would use to describe or introduce myself. If you asked me directly, yeah sure, but it’s not a characteristic I would use to describe myself.

When Ximena answered “yes and no” she revealed conflict regarding her self-identification as an inventor. She explained that while she had “invented” to help her “solve things”, her identity as an inventor had not thickened to the degree where she would tell “anybody and everybody” she is an inventor. If asked directly, she said she would say yes, but it would not be “one of the first words” she would use to describe herself. Although she was hesitant about her identity as an inventor, Ximena acknowledged she had invented “some things”. Ximena’s response to the question not only captures her own hesitance regarding her identity as an inventor, but it also illuminates the ambiguity around the word inventor, which Isabel and Lesly also brought up in their narratives. I will expand on this topic below and in the synthesis of this chapter.

In our conversations, Ximena continued to discuss her self-identification as an inventor and explained the reason she hesitated to identify as an inventor was because if she told people she was an inventor, they would ask her what she had invented. She continued:

Anyone can be an inventor. I’ve been an inventor in times of difficulty where I just have to invent something right then and there or even the cup, but I wouldn’t take full credit for that. I was part of a group that invented something. I guess I could talk about that. So yeah, that’s why I think I wouldn’t describe myself as an inventor because then I would
have to talk about what I invented. That’s when I would be like, oh well the coolest thing has been the cup we presented at MIT, but other than that, it’s just me in my room figuring out life.

She explained her hesitance to identify as an inventor was because if she claims to be an inventor, she would have to talk about what she has invented. This example illuminates the importance of recognition from others in the development of an inventor’s identity (Carlone & Johnson, 2007). For Ximena, other people recognizing her as an inventor played a role in her identifying as an inventor.

In the above quote, Ximena explained “anyone can be an inventor”. She positioned herself as an inventor “in times of difficulty” when she had to “invent something right then and there” as she faced challenges in her daily life. Ximena also referred to her experience on the InvenTeam™ as she added “or even the cup” when considering examples of inventions she had developed which she could tell others about. She clarified she “wouldn't take full credit for the cup” because she was “part of a group that invented something”. Ximena’s participation in a year-long invention project was not the only experience Ximena described as contributing to her identity as an inventor. While she explained “the coolest thing” she invented has been the cup the team presented at MIT, she also discussed the inventions she has developed while “figuring out life” independently to justify her identification as an inventor.

Ximena described invention as something she did informally and individually, as well as something she had done as part of a formal team. This captures the multiple conceptualizations of the word inventor. She acknowledged inventing things and said “anyone can be an inventor” but was still hesitant to identify as an inventor even though she provided evidence of inventions she created. Ximena’s inclusion of both examples not only demonstrates the multiple
understandings of the word, but also captures how students develop identities as inventors through their own life experiences, both in and out of the classroom. To Ximena, invention was something you can do as part of an organized team and also something you can do on your own as you solve the problems you encounter in everyday life.

Ximena traced her participation on the InvenTeam™ and the development of an inventor’s identity directly to Katrina’s positioning of her as an inventor and an engineer. Without Katrina’s encouragement and reassurance, Ximena would not have joined the InvenTeam™ and said yes to the opportunity. Ximena’s hesitance to identify as an inventor, despite her providing examples of her inventions is evidence of the importance of recognition from others and the multiple conceptualizations of the word inventor which can lead to ambiguity surrounding the word. I return to this topic later in Chapter Four.

Strength in Math as a Contribution to Ximena’s Identity as an Inventor

In telling her story, Ximena emphasized her strength in math and traced the development of an inventor’s identity to her outlook on learning math, in connection to other STEM subjects, specifically engineering. Ximena explained that although she struggled with reading when she arrived from Mexico because of the language barrier, she was always strong in math. She explained, “Yeah, math was my forte because all you need is numbers, especially in the early grades. So, I was pretty good at it”. Ximena positioned herself as someone who was strong in math by stating math was her “forte.” In the quote above, she acknowledged that because she did not need English for math in the early grades, she saw herself as “pretty good” at it. In our conversations, Ximena also told me she was frequently the first one finished with math tests and
was typically the “last girl standing” when they would have math competitions in elementary school and middle school. As she reflected on her strength in math, Ximena recalled considering studying mathematics in college or becoming a math teacher. She continued to explain that from a young age, she always saw herself as more of a “STEM person”:

I always saw myself more as a STEM person than a liberal arts type of person. I think I say STEM because I have always been pulled towards math and things that allow my brain to problem-solve more than writing a poem. I'm not very good at that, for example. I’m just a critical thinker, just an overall critical thinker.

As Ximena situated herself “more as a STEM person”, she created a juxtaposition between being a “STEM person” versus a “liberal arts type of person”. She explained she was drawn towards activities which “allow my brain to problem solve”, and contrasted problem solving with writing poetry, consistent with her earlier statement regarding being strong at math because “all you need is numbers”. Ximena believed she was strong in math because she was a problem solver and a critical thinker. Her self-identification as a problem solver who was strong in math contributed to her development of an inventor’s identity because of her understanding of the relationship between problem solving, inventing, math, and engineering, which I discussed in the previous section.

Given Ximena used the words engineering and inventing interchangeably throughout her narrative, late in our second interview, I asked her what engineering is. She responded, “Problem solving and inventing. It really is that. It really is just pretty much looking at a problem that no one is familiar with and working around it to try and find a solution”. For Ximena, problem solving, inventing, and engineering are intricately connected. Her strength in math was connected to her identity as a problem solver, and based on her own definition, engineering was problem solving and inventing. Her self-positioning as someone who was drawn “towards math
and things that allow her brain to problem solve” provided evidence for the foundation of an inventor’s identity.

As I describe above, Ximena provided evidence that her self-positioning as a problem solver who was strong in math contributed to the development of her inventor’s identity. Ximena was not the only participant to make the connection between problem solving, inventing, and engineering in her narrative. All three participants make similar connections. I will return to these connections in the synthesis of Chapter Four. In the final section of the analysis of Ximena’s narrative, I discuss how her positioning of her family members as engineers contributed to her development of an inventor’s identity.

Positioning Family Members as Engineers and Ximena’s Identity as an Inventor

Ximena’s conceptualization of an engineer was not limited to those individuals who have received formal engineering training. She also referred to individuals who develop solutions to problems they encounter in their everyday lives as “engineers”, demonstrated by her description of her own family members as engineers. Ximena shared that her brother and father were both natural engineers. Having individuals in her family who displayed the ability to problem solve contributed to her own identity as an inventor. Below, Ximena described her older brother and his abilities as a natural engineer. “He's just a natural engineer. He knows how to fix anything and everything. I tell him, if you go to school, you’re going to outsmart everyone because of how much your own personal experience has taught you”. She positioned her brother as a natural engineer, because of his ability to “fix anything and everything”. She recalled telling her brother he will “outsmart everyone” if he goes to school, because of how much his “own personal
experience has taught” him. Just as Ximena described herself as an inventor for solving the problems she encountered in her own life, Ximena included solving problems people encounter throughout their everyday lives as justification to define them as engineers. She continued:

During the pandemic, we needed to fix our doorbell and there I was, trying to figure it out and he was already connecting positives and negatives and already working with what was there. I was so impressed because I worked with the InvenTeam™ team with electrical things like that and it took me so long to learn those little things and he already knew how to do that and more.

While her older brother had no formal experience or training as an engineer, he knew how to solve electrical issues better than she did, even after her exposure to electrical engineering throughout the InvenTeam™ process. She explained she “was so impressed because I worked with the InvenTeam™ with electrical things” and knew she how long it took her to learn the concepts of electrical engineering, yet her brother “already knew how to do that and more”.

Ximena’s example of her brother’s knowledge of electrical engineering is evidence of people developing engineering knowledge and problem solving skills on their own, without formal instruction or credentials. This example also captures how individuals who have developed engineering and problem solving skills informally can affect the identity development of their family members as inventors.

Later in the interview, I asked Ximena to clarify who was who regarding her siblings. I said, “Ok, so Berto, he’s the one who is the natural engineer right?”. Her response was, “Yeah, and also my dad is a natural engineer”. I asked her to expand on the idea of her dad as a natural engineer.

Engineering is problem solving and with my dad, there's just so many examples. He just figures out ways to solve things. For instance, if something breaks in his car, he goes to what he calls a junkie which is where they have old parts of cars or like old cars and he finds a car or a piece that is similar to his. He undoes it and he does it and undoes it and
he figures out a way to solve it and then comes back home takes out his car and does it on his car and then knows how to solve it. To me, that is engineering.

Ximena began by reaffirming her belief that “engineering is problem solving”. Ximena shared her father “figures out ways to solve things” and provided the example of him fixing his car as evidence. She explained when something breaks on his car, her father would go to the junkyard to find parts similar to the parts of his own car, and he then “undoes it and he does it and undoes it and he figures out a way to solve it”. Through the iterative and recursive process of “undoing” and “doing”, which is a frequent practice in engineering, her father “then knows how to solve” the problem on his own car. Ximena said, “to me, that is engineering”. By describing her family members as engineers, Ximena positioned herself as someone who has been exposed to engineering and problem solving throughout her life. She also emphasized the role of life experience and informal problem solving in the development engineering identity, which was consistent with her considering herself an inventor because of her ability to “engineer her way through” problems she encountered in her own life.

Ximena explained she was not the only one of her friends who comes from a Hispanic background who has parents who are engineers.

I was talking about this with friends, and I think it's very common among Hispanic families to have parents who are engineers because that's the way they grew up, always having to always solve their own things. Yeah, we don't really reach out for help unless we have to.

Ximena explained she had discussed the topic with friends, and she thought “it's very common among Hispanic families to have parents who are engineers” because they grew up “having to solve their own things”. Ximena again conceptualized engineers as those who solve problems they encounter. She situated her family as part of a group of people who solve problems they
identify in their everyday lives when she said, “we don’t really reach out for help unless we have to”. The intersection of socio-economic class and ethnicity contributed to Ximena’s family and other “Hispanic families” not reaching out for help when faced with problems, but rather, solving “their own things”, out of necessity. Ximena’s description of her family members as natural engineers provided a link to the second research question regarding how the participants drew on the cultural capital of their families in their development of an inventor’s identity, which I address in Chapter Five.

Ximena’s narrative illuminates the role educators may play in fostering the development of an inventor’s identity in their students. Her story also captures the importance of having a growth mindset as an inventor. Her self-perception as a problem solver who was strong in math contributed to development of her identity as an inventor because of her understanding of the connections among problem solving, engineering, and invention. Finally, by describing her family members as engineers, Ximena positioned herself as someone who has been exposed to problem solving and engineering through her experiences at home and with her family. Ximena situated her family as part of a group of people who solve their own problems, as opposed to seeking help from others. In Chapter Five, I share more of Ximena’s story as I describe the different types of cultural capital she evoked as she developed her identity as an inventor.

**Lesly Rojas, The Aspiring Engineer**

Lesly is currently 19 years old and a first year student at Oregon State University majoring in electrical and computer engineering. I first saw Lesly through the video records I worked with as a research assistant on the ethnographic study which explored the networks of
support for the McKay InvenTeam™. Lesly was one of two people on the team with years of experience in out of school STEM activities leading up to her team participation. Her knowledge and experience were evident in the video records I indexed. Because of what I saw in the videos, Lesly was someone I had kept in mind for my dissertation.

Lesly is soft-spoken and humble, yet confident. She has a passion for engineering, invention, and entrepreneurship and was the first of the girls to respond to me to confirm her participation in the study. The first time I met Lesly was during the introductory Zoom call with the three participants. Although Lesly gave no indication on the initial Zoom call, I would come to learn she is acutely aware of the impact her story can have on Latinx students who pursue STEM.

Lesly’s Story

Lesly was born in Salem, Oregon, to Mexican parents. She is the oldest of three children, with two younger brothers who are 15 and eight. She described herself as a first generation student and first generation Mexican American. Lesly explained that although her parents did not have the luxury of continuing with their education beyond high school, they consistently emphasized education was a privilege. Lesly always wanted to make her parents proud, and she described a happy childhood with supportive parents. She spoke of her early years fondly and held back tears as she described what it was like growing up in her family. Her mother was a stay at home mom for the majority of her childhood, occasionally working seasonal jobs at a local blueberry cannery. Her father works at a grass farm where he operates heavy machinery.
From a young age, Lesly knew she was going to go to college. Lesly had a second grade teacher who would frequently speak to the students about her experience in college. She explained hearing about college at a young age helped make it seem like a realistic possibility for her.

My third grade teacher talked so much about her college experience. Even though I already knew I was going to go, I feel like her talking so much about her college experience in elementary school made a really big impact.

Lesly took advantage of the opportunities she was presented throughout her educational journey, both in the classroom and out. She attributes her competitive streak to her participation in orchestra growing up.

As I analyzed the different life experiences Lesly described, I identified themes which contributed to her development of an inventor’s identity. For Lesly, the support of her family was a major theme. Her participation in extracurricular STEM activities also played a significant role in the development of an inventor’s identity. Additionally, her acute awareness of the importance of representation of Latinas in STEM and her continued exposure to engineering at college were also themes I established through inductive analysis of Lesly’s narrative. In Figure 2, I provide a visual which captures the four themes I developed through inductive analysis of Lesly’s narrative.
Early and Consistent Family Support Contributing to Lesly’s Identity as an Inventor

The support of Lesly’s family throughout her educational journey contributed to her development of an inventor's identity starting at a young age. Lesly explained, “Yeah, my mom and dad, they're my number one supporters. Again, they're very education driven, even though they didn't have that opportunity”. Lesly positioned her parents as her “number one supporters” in the above quote. She explained that although her parents did not have the opportunity to continue with their own formal education, “they’re very education driven”. Lesly remembered as early as first and second grade, her father would come home from work and helped her with her homework and assisted her in making corrections if needed. She explained:

So that was my childhood, it was just school and learning. I always knew it was a privilege because they always told me about it. So yeah, by first or second grade, I knew I was going to go to college. At some point we talked about it, like, do you want to go to college, mija? Some parents ask their kids, I would say yes.
Lesly recalled the focus of her childhood being “school and learning”. In the second sentence of the above quote, Lesly identified herself as a person who was aware of the “privilege” of education because her parents reinforced the idea. As early as first grade, Lesly already saw herself as a person who would be going to college. Lesly stated “some parents” ask their kids about their intentions to attend college. Lesly’s parents were part of the “some parents” Lesly described and their discussions about college with Lesly as a young child had an impact on her educational trajectory. Lesly recalled a conversation with her parents in which they asked her, “do you want to go to college, mijita?”. As a child, Lesly told her parents “Yes”, she did intend to go to college. She maintained that intention throughout her K-12 experience and was the first in her immediate family to attend college.

Throughout the interviews, Lesly shared how her mother and father were both deeply invested in her education. Below she explained her father’s support as she progressed through school.

There were times, as I got into middle school and high school math, you know, my dad wasn’t able to help me in any way, but he had already provided that path of asking questions and asking how we will get to the right answer and that kind of thing. I had learned that in this household, we get good grades, and we try our best, and we do the best that you can.

Lesly explained there were times her dad was not able to help her as she progressed into higher level math; however, he had already “provided the path of asking questions” and asking how we will get the right answer”. Her use of the word “we” signals recognition of her father’s support as she engaged in problem solving in school. She continued to use the word “we” as she explains “I learned that in this household we get good grades, and we try our best and we do the best that you can”. Lesly positioned herself as part of a family who do their best and get good grades. The
support of Lesly’s parents contributed to identity as a person who works hard in school and cares about academics. This continued as Lesly progressed into high school and onto college.

As Lesly made decisions regarding which high school and college to attend, her parents were deeply invested in the process. Lesly remembered when it was time to select a high school, it was a decision her family made together. She explained:

My family has been very, my dad, specifically, but my mom as well have been like, we have to choose the right direction, for your education path. I had three options of where I could potentially be going, so it was Early College High School, which would allow me to complete my high school in two years and go on straight to college, which we were really considering. Then we were considering South Salem High School which is a little bit more rigorous. It’s an IB program rather than AP. And then there was McKay High School, the one that was near my zip code, but they had MESA and I had seen the Recycl3D team.

Lesly also recalled her parents' recognition of the importance of “choosing the right direction” for her “educational path”. She described the three options and includes reasons the family “considered” the schools for Lesly. Lesly’s repeated use of “we” in the above quotes signals the support of her parents and their involvement in her academic endeavors.

In the end, she decided on McKay because there was already a Mathematics, Engineering, Science, and Achievement (MESA) chapter at the school, run by Katrina, and because of her exposure to the Recycl3D team. The Recycl3D team was an engineering team of all Latinx students from McKay high school who won competitions against college teams and earned thousands of dollars for the new engineering program at McKay. It was through her participation in MESA that she was able to see the Recycl3D team. I will expand on MESA and the impact of the Recycl3D team on Lesly’s development of an inventor’s identity in the Recognizing the Need for Representation section. In the next section, I describe how
participating in extracurricular STEM activities contributed to the development of an inventor’s identity for Lesly.

**Participating in Extracurricular STEM Activities and their Contribution to an Inventor’s Identity**

Lesly’s first exposure to extracurricular STEM activities began in 7th grade with her participation in MESA (Mathematics, Engineering, Science, Achievement), a club at her middle school which met weekly on Thursday afternoons. She only knew about the club because her friend was joining and initially, she only joined because she wanted to spend more time with her friend. Lesly explains she was hesitant to join because she wasn’t sure what engineering was and she was already an active member of the school orchestra. When she did take the risk and agree to join, she explains how the first challenge she participated in was her first exposure to IvE and explained how the experience “hooked” her into engineering. Below, she describes her first design challenge in MESA, which was creating a wallet.

My crazy mind was like, Okay. We're going to put chargers in this, you’re going to be able to charge your phone. You're going to be able to do this and this. I was so excited. I made a little cardboard prototype and that was my first insight into invention education and kind of using my mind to do these crazy things and to think of these crazy ideas that nobody else thinks about. So, I was obviously the only one in the class that actually took it, not seriously, but more to the next level. I remember it so clearly and that's kind of how they hooked me in.

Lesly recalled “being so excited” about her first design challenge and describes her “crazy mind” considering all the different features the wallet would have. Designing the wallet in MESA was her “first insight into invention education” which allowed her to provide her own unique, perspective. Although this was Lesly’s first activity in MESA, she stated she “obviously” was
the only one in the class who “took it to the next level”, signaling her desire and willingness to learn. Lesly said the experience of designing the wallet was how they “hooked” her in to IvE.

By the spring of her eighth grade year, Lesly was building a prosthetic arm through her participation in MESA. As Lesly reflects on her experience with building the prosthetic arm, she recalls the exact moment in the eighth grade when she told herself, “Ok, this is what I am going to be doing for the rest of my life”. As early as middle school, Lesly knew she wanted to invent “for the rest” of her life. The above quote captures the effect of participating in engineering and design challenges on the development of an inventor’s identity. Starting in the seventh grade, Lesly was provided with opportunities to engage in identity work (Kelly et al., 2017) which allowed her identity as a problem-solver and inventor to develop and thicken.

Towards the end of our first interview, I asked Lesly if she considers herself an engineer, to which she responded, “I identify myself as an inventor. I think I will consider myself an engineer once I graduate. That's how I've been thinking about it, but I definitely consider myself an aspiring engineer”. Lesly identified herself as an inventor, but not yet an engineer. To Lesly, being an engineer is tied to a credential she will receive. When Lesly stated “that’s how I’ve been thinking about it” she signaled this is not the first time she has thought about her identity as an inventor or engineer. She continued, “I definitely consider myself an aspiring engineer”, I follow up by asking, “So what is an inventor, then?”. Lesly responded:

An inventor for me is somebody who either has identified a problem or has made something in order to better something else. In this case, for me, specifically, it has been building something that would help others. So, for example, the adaptive cup for me, that was a process where I identified the problem for somebody who actually needs it and I made that for them. So that's an inventor for me or somebody who can just make something. Now that I think about it, it’s somebody who identifies, it’s a problem solver. An inventor is a problem solver.
Lesly defined an inventor as “someone who has either identified a problem or has made something in order to better something else”. She positioned herself as an inventor because she has built something to help others. Lesly provided the invention developed by the InvenTeam™ as justification for why she identifies as an inventor. She “identified the problem for somebody who actually needs it” and was able to “make” the adaptive cup for them. For Lesly, an inventor is a “problem solver” and “someone who can make something”.

Lesly expressed her self-identification as an inventor confidently. To support her position as an inventor, she provided evidence of the adaptive cup she created with the InvenTeam™. She also connected problem solving and inventing in her definition of an inventor. All three participants establish a connection between inventing and problem solving in their definitions of an inventor. In the following subsection, I discuss the importance of Lesly hearing the word “inventor” through her participation in MESA and the role it had on the development of her identity of as inventor.

Hearing the Word “Inventor” and How it Contributed to Lesly’s Identity as an Inventor

Lesly traced the development of her inventor’s identity to her exposure to the word inventor throughout her participation in MESA.

In MESA, the word inventor was used a lot, along with engineering and things like that. Oftentimes when you think of an inventor, you think of some of the biggest names out there, right? People don't usually think of themselves as inventors. I think what contributed to me considering myself an inventor, and in a way knowing that I am one, is being surrounded by that community of people who understand that inventors are people who are problem solvers and who like to solve problems and who like to build things.

Lesly recalled her first exposure to an inventor’s identity related to the discourse used in MESA. She explained “the word inventor was used a lot, along with engineering and things like that” in
MESA. In the second and third sentence of the above quote, Lesly acknowledged the ambiguity and uncertainty around the word inventor. She stated, “people don’t usually think of themselves as inventors” because they conceptualize inventors as “some of the biggest names out there”. She explained she knows she is an inventor because she was surrounded by a “community of people” who understood “inventors are problem solvers who like to solve problems and who like to build things”. Lesly’s experiences in MESA and on the InvenTeam™ contributed to the development of an inventor’s identity by allowing her to take part in the practices of inventors. In her extracurricular STEM activities, she was surrounded by the word “inventor” and by a community who define inventors as problem solvers, which also contributed to her self-identification as an inventor.

Lesly’s participation in MESA and on the InvenTeam™ contributed significantly to the development of her identity as an inventor. Of all the participants, Lesly spoke the most confidently about her identity as an inventor. Lesly knew she was an inventor, because she was exposed to a community which used the word and defined inventors as problem solvers. Taking part in extracurricular activities such as MESA and the InvenTeam™ also allowed Lesly to engage in the iterative and recursive process of inventing. Starting in middle school, Lesly was provided with opportunities to take part in identity work as an inventor (Kelly et al., 2017). Below, I discuss how Lesly’s understanding of the important of representation in STEM contributed to the development of her identity as an inventor.
Lesly’s Understanding the Importance of Representation in STEM and its Contribution to Her Identity as an Inventor

The Impact of Lesly’s Exposure to the Recycl3D team

Lesly was exposed to the Recycl3D team, an engineering team from McKay High School composed of all Latino students, when she was in middle school. She saw them for the first time at MESA Day, an engineering challenge for teams from different high schools, and continued to follow their progress throughout her final year of middle school into high school. Lesly attended middle school at the local public school for which she was districted that was a feeder school for McKay. In our interviews, Lesly described the impact of the Recycl3D team on her decision to attend McKay High and continue her involvement in engineering. Her first year of high school, the MESA club at McKay took Lesly and fellow MESA participants on a field trip to an engineering challenge at a local university where the Recycl3D team were competing against college students. Lesly described the experience:

They [MacKay High] ended up winning first place at the semi-finals and then second place at the finals, winning over $30,000.00 for our engineering program. So, I get to see them present, just people who actually look like me start winning these competitions. I really hoped that I could do that one day, but I hadn't seen it happen, and so when I saw that happen, I was like, I’m ready for what’s next for me. I’m ready to take this to the next level. I want to do what they did.

In the above quote, Lesly described the importance of seeing Latinx students win engineering competitions. For Lesly, “seeing people who actually look like me start winning these competitions” made her “ready for what’s next”. When she stated, “I really hoped I could do that, but I hadn’t seen it happen,” she signaled that prior to seeing the Recycl3D team compete, she aspired to become an engineer, while also positioning herself as someone who had never seen Latinx individuals succeed in engineering competitions. When she “saw” the Recycl3D
team’s success firsthand, she explained she wanted “to do what they did”. Although Lesly was already passionate about engineering, the Recycl3D team provided her with an example of how to “take it to the next level”. The above quote underscores the importance of students having direct, firsthand exposure to individuals to whom they feel connected through shared identity.

Seeing people who looked like her succeed in STEM inspired Lesly to continue her journey as an aspiring engineer. The exposure to the Recycl3D team also affected her decision on where she would attend high school, which had a lasting impact on her educational trajectory. Below I describe how the InvenTeam™ experience reinforced the importance of representation in STEM for Lesly and inspired her to want to be an example for other minorities in STEM.

The InvenTeam™ Experience Reinforcing the Importance of Representation in STEM for Lesly

Lesly continued pursuing engineering opportunities through MESA and other organizations while she attended McKay. At the end of her first year of high school, she was introduced to the possibility of McKay receiving an InvenTeam™ grant from LMIT. Lesly was the only one of the three participants in my study who knew the prestige of MIT when Katrina, her math teacher and MESA instructor at the time, first introduced the idea. Lesly described MIT as her dream school. She recalled Katrina announcing McKay were selected as one of the 15 teams to receive the InvenTeam™ grant at the end of her first year of high school. Lesly described how she cried tears of joy upon finding out.

It was Lesly's idea, an adaptive cup for individuals who suffer from dysphagia, which would become the invention developed by the McKay InvenTeam™ during the 2018-2019 school year. Lesly first developed the idea as part of a project for MESA during her first year of
high school. A healthcare professional who worked with geriatric patients at a nursing home visited MESA and explained the various needs of the patients based on their conditions. The healthcare professional introduced the students to dysphagia and the effect it has on an individual’s ability to swallow. She also shared a lack of cups available for individuals who suffer from the condition. Based on the problem that Lesly was introduced to through the healthcare worker, Lesly decided to focus on inventing a new cup for individuals with dysphagia. While she did not make it to the stage of developing a prototype for her cup invention, she introduced the idea to the InvenTeam™ at the end of her first year of high school, once they received the grant and trying to decide which invention to focus upon.

Lesly played an integral role on the team because of her experience and passion, yet she was always humble when discussing the InvenTeam™. When I asked her what she learned through her experience on the InvenTeam™, she explained:

I learned how to share my story, not to benefit me, but to, this is going to sound braggy, but to become an inspiration to others. I understood the importance of representation in the STEM world and what I want to do with that in the future. It opened my eyes again to what I want to do with community involvement for minorities in STEM.

Through the InvenTeam™ experience, Lesly “learned to share her story” in order to “benefit others”. In the above quote, Lesly positioned herself as someone who has a story that will inspire other minorities in STEM. As a result of her participation on the InvenTeam™, Lesly “understood the importance of representation in the STEM world” and what she “wanted to do in the future.” The InvenTeam experience “opened” her eyes “again” for Lesly, in terms of her desire to become involved with minorities who are pursuing STEM.

Participating on the InvenTeam™ also reinforced Lesly’s desire to work to engage more minorities in STEM. Lesly continued:
I saw the importance of representation through the Recycl3D guys and now I understand that my story hopefully will serve a similar purpose, where I am somebody who looks like them and if this encourages the next generation of Latinas to continue engineering, I really, I really want that to happen.

Through her experiences on the InvenTeam™, Lesly strengthened her identity as a Latina in engineering and inventing “who looks” Latina and can encourage the “next generation” of Latina students. Lesly continued to discuss the need for representation of Latinx individuals in STEM:

They are a big part of the population, and we can’t ignore it. They need to be represented in these subjects. I think that it just opened my eyes and made me understand that my perspective is also important, and it made me comfortable knowing that my perspective is different, and it made me understand that there are different opinions and I’m always going to have that one sticking out, and I am not embarrassed or shy to talk about it.

Lesly began by referencing the large Latinx population in the United States and said, “we can’t ignore it”. She again stated the InvenTeam™ experience “opened my eyes” and adds it “made her understand” the value of her perspective in STEM. Lesly acknowledged she is not the norm in engineering when she positions herself as always having the opinion and perspective which is “sticking out”. She continued by asserting she is not “embarrassed or shy” to share her perspective and ideas with others, because she knows there is value in her perspective. Lesly understands the value she brings to engineering as an underrepresented minority and wants to help other Latina students to see the valuable assets and perspectives they can also contribute to engineering and invention.

In the above section, I described how Lesly’s understanding of the importance of representation in STEM fields contributes to the development of her identity as an inventor. Seeing herself and her story reflected in the Recycl3D team encouraged her to continue in engineering and helped her understand the value of her own experience. As a result, she wanted to become an inspiration for younger Latina students pursuing invention and engineering. In the
final section of Lesly’s narrative, I discuss her continued involvement in engineering at the 
university level as a theme which contributes to the development of her inventor’s identity.

How Continued Involvement in Engineering at the University Level Contributed to Lesly’s 
Identity Work

In the fall of 2021, Lesly began her first year at Oregon State University (OSU). Upon 
moving onto the OSU campus, Lesly immersed herself in the engineering community. She lived 
on a floor with other female engineering students and joined identity specific engineering 
organizations, such as the Society of Hispanic Engineers.

Right now, I'm surrounded by a community of people of color who are pursuing their 
degrees in STEM and I tell people, you need to talk about your experiences because your 
experiences are so unique. I feel so inspired by them because some of them, although 
they didn't have the same opportunities as me, the amount of work and grit they put into 
their education. I feel so impressed and so good because, my friend did all of these 
things. A lot of people need to hear it. It can help so many girls continue in STEM and 
continue going in their engineering path.

At OSU, Lesly was “surrounded by a community of people of color” in STEM. Lesly reflected 
on her own experiences as a Latina who saw herself and her story in the Recycl3D team, which 
led to her envisioning herself as a Latina in STEM. Through her own experience, Lesly saw the 
importance of exposing younger generations to the stories and experiences of Latinx individuals 
in STEM. She encouraged her friends to “talk about your experiences because your experiences 
are so unique” which signals her understanding that people of color have unique experiences in 
STEM and those perspectives need to be heard. Lesly also stated she is inspired by “the amount 
of work and grit” her friends have put into their education. Lesly “feels so impressed and so 
good” having friends who “did all these things”. She explained that by hearing the stories of 
other people of color in STEM, it can “help” other girls to persist in STEM and engineering.
During her first year at OSU Lesly also worked with an engineering professor on research which focuses on improving power grids. She describes the experience below:

I am now doing research with one of the professor's here in the electrical and computer engineering department. I do research on that and we're learning about microgrids and how we can improve power grids and just all of that research, which again, you never think of doing that your first year. It’s just been surreal, and it's just been amazing.

During her first year of college, Lesly was “doing research” with a professor in the electrical and computer engineering department at Oregon State University. She was continuing to learn about engineering, in this case, researching how to improve power grids. Lesly never thought she would be participating in research her first year of college. She described the experience as “surreal and amazing”. By engaging in the practices of inventing and engineering, Lesly continued to take part in identity work on both ontological and epistemological levels which provided opportunities for her identity as an inventor and an engineer to develop and thicken.

Lesly’s continued engagement in engineering at the college level contributed to the development of her identity as an inventor because she was surrounded by people of color in STEM who she identifies with. Lesly made specific choices to surround herself with aspiring female engineers and people of color in STEM. I return to this topic in Chapter Five as I discuss the navigational capital Lesly drew on in the development of an inventor’s identity. Through her involvement in engineering in college, she continued to take part in formal engineering practices, which gave her the opportunity to apply her knowledge of problem solving and inventing.

Lesly had the most experience with inventing and engineering leading up to the InvenTeam™ experience. She also was the most confident in her self-identification as an inventor, as she stated she knows she is an inventor because she had been surrounded by the word since middle school through her participation in MESA. Lesly’s narrative provides
evidence of the benefits of participating in IvE before high school. The early and consistent support of Lesly’s family also contributed to the development of her identity as an inventor. Additionally, Lesly continued to strengthen her inventor’s identity through continued participation in engineering at the university level. In Chapter Five, I discuss the different types of cultural capital Lesly drew on throughout her narrative which contributed to her inventor’s identity.

**Isabel Mejia, The People Person**

Isabel was the only participant I actually knew before the start of this study. When I met her, she was beginning her final year at McKay High School. I was intrigued by Isabel and selected her for a pilot study I conducted during the second year of my doctoral program at UCF. I selected her and was glad she agreed, because of the tremendous growth I witnessed while working with the records on the previous ethnographic study with the McKay InvenTeam™.

Currently, Isabel 19 years old and a first year student at Chemeketa Community College in Salem, Oregon. Isabel is warm and friendly; I have ever seen her without a smile. She has a self-described lighthearted energy about her. My interviews with Isabel were unique because I already knew what she shared with me about her life during the pilot study. I began by asking her what she had been up to since we last spoke. She shared that she has been taking a full course load of classes in addition to working at a popular fast-food restaurant near her home.

**Isabel’s Story**

Isabel, like Ximena, is also the youngest of five children. Although she was born in the United States, Isabel identifies as Mexican. Her parents are both from Mexico and her three
oldest siblings were born in Mexico. Before moving to the U.S., her father was the first in the family to receive legal residency after a long application process. Isabel explains that her mother had an easier process of becoming a U.S. resident because Isabel's uncle, her mother’s oldest brother, submitted her application for citizenship while Isabel’s mother was still a minor.

Although her parents moved to the U.S. to begin work in 2000, her older siblings remained in Mexico with their paternal grandmother until 2002. Isabel explains that being separated from their parents was difficult for her siblings:

So, during that time, they were staying with my grandma in Mexico. I've talked to my siblings about how hard that was for them, that they didn’t see their parents for a couple years. I think that's why they were really close to my grandma.

After Isabel’s parents brought her siblings to Salem, OR from Puruandiro, Mexico, where they had two more children, Isabel and her brother who is one year older than her. In Chapter Five, I expand on the role her siblings play in her life and the effect their own life experiences have on the support they offer to Isabel.

When Isabel was young, her mother was a stay-at-home mom. Later, when Isabel was in elementary school, her mother began to work seasonal jobs at local canneries. According to Isabel, her father always had jobs which “revolved around field work” and during the summers, he would work as a Woodlands firefighter. For the past six years, her mother has worked in a meat packaging plant, where Ximena’s father also worked. Isabel’s father currently works in maintenance at a berry farm in Salem and as a truck driver in the summer.

Although Isabel is the first to attend college, education and school have always been a priority for her family. Isabel shared vivid memories from her first day of kindergarten and receiving her first homework assignment:
I got straight home to do my homework and I feel like that set the pace for the rest of my high school. I realized that I'm getting this homework for a reason and I'm going to try my hardest. I knew I needed to dedicate time to this because I would always see my family working and I was like, I get to go to school. I really took that to heart in the earlier years and it stayed with me.

Isabel’s early experiences with school initiated her commitment to learning for the rest of her schooling. Isabel was always a strong student throughout her K-12 experience, especially in math. Her family had high expectations for her grades, which pushed her to work hard and make the most of her academic experience. Isabel continued her commitment to her education and learning by becoming the first member in her immediate family to attend college.

I selected Isabel for my pilot study because of the incredible growth she demonstrated over the course of the InvenTeam™ year, which was captured on the video records I indexed as a research assistant. Through the pilot study, I learned she joined the InvenTeam™ with no prior STEM experience, and by the end of the year she was the most skilled team member in 3D modeling and printing on the team. Isabel’s design of the cup was one of the final two prototypes presented at MIT. I also learned about Isabel’s determination, contagious positive attitude, and willingness to learn through the pilot study. Initially, it was Isabel and her story which inspired me to pursue a narrative study for my dissertation focusing on identity development and cultural capital of Latina inventors.

Through analysis of Isabel’s narrative for this study, I identified four major themes which contributed to the development of an inventor’s identity. The first theme I identified was the role of her participation on the InvenTeam™. Isabel brought an “outside” perspective to STEM which served as an asset to the InvenTeam™ and contributed to the development of her identity as an inventor. She also discussed the importance of speaking about her experience on the team
and the value of receiving validation and recognition from others. Isabel spoke frequently about the importance of not comparing herself to others, which I identified as a theme in her narrative as she developed an inventor’s identity. I provide a visual of the four themes in Figure 3 below.

![Figure 3: Concept map of themes developed from Isabel’s narrative](image)

The Significance of Isabel’s Participation on the InvenTeam™ in the Development of Her Identity as an Inventor

Developing Confidence through Participation on the InvenTeam™

Of the three girls, I found the InvenTeam™ experience had the most substantial effect on the development of an inventor’s identity for Isabel. She described her experience on the InvenTeam™ as a period of major change in her life. She viewed her experience on the InvenTeam™ as an opportunity from which she developed confidence and found the value of her voice. She explained how before participating on the InvenTeam, she was shy and soft spoken
and would often compare herself to others who seemed more confident than she was. She told me the only reason she had the courage to join the team was because her close friend was joining, which provided a sense of safety for her. When I asked her what she wanted people to know about her InvenTeam™ experience, she said:

I think I would want people to realize that you meet people at certain points in their life, and you don't know what they’ve gone through. You don't know where they'll be if you meet them in another five years. I think if you would have met me in middle school, you would have never imagined that I would actually say yes to that opportunity and go with it. Obviously even that same year, I went to the first InvenTeam™ meeting with Jasmin, because I was too scared.

Isabel responded to my question by expressing her desire for others to understand “you don’t know what they’ve gone through” and what “point in their life” people might be at. This captures Isabel’s belief in peoples’ ability to change based on different life experiences. In the above quote, Isabel positioned herself as a person who has changed and become less fearful of trying new things. She emphasized her development when she says, “if you would have met me in middle school, you never would have imagined I would have said yes” to the InvenTeam™ experience. Isabel referenced her timidness prior to the InvenTeam™ by sharing she only went to the first meeting because her close friend Jasmin was attending, and she was “too scared” to attend alone. Isabel continued:

I remember in middle school looking at other people and thinking, oh my God, they're so confident; they're doing all these things. My confidence came from the InvenTeam™. It literally goes back to that. Before the InvenTeam™, I was more soft spoken and now I feel like I know within myself what I can do. I know I deserve to get a good job and deserve to take advantage of the opportunities in front of me.

Isabel recalled comparing herself to people she viewed as more confident than she was and equated confidence with “doing things”. She explicitly stated, “my confidence came from the InvenTeam” and contrasted pre-InvenTeam™ Isabel to the post-InvenTeam™ Isabel by sharing
she “used to be more soft spoken”, while she has since learned “within myself what I can do”. She knew she deserved a good job and deserved to take advantage of the opportunities she encounters in her life. Isabel spoke frequently in our interviews about the role her participation on the InvenTeam™ played in helping her become more confident and self-assured. The self-realization Isabel experienced as a result of her participation on the InvenTeam™ is evidence of the potential of extracurricular activities to assist in building confidence in those students who participate.

Experiencing Personal Growth Through Participation on the InvenTeam

As we discussed her InvenTeam™, Isabel continued to explain the impact of the experience on her life and development.

I looked at that opportunity as a place where my voice was heard and where I experienced personal growth on my own. I know I came in very shy and not knowing anything, but just during the span of one school year, I feel like I realized how much I had grown as a person. Not even just because I learned to 3D model and code, but because my work ethic improved, and I realized I needed to meet deadlines.

Isabel saw the InvenTeam™ not only as an opportunity for “personal growth” but also “as a place where her voice was heard.” While she was a member of an eleven-member team, she emphasized the growth she experienced individually. She underscored her shyness at the start of the InvenTeam™ year when she stated, “I know I came in very shy”, and recognized the change she experienced in just one school year. She acknowledged the technical skills she learned while she was on the team, but placed more importance on the self-realization which occurred as a result of her participation. She explained, “Looking back on it, I think it’s very cool that we created a cup for individuals with dysphagia, but I feel like for me, the personal growth I
experienced was more important”. Again, as she reflected on the InvenTeam™ year, she
described the invention itself as “very cool” but emphasized, for her, “the personal growth I
experienced” was the most important outcome of her participation on the InvenTeam™.

The InvenTeam™ experience contributed to the development of Isabel’s identity as an
inventor by providing opportunities for Isabel to develop confidence and see the value of her
own voice. Isabel traced her confidence directly to the InvenTeam™ experience which
illuminated the potential of IvE experiences as catalyst for positive change and growth in
students. I return to this topic in Chapter Six.

The Development Isabel’s Inventor’s Identity through Participation on the InvenTeam™

During the first interview, I asked Isabel if she considered herself an inventor. She
responded by saying:

I think so. I think especially after the MIT project and the InvenTeam. I think I’m an
inventor. We created something and I feel like we really tested our problem solving
skills. I think it might have even been that last month before we presented that I was like,
this is crazy, what we've been doing. I don't think I realized how big the stakes were and
how I formed a part of it, and I thought that was really amazing.

Isabel placed value on her own perception of her inventor identity when she said, “I think so”.
When she said this, she did not include the opinions of others as she positioned herself as an
inventor, and instead focused on her own beliefs. In saying “especially after the InvenTeam” she
provided her experience on the InvenTeam™ as evidence for why she “thinks” she is an
inventor. Isabel then situated herself as a member of a team of inventors when she stated, “we
created something”. She reflected on her being a “part of” the team and describes it as “really
amazing”. Like Ximena and Lesly, she also connected invention with problem solving when she said, “we really tested our problem solving skills”.

As I did with the other participants, I ask Isabel, “So what is an inventor?” She responded:

I think an inventor is anyone who, and it doesn't even have to be revolutionary, like we're going to get this patent. I think it's someone that is good at problem solving and someone who has their ideas, and they go forward with them. It's problem solving skills, it's the ability to create something new that makes you an inventor.

Isabel defined an inventor not only as a person or team seeking a patent, but more importantly as “someone who is good at problem solving who has their ideas and they go forward with them”. She defined inventors as those who create something new, and “it doesn’t need to be revolutionary”. Providing multiple conceptualizations of what an inventor is captures the duality of the word “inventor” for Isabel, which is something Ximena and Lesly also illuminate in their narratives.

In both quotes from this section, Isabel connected problem solving skills with invention. The link between problem solving and inventing is a topic all three participants discuss as they conceptualize invention and what it means to be an inventor. Additionally, all three of the participants define inventors as problem solvers. I expand on this topic in Chapter Six as I discuss the implications of my study for policymakers and educators and the importance of the language used in both policy and education surrounding IvE. In the following section, I introduce the importance of Isabel receiving validation from others as a theme which contributed to the development of an inventor’s identity.
How Receiving Validation from Others Contributed to the Development of Isabel’s Identity as an Inventor

Isabel and other members of the McKay InvenTeam™ were invited to speak to various organizations about their experiences. Isabel discussed the impact of speaking with others after the conclusion of the InvenTeam™ year and the validation she received through those speaking engagements. On one occasion, Isabel, Ximena, and Lesly were invited to speak about their experiences at the Lemelson Foundation in Portland. Isabel referenced the experience:

When we talked to the Lemelson Foundation, I always said my biggest weakness is my need for reassurance. I feel like I started off really needing that reassurance and feeling like if I didn't hear “good job”, I'm not doing a good job. I would doubt myself a lot, and I feel like later on, I started realizing that’s okay, my voice does matter.

When Isabel spoke at the Lemelson Foundation, she spoke about her own “weaknesses” and “her need for reassurance”. In the first section of Isabel’s narrative, I discussed the impact of the InvenTeam™ experience on her confidence and how it led to her seeing the value of her voice. In addition to the InvenTeam experience, the speaking engagements at the Lemelson Foundation also provided Isabel with the opportunity to realize “okay, my voice does matter”. Speaking to and receiving the validation of others contributed to Isabel’s own realization that there is value in her perspective and voice. She continued:

I feel like when I was speaking in front of people, I started realizing that, wow I did that and I feel like I'm smarter than I thought I was. I can do more things than I thought I could.

Through her speaking engagements, Isabel realized she is “smarter” and more capable than she previously thought. The above quote is evidence of the value of student’s speaking about their experiences and engaging in dialogue about their accomplishments. As Isabel’s narrative
captures, speaking about experiences may provide students with opportunities to reflect on their personal growth and to develop their ontological identities through discourse (Kelly et al., 2017).

Isabel again referenced speaking to the Lemelson Foundation and explained:

I think it was when we started talking to the Lemelson Foundation, and we were presenting in places that I was like, wait, this is actually really cool and hearing it from other people gave me validation that this is not something just anyone does. I’ve always imagined myself as a regular high school student. I think receiving that validation from adults and people in the field was really really cool. I think that the InvenTeam played a really big part of it.

Through the validation from others, Isabel was influenced to self-validate her own experience. Isabel explains that when she began speaking and presenting about her InvenTeam™ experience, it helped her realize her experience was unique and “really cool”. She highlights the benefits of receiving positive feedback from others when she stated, “hearing it from other people gave me validation”. Although Isabel positioned herself as a “typical high schooler,” she acknowledges her experiences on the InvenTeam™ was not a typical high school experience. Isabel described “receiving validation from adults and people in the field” as beneficial and said the InvenTeam™ “played a big part” in providing the opportunities for recognition and to receive validation.

Isabel’s description of the validation and recognition she received from the speaking engagements captures an example of the benefits of providing students with opportunities to share their experiences with adults and experts in the field. What Isabel shared about the importance of validation and recognition from others is consistent with the findings of Carlone and Johnson (2007) and their science identity model for women of color. The authors found being recognized as a “science person” by others contributed significantly to the development of a science identity. Similarly, when Isabel is recognized and validated as an inventor during her speaking engagements, it facilitated the development of an inventor’s identity.
Each time Isabel spoke about her participation on the InvenTeam™ she simultaneously constructed her own narrative and identity as an inventor (Riessman, 2008). Additionally, in speaking about the experience with the Lemelson Foundation, she was provided with opportunities to reflect on and engage in dialogue regarding her own personal growth and accomplishments. In the following section, I discuss how Isabel’s recognition of the value of non-STEM perspectives in inventing contributed to the development of an inventor’s identity.

Isabel’s Recognition of the Value of “Non-STEM” Perspectives in Invention Contributing her Inventor’s Identity

Although Isabel had always been strong in math, during our interviews she told me she does not think she would ever pursue a STEM major. She said she does not consider herself “a STEM person”. When I asked Isabel if invention is connected to STEM, she explained while STEM is an element of invention, invention is more about solving real world problems for people.

I feel like my passion for the cup was because I was meeting people that were like, oh my grandpa had dysphagia, my uncle had dysphagia. I think that’s where my passion really grew. I always said that it was because I loved math and I thought I was good at math, but I feel like the progress I made was not in how good I got at math or science or the 3D printing I learned. It was the progress I made in helping people.

Isabel explained her passion for the invention developed through meeting individuals who had family members affected by dysphagia. Isabel also acknowledged she previously believed her passion for the invention could be traced to her love of math or because she “thought I was good in math.” She continued, the most significant “progress I made was not in how good I got at math or science or the 3D printing” but “in helping people”. For Isabel, it was helping people which gave meaning to her work. She continued:
You can think of the real-world problem not through math, but through meeting people and discovering who the problem is being solved for. So, I think there’s definitely a connection with STEM because knowing math obviously helped us create the cup, but when you dig deeper and look into what problem it’s solving, I think it’s amazing to be able to get to know people and realize how big of a problem it can really be for everyone.

In the first sentence, Isabel explained real world problems arise through interacting with people who can shed light on the problems they encounter. She emphasized the importance of “discovering” for whom the problem is being solved. While she acknowledged the importance of understanding mathematical concepts in the invention of the cup, for Isabel it was “amazing to be able to get to know people and realize how big of a problem it can be for everyone”. Isabel’s self-positioning as “non-STEM person” emphasizes how engaging those who might not see themselves as “STEM people”, but who may see value in connecting with people and understanding how the problem affects people, can provide a different perspective.

Given Isabel positioned herself as an outsider in STEM, I was interested in what Isabel sees as her contributions to the team. When I asked her directly about what she contributed to the InvenTeam™ she explained:

I like to think I’m smart. I feel like I had smart ideas to bring to the table. At the same time, I feel I contributed a lighthearted energy, because I did not come in so invested in STEM. I did not come in knowing how to 3D model and I guess, the technical aspects. So, I feel like I kind of brought almost an outside view. I was able to use the common knowledge from just being a high school student and to bring those ideas to the table. I feel like maybe if I had already started doing MESA, for example, I would be a little more strict on myself.

While acknowledging her ideas and intelligence as contributions, Isabel also included “lighthearted energy” as a contribution she brought to the team. She attributed her “lighthearted energy” to her not coming into the InvenTeam™ “so invested in STEM”. Isabel said because she was not “so invested in STEM,” she contributed an “outside view” and that perspective allowed
her to put less pressure on herself throughout the InvenTeam™ year. Isabel said she contributed “common knowledge” as opposed to academic knowledge she might have gained through previous experience in STEM. She explained more about the contributions she made to the team as a result of her outsider perspective:

I think I was able to bring an outside perspective in a way. I remember giving some ideas, like, I don't know how we would make this happen, but I think it would work if we did this to the cup. Then that's where I came in and learned how to actually make it happen. But coming in, the ideas I was giving were solely based on what I think the person would need versus, like I wasn't given the opportunity to even think about how hard it was going to be to make it happen.

Isabel explained she brought “an outside perspective”, initially not knowing how the team would make her ideas happen. Isabel provided a unique perspective because she was not ‘boxed in’ by expectations gained through prior experience with engineering or STEM. She was able to think more creatively and envisioned possibilities which did not consider “how hard” it might be “make it happen”.

As the InvenTeam™ year progressed, Isabel “came in” and learned the technical skills required to design and print the cup and “make it happen”. She described “thinking about how hard it was going to be to make it happen” as an “opportunity”, which she eventually “was given” when she learned how to 3D design and print using computer-aided design (CAD). Despite not participating in extracurricular STEM activities before the InvenTeam™ and having no prior knowledge with 3D printing or CAD, Isabel designed and printed one of the final two prototypes of the cup which was presented at MIT.

By providing a “non-STEM” perspective, Isabel contributed ideas which were not limited by considerations of how the team would execute her ideas. Through engaging “outside” perspectives in STEM and invention, teams and classrooms gain access to the ideas of those who
can think outside the box and think more creatively. Isabel’s narrative also captures how students who are “non-STEM” people learn skills which are needed to “make it happen” and execute ideas in invention and STEM. In the final section of Isabel’s narrative, I describe how Isabel’s not comparing herself to others has contributed to her identity as an inventor.

How Not Comparing Herself to Others Contributed to Isabel’s Identity Work

When I asked Isabel what she would want others to know about her InvenTeam™ experience, she emphasized her desire to want other people to not compare themselves to others.

Even though it may seem that someone else is making more progress than you, you can't really compare yourself because everyone has different goals, everyone is different. I guess, don’t compare yourself to other people because you might not want to get to the same point they’re at, but you’re making that progress within yourself, and I feel like, even though I may not have made the progress that the person next to me did, I still am not at the point where I started.

In the above quote, Isabel explained you should not compare yourself to other people who are “different” and have “different goals”. She also acknowledged progress might appear different based on those goals when she said, “you might not want to get to the same point they’re at, but you’re making that progress within yourself”. She emphasized personal goals and progress as key to learning and becoming an inventor. She positioned herself as an individual who has made progress, even though she “may not have made the progress” of the people around her.

She returned to the importance of not comparing yourself to others again when she discussed her experience at the Young Entrepreneurs Business Week Camp (YEBW).

You can't compare yourself to other people, because I remember that summer after we went to Boston, we attended a summer camp. That's YEBW, Young Entrepreneurs Business Week and we would talk to people and they're like, Oh my God, I could never at your age. I think there's been so much progress with invention education being added
to younger ages and those opportunities are being given, but you can't compare yourself to other people because they may be at a different point.

Isabel and her teammates attended the YEBW camp the summer after the InvenTeam™ year. She explained while at the camp, she would talk to others who would say “I could never at your age” referring to her being an inventor. She added “there has been so much progress with invention education being added to younger ages” and she referred to IvE an “opportunity”. She again emphasized not comparing yourself to others, because “they may be at a different point”. By not comparing herself to others, Isabel thrived on the InvenTeam™.

Not comparing herself to others was important for Isabel as she developed her identity as an inventor. Her emphasis on personal goals and progress captures her understanding of how comparing her own progress to others was not helpful to her as she progressed through her educational journey. By focusing on her own goals and learning, Isabel developed her identity as an inventor at her own pace and in her own way.

Isabel’s narrative illuminates the potential of extracurricular IvE activities even in early grades to serve as a catalyst for building confidence in students and developing an inventor’s identity. Her story also underscores the benefits of students having the opportunities to speak about their experiences as inventors. The growth Isabel described, both internally and in the technical skills she learned, strengthens the argument for providing IvE opportunities to more students in schools at earlier grade levels throughout the United States. Isabel’s narrative also provides evidence for the need to engage “non-STEM” perspectives in invention and STEM. Finally, her statements echoing the need to avoid comparisons to others as an important element of becoming an inventor brings awareness for the need to emphasize personal goals and progress in IvE settings.
Synthesis of Chapter Four

In Chapter Four, I presented a thematic analysis of the narratives of each of the three participants to answer Research Question One, what are the life experiences of young Latina inventors which contribute to the development of an inventor’s identity? Each participant’s narrative provides insight into how the unique, contextual elements of their lives contributed to their development of an inventor’s identity. I identified themes unique to each individual narrative. The themes of these three Latina participants revealed the multifaceted nature of the development of an inventor’s identity which is shaped by individual, social, and contextual influences. At the same time, commonalities exist among the life experiences of the participants. The commonalities among the three narratives included the impact of the InvenTeam™ on the development of their identities as inventors, an understanding of inventing as problem solving, the importance of recognition from others when identifying as an inventor, and positioning family members as problem solvers or engineers, and a strength in math.

The first commonality among the three narratives is the impact of participating on the InvenTeam™ had on the development of their identities as inventors. Each girl described the experience differently, but all used the cup they invented with the team as evidence for why they identify as an inventor. When I asked each of them to define invention, all three participants conceptualized problem solving as inventing. As they discussed invention and how invention is connected to problem solving, all three young women also revealed the ambiguity and uncertainty surrounding the use of the word inventor. They acknowledged that inventors are usually thought of as “big names” and people who have earned patents, but they also conceptualized inventors more broadly, as problem solvers who create things.
All three girls discussed the importance of recognition from others in the development of their identities as inventors. As I discussed in Chapter Two, Carlone & Johnson (2007) found recognition from others to be one of the three foundational elements of science identity development for women of color. The other two elements of their model are performance and competence (Carlone & Johnson, 2007). Isabel described the benefits of being recognized as an inventor and receiving validation through the speaking engagements after the InvenTeam™ experience. Katrina’s recognition of Ximena as an inventor contributed significantly to Ximena’s decision to join the team and to the development of her identity as an inventor. Ximena also captured the importance of recognition from others when discussing her self-identification as an inventor. She explained she was hesitant to tell others she was an inventor because then she would have to tell them what she had invented. Although she invented the cup, she still hesitated to embrace her identity as an inventor, because of the possibility others would not consider her an inventor.

Of the three participants, Lesly was the only one to say she knew she was an inventor. Lesly said the reason she knew she was an inventor was because through her participation in MESA, she was a member of a community who recognized inventors as people who solve problems. Isabel said “she thinks” she was an inventor, and Ximena says “yes and no” when I asked her directly if she is an inventor. I posit that Lesly’s identity as inventor has thickened to the point of “knowing” she is an inventor, because she has consistently been recognized as an inventor through MESA for over six years and because of her early and consistent exposure to IvE and engineering. My findings concur with authors in the field who have found the
ontological identity of students is established through discourse and interactions (Couch et al., 2018; Kelly et al., 2019).

All three participants demonstrated or spoke about a strength in math in their narratives. Ximena described herself as being strong in math and established a link between problem solving and math, which contributed to the development of her identity as an inventor. Isabel provided “being good in math” as her only prior experience with STEM, but she did not consider herself a “STEM” person and said she offered an “outside perspective” on the team. Isabel’s story provides evidence of the importance of engaging those who may not consider themselves “STEM people”, but instead are more interested in connecting with people and understanding how the problem affects people. While Lesly did not explicitly say she was strong in math, she was in all honors math courses in high school and is pursuing engineering at the university level which implied a strength in math.

Ximena positioned her dad and brother as engineers and problem solvers. Lesly and Isabel do not use the word ‘engineer’ when discussing their fathers, but they describe their fathers as problem solvers. During our pilot study, Isabel described her father as a problem solver who was constantly fixing things and improving things in her home. When I shared Ximena and Isabel’s description of their fathers as problem solvers or engineers with Lesly, Lesly agreed and said, “that is so true”. Ximena said many of her friends from Hispanic families also have parents who are engineers which illuminates the intersection of socio-economic status, ethnicity, and problem solving. She situated herself and her family as part of a group of people who solve problems on their own because of necessity. In doing so, she conceptualized invention
as socially contextual and underscored the relationship between invention and agency, first introduced by Calabrese-Barton (1998).

Inductive analysis of the narratives of each of the three participants revealed the different contextual elements of their lives which contributed to the development of their identities as inventors. Beyond the individual themes developed, analysis revealed commonalities between the three young inventor’s stories which raise additional implications for policy makers, educators, and researchers. In Chapter Five, I draw on CCW theory (Yosso, 2005) to present both deductive and inductive analysis of the participant’s narratives. Through theory informed analysis, I demonstrate how the participants drew on the different types of cultural capital in their development of their inventor identities.
CHAPTER FIVE: THEORY INFORMED FINDINGS

To answer the second research question, how do young Latina inventors draw on cultural capital in the development of an inventor’s identity? I utilized Yosso’s (2005) CCW theory to first conduct a deductive analysis of each of the participant’s narratives. Through this theory-informed analysis I sought to determine the different types of cultural capital on which participants drew throughout their development of an inventor’s identity. In Chapter Four, each participant’s narrative was presented in one section, separated from the narratives of the other two participants. Chapter Five is different because I separate the sections by the different types of CCW described in Yosso’s (2005) theory. I include examples from the participants’ narratives, toggling among the experiences of the young inventors to capture how they evoke cultural capital throughout their life experiences in each section. Following the deductive analysis, I then completed an inductive analysis of the three narratives to identify additional forms of cultural capital which have not yet been established in the field. The types of cultural capital the participants described intersect with one another and are not mutually exclusive. There is also overlap between the themes developed through the narrative analysis discussed in Chapter Four and the different types of cultural capital the young inventors illuminate through their stories.

While the sources of cultural capital I discuss in this chapter may not all link specifically to invention, all forms of cultural capital I include contribute to the overall growth and development of the participants. Including life experiences which might not connect directly to invention is consistent with bildungsroman narratives, which focus on the journey of identity development. By including life experiences beyond those which directly link to invention, I
provide a deeper understanding of the rich contexts of the participants’ individual and collective journeys and development.

Table 3 below indicates the different types of cultural capital as informed by CCW theory (Yosso, 2005) that each participant discussed as they shared their life stories. In my analysis, I do not include every instance of cultural capital that participants signaled through their narratives. Instead, I selected excerpts from their narratives as illustrative examples of particular kinds of capital, utilizing CCW theory (Yosso, 2005). In Table 3, the rows indicate the different types of cultural capital in Yosso’s CCW, and the columns indicate the different participants.

Table 3
Types of Cultural Capital Demonstrated by the Participants

<table>
<thead>
<tr>
<th>Type of Cultural Capital</th>
<th>Ximena</th>
<th>Isabel</th>
<th>Lesly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social capital</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Aspirational capital</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Navigational capital</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Linguistic capital</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resistant capital</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Familial capital</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Risk taking capital</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Hustle capital</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

The first six types of cultural capital included in the table are based on Yosso’s (2005) CCW theory. I performed deductive analysis of the narratives of the young inventors to identify how each of them drew on the various kinds of capital throughout their life stories. All three participants demonstrated how they drew on the different forms of cultural capital Yosso (2005)
described. Ximena was the only one who also demonstrated the importance of the linguistic capital.

Following deductive analysis based on Yosso’s CCW theory, I further identified the final two kinds of cultural capital through inductive analysis which are included in the last two rows of Table 3. The new forms of capital I added from the inductive analysis of participant narratives include risk taking capital and hustle capital. The following sections are organized by the kinds of capital listed in the table. In each section, I connect illustrative examples from the narratives of the participants with the kinds of cultural capital listed in the above table. In presenting the first seven kinds of capital, I also briefly review Yosso’s (2005) CCW theory to demonstrate the lived experiences of the different forms of cultural capital as narrated by the three young women. The last two new forms of capital I uncovered through inductive analysis of participant stories do not yet have direct grounding in theory. The risk taking capital and hustle capital are my own extensions, developed through inductive analysis, to Yosso’s CCW theory.

**Deductive Analysis**

**Social Capital**

Yosso (2005) defines social capital as “networks of people and community resources” (p. 97) which provide support for individuals as they maneuver through society and its institutions (Yosso, 2005). Each of the girls described various sources of social capital throughout their interviews. The most prevalent sources of social capital the participants discussed were the educators they encountered throughout their educational journey, most notably their high school math teacher and InvenTeam™ leader, Katrina Hull.
As I described in Chapter Four, for Ximena, Katrina encouraging her to join the team and positioning her as “an inventor” and “an engineer” was a major theme which contributed to Ximena’s development of her inventor identity. Ximena traced her development of an inventor’s identity directly to Katrina’s involvement in her life. Katrina also served as a source of social capital for the other two participants throughout their high school experiences and beyond. Katrina is a mentor and advocate for all three of the participants and each of them spoke about their connection with her and the impact she continues to have on their lives. In demonstrating the theory grounded analysis of how the teacher provided social capital for the three young inventors, I start with Lesly’s account of Katrina as a source of capital because of the opportunities she provided for students and helped Lesly navigate the college application process. I also describe how Katrina served a course of social capital for Isabel as Isabel progressed through high school and into college. I include an example from Ximena’s narrative which captured the role of a teacher in her elementary school serving as a valuable source of social capital for Ximena. I conclude the section on social capital with Lesly’s stories about how the Lemelson Foundation has impacted her life.

**Lesly on Katrina as a Source of Social Capital**

In our interviews, Lesly described Katrina Hull as “one of the closest people” in her life. Katrina was not only her geometry teacher and InvenTeam™ leader, but also the leader of the McKay High School Mathematics Engineering Science Achievement (MESA) club, where Lesly was a member. By providing opportunities and spaces for Lesly and other students at McKay to grow and develop, and by offering Lesly support during the college admissions and decision-
making process, Katrina served as a source of social capital for Lesly as she developed her inventor’s identity. Lesly was able to draw on Katrina as a source of social capital because of the relationship established throughout high school. Lesly explained:

She’s so passionate about her students and about providing opportunities to everyone around her and so driven and that has inspired me to be like that. That is why, you know, I talk about how I want to be an engineer, but I also want to be someone who, in the future, can provide opportunities for minorities, for the girls in STEM and people who are underrepresented in the fields of engineering and STEM. That's something that I already know that I will be doing no matter where my career takes me. That’s what I want to do and that stems from me seeing her constant drive to bring those opportunities to her community and to the people around her.

Lesly positioned Katrina as a source of social capital when she described her as a person who is passionate about “providing opportunities” for “everyone around her”. By providing “opportunities” for students, Katrina enhanced student access to activities that may make an impact and assist them in navigating their high school experience. Creating opportunities and access are aspects of social capital as conceptualized by Yosso’s (2005) CCW theory. By providing the opportunities to everyone, especially the underrepresented students, Katrina has “inspired” Lesly to provide “opportunities” for other minorities, girls, and underrepresented groups in STEM. While Katrina served as a source of social capital for Lesly, the teacher also inspired Lesly to become a source of social capital for other girls and minorities in STEM. Yosso (2005) explains that once students gain access to social capital, underrepresented students frequently utilize such social capital, and in turn, share the resources they have gained with their own communities. Lesly’s desire to become a source of social capital for underrepresented students in STEM is an example of her sharing resources she gained through her own experiences with her community (Yosso, 2005).
Lesly also drew on Katrina as a source of social capital as she navigated the college application and decision-making process. Yosso (2005) explained social capital is understood as drawing on contacts who can reassure students that they are not alone in preparing for college and acquiring scholarships. Below, Lesly described the guidance and advice Katrina offered during a difficult time in Lesly’s life.

My mom was in the hospital, and I needed to make a decision pretty much now. I talked to Katrina about it because I was freaking out and crying. At this point, my options were I would either go to OSU or Chemeketa, which is the community college five minutes away where I would get pretty much everything covered and I haven't heard back from scholarships yet. So, I talked to Katrina, and she said, accept the OSU, commit and worst case scenario, you don’t end up going and that's fine. I was really glad I had a mentor who could tell me this, or else I would have just not accepted and not gone.

In the above quote, Lesly described her teacher as a “mentor” who assisted her in the college decision making process. Such reference to mentoring exemplifies Yosso’s (2005) description of social capital as contacts who support students as they pursue higher education. Lesly recalled her mother being in the hospital during a time when she needed to decide where she was going to attend college. Lesly “talked to Katrina about it” and was “freaking out and crying”, signaling the level of trust with the teacher. Katrina’s support let Lesly know she was not alone (Yosso, 2005) in her college application and decision-making process. Lesly explained her options were to attend Oregon State University (OSU), although she had not heard back regarding scholarships, or to attend a community college close where the costs would be covered. Katrina made the suggestion to accept the spot at OSU and told her, “worst case scenario you don’t end up going and that's fine”. Using her knowledge of the college application process, Katrina provided advice to Lesly and reassured her as she transitioned to higher education. Trust, support, and reassurance of mentees and their decision-making processes are part of the social
capital Katrina shared with her students (Yosso, 2005). Lesly expressed she was glad to have a mentor to offer guidance during a difficult time in her life. If Katrina did not provide advice to Lesly, Lesly says she “would have just not accepted and not gone.” Lesly continued:

My thinking was that, I don’t know if I’ll be able to pay or not, so why would I commit? But she said, “Well, let's see. It's not a deal until you sign the contract, so you’re still good to go.”

Lesly was unsure if she would be able pay for college, and therefore questioned “why would I commit?”. Katrina told Lesly it was “not a deal until you sign the contract”, which changed Lesly’s outlook and encouraged her to accept a spot at OSU. Lesly found out a few weeks later she received a scholarship, which fully covered the costs of her education.

Katrina was a source of social capital because of the opportunities she provided for Lesly and other students. She also inspired Lesly to become a source of social capital for other underrepresented minorities in STEM. The advice and support Katrina offered affected Lesly’s college trajectory and provided the guidance Lesly needed during a critical time in her life.

Providing support, advice, and guidance are consistent with Yosso’s (2005) conceptualization of social capital. Katrina could offer this support because Lesly felt comfortable reaching out to Katrina and seeking her guidance. The above example from Lesly’s narrative captures how teachers can serve as valuable and ongoing sources of social capital for students when strong relationships are formed.

Isabel also spoke about Katrina and the support she offered both in high school and beyond. In the quote below, Isabel positioned Katrina as a source of social capital as Isabel
described an opportunity Katrina presented to her. Katrina was willing to connect Isabel with the Lemelson Foundation for a possible internship opportunity as Isabel moved forward through college and towards a career (Yosso, 2005).

I knew that I wanted to only go to community college for two years and then transfer to a university. I talked with Mrs. Hull in November (2021), and we had lunch and I met her baby for the first time, it was so amazing. We kind of talked about it, and I think we mentioned it junior year of high school, if I was to do an internship or something, with the Lemelson Foundation in Portland, and Portland State University is really close. So, she's like, “Whatever you need, we can talk to people. We can make something like that happen.”

Isabel recalled a lunch she and Katrina (Mrs. Hull) had a few months before the interviews for this study took place. During their lunch, they discussed if Isabel “was to do an internship or something with the Lemelson Foundation”, which is near Portland State University. Isabel shared the two had previously discussed the topic during her junior year of high school, which demonstrated Katrina’s long-term support for Isabel. Katrina told Isabel, “Whatever you need, we can talk to people. We can make something like that happen” which signaled Katrina’s willingness to connect Isabel to a larger network of support, which is evidence of her role as a source of social capital (Yosso, 2005). Creating potential opportunities and connecting students to networks of people and organizations aligns with Yosso’s (2005) description of social capital. Katrina’s use of the word “we” also provided reassurance for Isabel that she was not alone as she progresses through higher education, including considering internship options. Offering support and reassuring students they are not alone as they pursue higher education connects to Yosso’s explanation of social capital (Yosso, 2005). Additionally, Katrina and Isabel meeting to have lunch after Isabel graduated high school, is evidence of the positive relationship and continued support Katrina offered.
Isabel continued, “I was just like this is a new door that I didn't even think about until the last two months”. The conversation with Katrina provided “a new door” for Isabel she had not considered since high school. The “new door” Isabel described was a possible “opportunity” that Katrina provided to connect Isabel with people at the Lemelson Foundation. The teacher’s ability and willingness to connect students with larger networks is consistent with Lesly’s description of Katrina as a source of social capital. As Isabel continues through her educational journey from community college onto a four-year university, Katrina remains a source of social capital (Yosso, 2005). Through her willingness to connect Isabel with potential opportunities and networks of people at the Lemelson Foundation, Katrina served as a source of social capital for Isabel. Katrina also served as a source of social capital for Isabel when she reassured Isabel that she was not alone as she progressed through higher education (Yosso, 2005). By providing opportunities for students and offering her support and guidance for both Lesly and Isabel as they transition into higher education (Yosso, 2005) Katrina demonstrates how educators may serve as valuable sources of social capital for their students. Katrina’s relationship with the three participants was the foundation for her role as a source of social capital, which was made possible because the participants trusted Katina (Yosso, 2005). In the next section, I present another example of an educator serving as a source of social capital for Ximena.

Ximena on Ms. Ruiz as a Source of Social Capital

Katrina was not the only educator who served as a source of social capital throughout the participants’ educational journeys. Ximena described an educator from elementary school who
played a critical role as Ximena maneuvered through elementary school. Due to Ximena’s family moving school districts in Salem, Ximena began second grade at a new school. At the start of the school year, she was placed in a bilingual classroom where, as Ximena described, Spanish was the priority. Her mother volunteered at the school twice a week and established a friendship with a teacher named Ms. Ruiz.

She (Ximena’s mother) wanted to make sure that I was OK, so she would volunteer like twice a week at school, and she made a really good friendship with a teacher named Mrs. Ruiz. Mrs. Ruiz spoke with my mom and told her, I know that Spanish sounds like a good idea right now, but your daughter’s not learning any English right now. So, if you keep her in that class, when she reaches fifth grade, which is when they don't offer that class anymore, she’s going to struggle a lot.

Ms. Ruiz was a source of social capital for Ximena and her mother, because she offered advice and guidance regarding Ximena’s educational trajectory (Yosso, 2005). The reference to the friendship between Ms. Ruiz and Ximena’s mother, both Latinas, aligns with Yosso’s (2005) description of social capital, which emphasizes how members of communities of color can unite to offer support and guidance to one another. Ximena recalled Ms. Ruiz telling her mother it might seem like the right decision “right now” to keep Ximena in the bilingual classroom, but Ximena was “not learning any English”. Ms. Ruiz told Ximena’s mother the bilingual class was not offered beyond fifth grade and said if Ximena stayed in the bilingual class “she’s going to struggle a lot”. Based on Ms. Ruiz’s advice and because of the relationship and trust between Ximena’s mother and Ms. Ruiz, Ximena’s parents agreed to move her into a mainstream second grade classroom two months into the school year.

Ximena told me once she moved into “an English only classroom,” she started to learn English, an achievement I discussed in Chapter Four. Through Ms. Ruiz’s understanding of the structure of bilingual classes at Ximena’s elementary school and the friendship she established
with Ximena’s mother, the teacher was willing to share her own social capital with Ximena’s mother to help Ximena navigate through elementary school and develop the necessary knowledge in the English language Ximena would need to succeed in further education (Yosso, 2005). Although this experience does not tie directly to “invention” or the development of an inventor’s identity, it contributed in a significant way to Ximena’s educational journey.

Through offering support to students and mentees during decision making processes and by reassuring students they are not alone as they pursue higher education, educators at all levels may serve as instrumental sources of social capital for students. Establishing relationships and trust with students and their families can also provide a network of support for students as they maneuver through educational institutions (Yosso, 2005). When teachers establish meaningful relationships with students, they can provide advice and support based on the unique circumstances of their students’ lives, as Katrina and Ms. Ruiz did. Actors beyond the local school and community can also serve as sources of social capital for young Latina women. In the next subsection, I discuss the Lemelson Foundation as a source of social capital for Lesly.

**The Lemelson Foundation as a Source of Social Capital for Lesly**

The Lemelson Foundation served as a source of social capital for Lesly as she developed her inventor’s identity. The Lemelson Foundation is an organization and a community of people Lesly gained access to through her participation in MESA and on the InvenTeam™. Both organizations facilitated Lesly’s involvement in invention and engineering and provided her with opportunities to take part in the iterative and recursive processes of inventing. As I describe in
Chapter Four, Lesly explains her participation in MESA exposed her to IvE and “hooked” her on the idea of being an engineer.

Multiple times throughout our interviews, Lesly discussed the Lemelson Foundation and recognized the opportunities the organization provided for her multiple times throughout our interviews. As a result of her participation in MESA and on the InvenTeam™, Lesly was invited to speak to the Lemelson Foundation about her experiences. During Lesly’s visit, she thanked the organization for the opportunities they provided her. She described the experience below:

I just remember I got to talk to people in charge of the Lemelson Foundation. That was such a privilege, and I got to thank them for everything that they have done in my life because their programs, with LMIT and different invention education things they have done over the course of time that have impacted my life. I didn't even know it was the same organization until Katrina told me.

Lesly described talking to the Lemelson Foundation as a “privilege” and explained it gave her the chance “to thank them for everything they had done in her life”, which signaled her recognition of the opportunities the organization provided her with. Yosso (2005) described organizations providing opportunities for students from communities of color as a form of social capital in her life (Yosso, 2005).

When speaking specifically about Lemelson-MIT and the InvenTeam™, Lesly continued to express gratitude, “I am so grateful for the Lemelson-MIT program for everything, because it absolutely changed my life. And I grew so much in one year. I learned so so much after that experience”. As I described in Chapter Two, Lemelson MIT sponsors the InvenTeam™ program. Lesly explained Lemelson MIT “absolutely” changed Lesly’s life. The Lemelson Foundation served as a source of social capital throughout the development of Lesly’s inventor’s identity by connecting Lesly to a larger community of inventors, by providing opportunities to
Lesly through MESA and the InvenTeam™ which affected the development of her identity as an inventor (Yosso, 2005).

The various sources of social capital the participants described offered support throughout their educational journeys and contributed to the development of their identities as inventors. The greatest source of social capital for the participants were educators, while Lesly also discussed the Lemelson Foundation and the impact the Foundation and the programs it sponsored had on her life. The examples of social capital the participants described throughout their narratives provide evidence of how educators and organizations can function as social capital in the lives of Latina inventors. In the following section, I discuss resistant capital and how Ximena has drawn on resistant capital through the development of her identity as an inventor.

Resistant Capital

Resistant capital is defined as “those knowledges and skills fostered through oppositional behavior that challenges inequality” (Yosso, 2005, p. 80). All three of the girls discussed resistant capital throughout the (re)construction of their narratives, but Ximena was the most explicit in her description. Ximena spoke about resisting inequality within her own family in her pursuit to participate in sports and on the InvenTeam™. She also demonstrated resistant capital as she discussed the lack of critical thinking toys marketed towards young girls and the role gender norms played in her development of an inventor’s identity.
Ximena’s Participation in Sports as Evidence of her Resistant Capital

As I discussed in Chapter Four, Ximena’s participation in sports played a fundamental role in cultivating her growth mindset, which contributed to the development of her inventor’s identity. As she participated in sports, Ximena drew on resistant capital by demonstrating oppositional behavior in response to injustice (Yosso, 2005). In our first interview, she shared about defying her parents’ wishes when she decided to participate in sports in middle school and high school.

In middle school, I started to do sports; against my parents’ will, especially my mom’s. My mom, she didn't want me to do sports because she would say that as a woman I would get hurt. I got accepted into a weights class in middle school and that freaked my mom out so much.

Ximena explained she began to participate in sports in middle school, even though it was against her “parents’ will, especially my mom”. Ximena’s resistant capital of going against her parents’ wishes captured her oppositional behavior which challenged inequality (Yosso, 2005). Ximena’s mother did not want her to participate in sports because she was afraid Ximena would get hurt because she is a “woman”. Nevertheless, Ximena drew on resistant capital (Yosso, 2005) and continued to participate in sports and pushed back against her mother’s understanding of gender norms. Ximena continued to explain her resistance towards her parents and their understanding of traditional gender stereotypes in the quote below.

So, yeah, I think it wasn't until high school when I kind of started saying, oh no, it's my body, my choice. I love running. I'm passionate about it. I'm essentially pretty good at it. I have potential with it, I'm going to do it and they kind of had to give in and accept that I was going to be running for the rest of my high school.

Ximena recalled that by her high school years, she “started saying, oh no, it’s my body, my choice” in regard to her participation in sports. Ximena knew she was good at running, and she
was “passionate about it.” Ximena asserted she was “going to do it,” and her parents “had to give in and accept” her choice to be running for the duration of high school. Ximena demonstrated resistant capital in her actions and in her beliefs as she faced perceived injustice within her own family (Yosso, 2005). Below, I discuss how Ximena drew on resistant capital as she protected her InvenTeam™ experience from her parents.

**Ximena Protecting her InvenTeam™ Experience as Resistant Capital**

Given her parents’ response to her participation in sports, I was interested in what they thought about her participation on the InvenTeam™. When I asked her, Ximena smiled and said:

> I remember that I kind of didn't tell them until two months in. I knew that my mom wasn't really going to be okay with it. There are little things I had to learn to do with my parents. Like, if I made up my mind and I saw good in it for myself, I had to protect it before I told them about it, because then they would try to, especially my mom, would try to persuade me out of it.

Ximena drew on resistant capital as she kept her participation on the InvenTeam™ from her parents for the first two months. She explained she “had to learn” to “protect” what she saw as “good” for herself before sharing it with her parents. Ximena’s awareness of the need to “protect” what she saw as beneficial for herself is an example of her drawing on resistant capital despite her parents’ wishes and beliefs (Yosso, 2005).

Through the oppositional behavior of participating in sports and on the InvenTeam, Ximena challenged injustices and pursued opportunities she was passionate about (Yosso, 2005). Ximena’s opposition against her parents’ wishes is consistent with literature in the field which brings to light the conflict Latinas may face between developing their identities in STEM while
also being “good daughters” in the home (Rodriguez et al., 2019a). Below I present Ximena’s understanding of gender norms in inventing as a form of resistant capital.

Ximena’s Understanding of Inventing and Gender Norms as Resistant Capital

Ximena was the only participant to explicitly address gender inequality in inventing. She did this when she discussed gender norms in connection to critical thinking and invention. By offering a critique of the critical thinking toys marketed towards boys versus those marketed towards girls, she challenged the status quo and demonstrated resistance capital (Yosso, 2005).

I watched a TED Talk for a class, and it was a female mechanical engineer speaking about how females are much less exposed to critical thinking toys when they're younger, like Legos and it's very true because I didn't grow up with any of those things. I grew up with the very traditional toys for females and so, I think that had a huge influence because I didn't really start actually exploring inventing things until high school.

Although Ximena consistently and confidently refers to herself as a critical thinker throughout the interviews, she agreed with the video she watched for class and connected the speaker’s view to her own experience. Ximena said, “it’s very true” and shared she grew up with “very traditional toys for females”, such as dolls and a play kitchen. She acknowledged the “huge influence” the lack of critical thinking toys had on her development as an inventor because she “didn’t really start actually exploring inventing things until high school”. In the above example, Ximena drew on resistant capital as she demonstrated her awareness of inequity in invention and cited a lack of exposure to critical thinking toys for young girls as a possible reason (Yosso, 2005). She continued, “So, am I an inventor? I don't know. Maybe I just haven't been exposed to it enough to know.” In the above quote, Ximena demonstrated her understanding that an inventor’s identity is developed through repeated exposure to invention. Ximena’s understanding
that inventiveness is developed, as opposed to being innate, resisted stereotypes which depict boys as naturally more inventive or as possessing more natural critical thinking ability than girls (Yosso, 2005).

Ximena provided examples of actively challenging inequality through her actions as well as through ideas, which challenged stereotypes. The examples she provided align with Yosso’s (2005) conceptualization of resistant capital. Ximena actively challenged the beliefs of her family as she participated in extracurricular activities she saw as beneficial to herself. As Yosso explained in CCWT, each of the seven forms of capital intersect one with another. Social capital and resistant capital intersect in Ximena’s narrative as she pushed back against her families and chose to engage in running and track through her school. Resistant capital connects to aspirational capital, because the participants resisted stereotypes as they simultaneously aspired to accomplish their own goals as well as those of their parents.

Aspirational Capital

Yosso (2005) described aspirational capital as the ability to maintain hope when faced with real or perceived barriers. In this section, I include examples of the aspirational capital Lesly demonstrated individually while also including examples of Lesly’s and Ximena’s parents “dreaming of possibilities beyond their present circumstances for their children” (Yosso, 2005, p. 78). All three participants discussed experiences which captured examples of drawing on aspirational capital throughout the development of an inventor’s identity; however, Lesly discussed her aspirations and the aspirations of her family most explicitly.
The Aspirational Capital of Lesly and Her Parents

Although they did not have the opportunity to continue with their education beyond high school, Lesly’s parents aspired for their children to attend college. In sharing her story, she explained:

So, they got to high school and then they had to get straight into the workforce. However, that didn't stop them from knowing that their children, they wanted them to have an education. So even at a young age, I was in first grade or second grade and I knew I was going to go to college. That was just something that was in my heart. I did not know for what, but I knew that I wanted to make them proud.

Lesly began by sharing her parents “had to get straight into the workforce” after high school. Despite their lack of formal education beyond high school, it did not stop her parents from aspiring for their children to have the chance to attend college (Yosso, 2005). From a young age Lesly knew she was “going to go to college” and continued by stating “that was just something that was in my heart”. The above quote captured Lesly’s aspirations to attend college, as well as her parents’ aspirations for their children to “have an education” (Yosso, 2005). Lesly spoke more about her parents’ aspirations for their children:

Even though they didn't have that opportunity to continue studying, it never took it away from them that they knew they didn't want us to have to work while we were still kids and always, you know, we just pushed on in school, in school, in school and even my younger brothers are still doing that.

Although Lesly’s parents didn’t have the opportunity, they were committed to Lesly and her brothers not having to work while they were in school, so they could focus on their education.

Lesly’s and her parents’ aspirations illustrate Yosso’s (2005) description of how children within communities of color draw on the aspirational capital of their parents. In reference to her and her siblings, Lesly stated “we just pushed on in school, in school, in school”. Repetition of school three times emphasized the importance of school in their lives.
The aspirational capital of Lesly’s parents fostered an environment which valued education and provided time for Lesly and her brothers to commit to schoolwork. Lesly drew on the aspirational capital of her parents as she developed her own dreams and goals for her future (Yosso, 2005). The aspirational capital Lesly drew on throughout her educational journey was a source of support throughout the development of her inventor’s identity, starting in elementary school.

**The Aspirational Capital of Ximena’s Parents**

In our first interview, Ximena spoke about the experience of her family immigrating to the United States. Her father moved to the United States for work in the mid 1980s, while Ximena’s mother and siblings remained in Mexico. He traveled back and forth until Ximena, her mother and her brother moved to the U.S. when Ximena was in the second grade. Ximena explained why her older siblings moved to the United States with their father:

> When I was four my two older siblings, they moved here to the U.S. We dropped them off to stay with my dad, so that they could pursue an education and start their high school here and go on to college, which was the goal here in the U.S.

Ximena recalled traveling with her family and dropping off her siblings to live in the U.S. with her father “so that they can pursue an education and start their high school here and go on to college”. The above example captured the aspirational capital of her family when Ximena stated the “goal” of coming to the U.S., was for her older siblings to one day “go on to college” (Yosso, 2005). Like Lesly, although Ximena’s parents did not have the opportunity to attend college and pursue their education, their aspirations and “goals” were to provide those opportunities for their children (Yosso, 2005).
The aspirational capital the participants discussed interconnects significantly with familial capital, which I discuss in an upcoming section. The examples I provided from Lesly and Ximena’s narratives captured aspirational capital as the dreams and aspirations their parents had for their children to have opportunities the parents did not have (Yosso, 2005). The examples the participants shared also illuminated the importance of parents sharing their aspirational capital with their children, and the impact it can have on their educational journeys, specifically for Lesly. Lesly also drew on her own aspirational capital, which she demonstrated through her “hope” to attend college and the individual agency she enacted throughout her educational journey to achieve her goals.

Navigational Capital

According to Yosso (2005), navigational capital refers to the skills individuals from communities of color develop to “maneuver” through social institutions not designed for them. Each of the girls drew and continues to draw on navigational capital throughout their development of an inventor’s identity. I begin with Isabel as she described her experience navigating the challenges of balancing work and a full course load of classes. I also discuss the choices Lesly made during her first year at OSU to surround herself with people of color in engineering as an example of navigational capital.

Isabel Navigating Work and a Full Course Load of Classes

As I explained in Chapters Three and Four, because I had already met Isabel through the pilot study, our interviews were slightly different than the interviews with Lesly and Ximena. When I met Isabel for the first time for the pilot study, she was a senior in high school and had
just started working her first job at a popular fast-food chain in Salem. I started the first interview by asking her how she had been doing since the pilot study. She responded:

I think good. I've been still kind of in the same routine with community college and working. I've been a full-time student, like 12 credits, and that's been something weird to transition into especially because they're still, a lot of them that are online. It's been hard trying to balance it all. I feel like sometimes my mind is too much on work and I'm like, oh, I have these assignments due at the end of the day, I'm in school. But I think I've been doing a lot better.

Isabel was taking a full course load of 12 credits the first semester of her first year of college while also working. Isabel demonstrated navigational capital as she balanced her responsibilities as a student and an employee simultaneously (Yosso, 2005). While she said she was doing “good”, she acknowledged it was a challenge. Yosso (2005) explained students from communities of color possess a set of inner resources which contribute to their resiliency and can assist them when navigating through society’s institutions. Isabel demonstrated this resilience when she maneuvered both school and work. The above quote also emphasized Isabel’s agency within institutional constraints as she faced the challenge of balancing work and school as a form of navigational capital (Yosso, 2005).

Isabel balancing work and school is an example her drawing on navigational capital by maneuvering through two social institutions at once (Yosso, 2005). Her narrative also sheds light on the challenges students face when working and attending school fulltime (Yosso, 2005). Like Lesly, Isabel also drew on navigational as she navigated her first year of college.

**Lesly Navigating College as a Latina Majoring in Engineering**

Towards the end of our first interview, Lesly told me what she has been doing during her first year at Oregon State University. She illuminated various ways she drew on navigational
capital throughout her first year of college as a Latina engineering student. Below she explained what life is like in college:

> When I came here, I found an amazing community. I found opportunities. I found the Society of Hispanic Engineers and I'm going to the regional conference in a couple months. It's going to be crazy because I'm going to meet other Latinas who are working to be engineers.

During her first year of college, Lesly “found” ways to make the most of her first year. She “found an amazing community”, “found opportunities”, and “found the society of Hispanic Engineers”. Lesly’s repeated use of the word “found” illuminated her individual agency as she sought out the opportunities and people who now surround her. Yosso (2005) conceptualized navigational capital both as the agency individuals take as they navigate societal institutions, and the social networks “that facilitate community navigation through places and spaces, including schools” (p. 80). Lesly’s example captured both, the individual agency of seeking and finding, and the connections to the community.

Lesly continued to share about her first year in college:

> I chose to be surrounded by, let’s see, even the community I chose to live in on campus. The fifth floor of this building is reserved only for women in engineering, so first year women in engineering, which is crazy. Some of my closest friends are STEM majors.

Lesly “chose” to surround herself with other women in engineering by selecting a dorm and floor reserved for women in engineering, which is an example of her choices to seek out a community which would help her maneuver through college (Yosso, 2005). Through her own agency and making intentional choices to surround herself with a community of people of color in STEM. Lesly drew on navigational capital in her narrative (Yosso, 2005).

Isabel and Lesly both provided examples of how they drew on navigational capital as they maneuvered through educational institutions and or the workforce. The examples they
provided capture their resilience and the intentional choices they made which contributed to their current persistence in higher education (Yosso, 2005). In the following section, I discuss linguistic capital and describe Ximena’s experiences as both a source and recipient of linguistic capital.

Linguistic Capital

Ximena as a Source and Recipient of Linguistic Capital

Yosso’s (2005) CCW theory described linguistic capital as the social and linguistic skills students gain through exposure to multiple languages. Yosso’s (2005) conceptualization of linguistic capital positions bilingualism as an asset of students from communities of color. While all of three of the participants are bilingual and speak both English and Spanish fluently, Ximena was the only participant who discussed the role of linguistic capital in her narrative. When I asked Ximena what her role on the InvenTeam™ was, she described her various tasks and added, “Oh, another thing I brought in quite a few times was translating.” Translating for the InvenTeam™ provided Ximena with an opportunity to draw on her linguistic capital, which was her fluency in both Spanish and English and her translation skills (Yosso, 2005).

In addition to mentioning her role as a translator on the InvenTeam™, Ximena also discussed how the linguistic capital of fellow classmates played a role in her transition from a bilingual classroom to a mainstream English-speaking classroom as she was learning English. Ximena recalled her first memories in her new class when she made the switch in second grade.

I introduced myself to the teacher and the teacher said, “Oh, you don't speak English?” or something like that, and she said, “Who would like to translate?” and I see this little girl, raising her hand with a huge smile, and saying, “Me, me, me!” I turned around and she came up to me, she's like, “Hi! My name is Perla!” She was my translator for the rest of
the year. Whenever I needed to take a test, she would come with me, and she would translate for me and so she was a huge part of my second grade year.

The above quote captures how the linguistic capital of Perla, another Spanish speaking student, who helped Ximena as she was learning English. Ximena positioned Perla’s fluency in Spanish and translation skills as assets and valuable forms of linguistic capital. Yosso (2005) described translating as a form of linguistic capital and a common practice for students from homes where English is not their native language. Ximena benefitted from having Perla translate for her. By having students serve as translators for their fellow students, educators place value on the linguistic capital bilingual students bring to the classroom.

Although Ximena did not discuss linguistic capital at length in her narrative, she highlighted the value of bilingualism. In sharing her contributions as a translator on the InvenTeam™ and her experience with Perla as her translator, Ximena illuminated the linguistic capital students bring to classrooms throughout the United States. Ximena’s example also provided an example of how the linguistic capital of bilingual students can be drawn on to support fellow students who are learning English. Many students bring linguistic capital to classrooms which they have developed at home through interactions with their families and members of their communities. Positioning the bilingualism and exposure to multiple languages as assets in schools also provides opportunities for educators to connect with the families of students who are typically marginalized in academic settings.

Familial Capital

Yosso described familial capital (2005) as “cultural knowledges nurtured among familia that carry a sense of community, history, memory, and cultural intuition” (p. 81). All three
participants spoke extensively about their families and the familial capital the participants drew on throughout the development of their identities as inventors. Given the prevalent role family played in the narratives of the participants, there is also a great deal of intersection between themes I developed in Chapter Four and familial capital. For example, the support of Lesly’s parents and their dedication to her education is a major theme in her development of an inventor’s identity. Ximena positioning her brother and father as natural engineers and problem solvers was also a theme which contributed to the development of her inventor’s identity. In this section, I focus specifically on the role of the siblings of the participants as both recipients and sources of familial capital.

Lesly as a Source of Familial Capital for Her Younger Brothers

As the oldest of three children, Lesly saw the impact her participation in MESA and the InvenTeam™ had on her younger brother, Oscar, and his development of an inventor’s identity. She also served as a role model for her youngest brother, Brandon, by being the first member of their family to attend college. A middle schooler at the time, Oscar, frequently joined Lesly for InvenTeam™ meetings, particularly during the Saturday sessions. Lesly recalled:

Katrina said to me, “Remember when Oscar would come with you like every other Saturday? Every time he would go he learned how to solder in what, seventh grade, eight grade?” and I was like wait, you're right, because I learned how to solder in my sophomore year, but he learned in his eighth grade or seventh grade year, and that got him really excited for high school and for what was for him, you know, kind of how I was that person where I was asking, what do you have for me? Now, that was his question.

Katrina brought to Lesly’s attention that through Lesly’s participation on the team, Oscar was exposed to invention and “learned to solder” as a middle schooler. Lesly served as a source of
familial capital for Oscar as she modeled the practices of inventors and shared access to education with Oscar when he would join her for InvenTeam™ meetings (Yosso, 2005). By Lesly bringing Oscar along to meetings, she provided opportunities for Oscar’s early exposure to invention. Lesly encouraged Oscar was to seek out opportunities to further his learning and education. Lesly served as a source of familial capital for Oscar by modeling the practices of inventors, providing access to educational opportunities, and being an example of a person who seeks out opportunities to learn more (Yosso, 2005). Following in Lesly’s footsteps, Oscar joined MESA in middle school and is still currently a member of MESA at McKay High School.

Lesly emphasized her understanding that her own experiences will not only impact her, but also her family. She explained:

My experiences don't just impact me. It provides even more opportunities for the next generation because even then, for my brother, you know, like even in my family it has made a generational impact, where it's not even that, my kids will become engineers, it’s that my brother will probably become an engineer or something in the STEM related fields.

Lesly recognized her experiences “don’t just impact” her, and they “provide even more opportunities for the next generation.” The above quote signaled Lesly’s understanding of the familial capital she has provided for her brother through her example (Yosso, 2005). Consistent with Yosso’s (2005) definition of familial capital, Lesly acknowledged the “generational impact” her own participation in IvE had on her brother. Lesly’s experiences with engineering and invention provided an example for her younger brother which served as familial capital in his own educational journey and potential development of an inventor’s identity. As we continued to discuss the impact Lesly’s experiences had on Oscar, she also brought up her youngest brother Brandon.
I’m assuming his experiences will be much different than mine because not only is he the youngest, but we’re about ten years apart. So, I didn’t have an example of somebody who went to college in my immediate family. My extended family only a couple of my cousins decided to go to college or secondary school, so he’s going to have a completely different experience in those terms.

Lesly predicts Brandon’s educational experiences will be different from hers, because Lesly did not have an example of someone who attended college in her immediate family.

Lesly was a source of familial capital for her brothers by providing Oscar with access to education through MESA, modeling invention, and by setting an example of attending college for both of her brothers. The familial capital Lesly shared with her brothers has already made a “generational impact” evidenced by Oscar’s continued participation in MESA and IvE. In the next section, I discuss Isabel’s siblings as a source of familial capital throughout her educational experience.

Isabel’s Older Siblings as a Source of Familial Capital

Isabel’s siblings were a source of familial capital throughout her experience in school and during her participation on the InvenTeam™. Isabel explained how and why her older siblings supported her participation in extracurricular activities.

So, the three oldest siblings, they’re right now, 30, 29 and 27. They were close in age and my parents had a gap and then they had me and my other brother, who are 20 and 19. I think with my oldest siblings, it was hard for them because at that point, my mom didn't drive either, so they would have loved to do these after-school sports and activities, but they weren’t able to.

When Isabel’s older siblings were in school, they could not participate in after school activities and sports because Isabel’s mother didn’t drive. Because Isabel’s siblings did not have the opportunity to participate in extracurricular activities, they encouraged both her and her brother
closest in age to participate and offered their support, serving as a source of familial capital for them (Yosso, 2005). Isabel explained:

They're always like, if you guys want to do an activity, you let us know. They signed us up for orchestra and band in elementary school. They were like if you guys want to do this, they supported it 100%. So, they bought our instruments. They’ve always been very present in that, and they've liked us taking advantage of the opportunities that school has given us and we're really thankful for that.

Recognizing the benefits of extracurricular activities, the older siblings encouraged Isabel to participate in extracurricular activities, paid for her instruments, and “supported her 100%”. Support from family members and reassurance they are not alone in their pursuits is a form of familial capital (Yosso, 2005). Isabel’s siblings contributed to her educational development by encouraging her to take advantage of the opportunities (Yosso, 2005) offered through the school, such as the InvenTeam™.

When I asked Isabel who in her family supported her throughout her participation on the InvenTeam™. She explained:

It was definitely my brother Juan. He's the second oldest. He was always like, you let me know when you need me to pick you up, like if you need to go someplace. They played a really big role for us, and I feel like without them we would have not lived our high school years to the fullest like we did. So, I think we’re really thankful for them and I think my older brother for me, played a bigger role.

Isabel positioned her older brother Juan as her greatest source of support during the InvenTeam™ experience. This example is evidence of the impact support from siblings can have on the educational experiences of each other. By encouraging Isabel to participate in activities, supporting Isabel, and reassuring her she was not alone, her siblings, particularly her older brother, were valuable sources of familial capital for her (Yosso, 2005). Above, I focused specifically on the siblings of the participants, as both recipients and sources of familial capital to
illuminate the impact siblings may have on one another’s academic trajectories and identity development.

**Inductive Analysis**

Above, I presented a deductive analysis based on Yosso’s (2005) original CCW theory. In this section, I present an inductive analysis of the three narratives in which I identified two additional types of cultural capital which may build on CCW, but have not yet been identified in the literature. In the following two sections, I describe the two additional types of cultural capital the participants evoked throughout the development of their identities as inventors. I introduce risk taking capital and hustle capital as important sources of the young Latina women’s identity work as inventors.

**Risk Taking as a Form of Cultural Capital**

Throughout the interviews, each girl spoke frequently about different risks they took throughout their educational journeys. Many times, these risks included “saying yes” to opportunities the participants encountered. Isabel also explicitly used the term “risk” when she discussed the benefits of exposing IvE to children in schools. I define risk taking capital as the willingness to take on a new or unfamiliar experience, which may or may not lead to potential benefits. Below, I introduce risk taking capital as an additional form of cultural capital the participants drew on throughout the development of their identities as inventors.
Lesly on “Saying Yes” to Opportunities

In our interviews, Lesly introduced the idea of “saying yes” to opportunities and discussed how “saying yes” has affected her life and has the potential to affect others as well. As Lesly reflected on where she is today, she explained:

It's crazy to think it all stems from one opportunity, one yes that I said, almost six or seven years ago. I realized when I say yes to one thing, it becomes a yes to another thing and I guess another thing that eventually kind of keeps the ball rolling and creates better opportunities for me, for my family and for my community.

Lesly explained through saying yes, multiple opportunities have been created for her, her family, and her community. The above quote is evidence of Lesly’s recognition of the greater implications her own risk taking and “saying yes” has on those around her. She continued, “My story is only the tip of the iceberg. There are so many more things that the future generations will be able to do if people just continue to say yes to opportunities.” Lesly acknowledged her story is “only the tip of the iceberg” and followed up by noting the impact on “future generations …if people continue to say yes to opportunities.” Lesly demonstrates her understanding how risk taking and choices to “say yes” set the groundwork for “future generations” to continue to take risks. In this way risk taking is not only an individual action, but also a form of cultural capital with potential impact for the larger community. Isabel also explores the idea of “saying yes” as a form of risk taking cultural capital.

Isabel on “Saying Yes” to Opportunities

In Isabel’s narrative, she also brought up the importance of “saying yes” to opportunities. She presented “saying yes” to the InvenTeam experience as an example of such risk taking capital.
I remember I was talking to Mrs. Hull about saying yes to opportunities and while some opportunities we have to say no to, if we had Mrs. Hull say that yes to apply for the grant for us, then the students that formed part of it, they gave that yes to the opportunity that was placed in front of them. I feel like with the more opportunities that are given, it’s so valuable to anyone growing up in the public school system.

Isabel illuminated the importance of multiple people, in different positions, saying yes to opportunities. She did this by acknowledging “that yes” that Katrina, an educator, modeled when she applied for the InvenTeam grant, and then “that yes” from the students who became the participants on the InvenTeam™. Isabel explained “saying yes” to opportunities is “so valuable” to anyone growing up in the public school system. Taking advantage of opportunities offered through public schools is particularly relevant to those students whose families cannot afford to pay for students to participate in extracurricular activities, which is common barrier students from underserved, Latinx communities face (Simpkins et al., 2011).

Isabel, like Lesly, also recognized the benefit “saying yes” can have on those around her. In the following excerpt from our second interview for this study, she discussed how “saying yes” to the InvenTeam influenced the future students at McKay.

I feel like I always compared McKay to the other schools that get bigger budgets, and they have better things, but that was able to come out of McKay. I think that was really important and it shows that even though it’s a Title One school, this little girl that’s going to her first day of freshman year, she can do that too.

Isabel recalled comparing McKay to schools with “bigger budgets” who have “better things”. She referred to the InvenTeam™ when she said, “that was able to come out of McKay.” That, the InvenTeam™, became possible because of multiple people “saying yes” to opportunities, as Isabel captured in the previous quote. She believed “that was really important” because it showed even though McKay is a Title One school, it was a place where a “little girl that’s going to her first day of freshman year” can also have the chance to “say yes” to opportunities such as
the InvenTeam™. Katrina taking the risk of “saying yes” to apply for the grant, and the students in Isabel’s, Lesly’s, and Ximena’s group taking the risk of “saying yes” to the InvenTeam™, opened opportunities for future students at McKay to see they “can do that too.”

Both Lesly and Isabel describe the importance and potential impact of “saying yes” to opportunities. They show how taking a risk and saying yes to opportunities without knowing what the opportunity entails can create benefits not only for the individual or the group involved, but also for the larger community and future generations of students. Just as saying yes to opportunities is risk, so is implementing IvE in schools. As Isabel describes below, many people may see IvE as a risk because of their lack of familiarity with the language use in IvE. In the following section, I discuss Isabel’s conceptualization of IvE as risk and what she thinks people in schools should know about IvE.

Isabel Describing Invention Education as a Risk

Isabel is the only participant to explicitly use the word “risk” in her narrative. She does so when I ask her what she thinks people in schools should know about IvE. She described IvE as a risk, but one educators and parents should be willing to take because of the potential benefits for their students. She also advocated for earlier exposure to IvE for both students and parents. She used her own experiences with IvE as evidence of the potential benefits and justification for taking the risk. Below, she described how IvE served as a “change” in her own life and why it would benefit students to be exposed earlier.

If it took me until high school, it can be that change for someone in middle school, it can be that switch. I don’t know if I would go into a STEM major, but it that could be the switch for someone else, that they didn’t even know they had.
Isabel described IvE as an experience which provided a “switch” and a “change” for her. She explained although she was not exposed to IvE until high school, IvE could be the “change” for other students earlier if they are exposed to IvE in younger grades. Although she doesn’t know if she would go into a STEM, she believes participating in IvE could be a “switch” for other students and an opportunity to expose them to new possibilities. Couch and colleagues found young women shifted their mindsets on STEM and engineering and saw themselves in new ways after participating on an InvenTeam™ (Couch et al., 2019). Isabel used her own positive experience with IvE as evidence for why it should be introduced earlier in schools. She continued to discuss the advice she would give others about IvE:

I think it’s relatively a new field that’s coming into schools. I guess I would advise them to not be scared to take that little risk, like even though maybe parents, when they were in school, they weren’t seeing that, I think it’s valuable for their kids to see their parents support them if they want to participate in extracurricular and if they want to try these new things, if they want to learn more. If they have the means to do that, I think it would be very helpful.

Isabel described IvE as a “new field” which is “coming into schools” and advised people in schools to “not be scared to take that little risk”. Isabel then connected the idea of IvE as a risk to parents “not seeing” IvE when they were in school. She posited that “even though” parents might lack exposure to IvE, it is “valuable” for kids to see their parents “support them” if they want to participate in extracurriculars. She expands on the need to expose parents to IvE below.

I think it’s amazing to be able to do it early on. So, growing up with Mexican parents, I feel like sometimes they don’t trust, like, oh you’re staying after school this much, what might you be doing? So, it was nice to have my brother and I feel like if at the same time parents are being exposed to it, I think that would be really great for the child and I feel like that could make the parents trust the child a little more and realize they are doing something cool.
Isabel again advocated for exposure to IvE “early on”. She then connected the topic back to her own experience as the child of Mexican parents. She expressed, at times, Mexican parents might question why their child would be staying after school. She again referenced the support of her brother and said if students were exposed to IvE earlier, it could provide more opportunities for parents to be “exposed to it”. According to Isabel, if parents are exposed and understand what IvE is, they are more likely to trust the experience will be valuable for their child.

As I discussed in the familial capital section, Isabel’s siblings, particularly her oldest brother Juan, were her biggest supporters during her InvenTeam™ experience. She believed the reason her siblings were willing to support her and encouraged her to participate was because they did not have the opportunity to participate extracurricular activities when they were in school. As Isabel told her own story, she advocated for other students to be exposed to IvE. At the same time, she illuminated the importance of exposing parents to IvE, because they might be unfamiliar with it and see it as a “risk”. Isabel continued to discuss IvE as a risk:

*I think even though it might seem like a little risk in the beginning, I think it’s important to motivate your kids to want to learn and to want to participate and like for me I think of how valuable the experience was for me and I would want other kids to participate in that and other students to delve into a field that maybe they thought they could never.*

Isabel positioned IvE as a risk, and as way to “motivate” kids to want to learn and participate. Isabel also expressed her desire for other children to experience IvE, because of the positive impact it had in her own life. She also positioned IvE as an opportunity for students to participate in a field they had not previously considered.

As I discussed in Chapter Four, Isabel’s participation in IvE became a source of confidence and a “valuable experience” for her, which was only possible because she took the risk and said yes to the opportunity. Saying yes to opportunities is one form of risk taking capital
demonstrated throughout each of the participants’ narratives and not addressed in Yosso’s CCW. Given her positive experience with IvE, Isabel believed exposing children to IvE earlier in their educational experience has the potential to create opportunities for other students to develop and grow, as she did. Isabel also raised the issue of exposing parents to IvE, because it is a new field and because some parents might not be familiar with what is required to participate in IvE activities, including staying after school for meetings and inventing work. She predicted that if parents gain a better understanding of IvE and what it requires, they are more likely to trust and support their children’s participation.

While I do not include specific examples from Ximena’s narrative in this section, her story in its entirety embodies risk taking capital. Many times, throughout Ximena’s narrative she described taking risks, including the risk of entering a mainstream English course without speaking any English midway through the second grade, her decision to participate in sports despite her mother’s objection, and her willingness to “say yes” to the InvenTeam™ experience. In the following section, I present hustle capital as an additional form cultural capital the participants made visible throughout the development of their identities as inventors.

**Hustle as a Form of Cultural Capital**

During my pilot study with Isabel in 2020, Isabel used the word “hustle” multiple times throughout our interviews. It struck me because during my work as a research assistant on the ethnographic study with the McKay InvenTeam™, the team historian, who was a close friend of Isabel’s, also used the word throughout our interviews. When Isabel and the team historian used the word, they seemed to use it to signal a person exerting hard work in an effort to accomplish a
goal, but I never asked them to clarify at the time. As I read through the transcripts of the first interviews with the participants, I noticed Lesly or Ximena never explicitly used the word “hustle”. However, all of the girls include examples from their experiences consistent with the hard work exerted to reach a goal consistent with the way Isabel had previously used the word.

Merriam-Webster (2022) dictionary defines hustle as “effort and energy in playing a sport” as well as “energetic activity”. It provides an additional definition of hustle as a verb, meaning “to make strenuous efforts to obtain especially money or business”. Based on the conceptualizations provided by the participants and the preexisting dictionary definitions of hustle, I reconceptualize hustle in an academic context as effort and energy exerted to learn and achieve a goal. I introduce academic hustle as a form of cultural capital each of the participants relied on throughout their stories.

Isabel on Hustle as a Form of Cultural Capital

Given it was Isabel who introduced me to the concept of hustle in an academic context, I wanted to learn more about what the word meant to her. Towards the end of our first interview, I asked her to define the word hustle for me. Below is her response:

So, when I think of hustle, I think of just looking for more things and seeing how I can take advantage of that moment to learn something new and do something new I feel would add value to my life.

Isabel defined hustle as taking advantage of opportunities to learn and do new things which would benefit her. Isabel then provided an example of her parents at work to expand on her conceptualization of “hustle”.

The job my dad has, and my mom; I can still see that hustle. They are actively trying to learn new things and they’re actively trying to better themselves and go up steps in the
company they’re in. I think I learned that from them, that you can’t really do the bare minimum.

Isabel connects hustle to her parents and explains she can “still see that hustle” in her parents as they are “actively trying to learn new things” and better themselves at their jobs. She acknowledged her parents taught her “you can’t really do the bare minimum”, which captures the intersection between familial capital and hustle capital. Isabel continued, “I guess it’s not doing the bare minimum. My manager actually said once, she was like, “I just know your parents are like hustlers, and I just know that they taught you to work hard”’. Isabel connected her own hustle to the example set by her parents. She shared her manager at work also recognized Isabel’s hustle and made the assumption that her parents are “hustlers” who “taught her to work hard”.

Isabel continued to discuss her family as an example of hustle in her life.

I feel like that was always ingrained in me that I can’t always do the bare minimum and I should try to exceed what I’ve done before and only go up from there. So, I feel like when I think of what my family has taught me, it has always been like you only live once. I should waste no time to try to improve and try to get better than I was before.

Isabel described feeling as if “that was always ingrained” in her to not “always do the bare minimum”, which signaled the impact her family’s hustle has had on her development. She explained her family taught her she should “waste no time to try to improve and get better than I was before.” Isabel’s conceptualization of hustle and the examples she provided capture the influence of family members in instilling a sense of hustle in their children.

Lesly on Hustle as a Form of Cultural Capital

During our second interview, I brought up the idea of “hustle” with Lesly and I asked her what hustle was to her; she replied:
You know, specifically for my dad right now, he sometimes has to work late nights. He sometimes has to sacrifice sleep, but he’s always on top of things. He also understands. I think that’s another reason why they were so supportive as well, because they understand the hustle, like always have to be doing something. He said when you have a luxury, you have to take advantage of it. I also felt that bit of pressure, but it’s the truth.

Lesly positioned her father as someone “who understands the hustle” and sacrificed for his family. She posited because her father understood “the hustle”, he was supportive of her own experiences. In the third sentence, she equated hustle to “always having to be doing something”, which connected to Isabel’s conceptualization of hustle as “not doing the bare minimum.” For Lesly, hustle is linked to taking advantage of luxuries you are provided with, in her case, the luxury of education her parents did not have.

Beyond our discussions which focused specifically on the word “hustle” and what it meant it her, Lesly also described herself as a learner who actively seeks out an understanding of how things work. In doing so, Lesly provided evidence of her own “hustle”.

I enjoy learning how things work, and if I don’t understand it, I want to learn how to until I do know. I think that’s just how my mind works, just because my parents have always told me there’s always something to learn so don’t be sitting on your butt watching TV. There’s always something to learn.

Lesly said she enjoys “learning how things work” and if she doesn’t understand how they work, she wants to “learn how until” she understands. The example Lesly provided is consistent with hustle defined as the energy exerted in an effort to learn or achieve a goal. She stated, “that’s just how my mind works”. Like Isabel, Lesly attributed her “hustle” to the influence of her parents, who have always emphasized there is something to learn.

Isabel and Lesly provided examples of hustle as a source of cultural capital throughout their narratives. Although I do not include any specific examples in the section on hustle capital from Ximena’s narrative, because like risk taking capital, Ximena’s hustle is a consistent thread
throughout her narrative made visible through her life experiences. Ximena’s narrative captures her hustle through her dedication to learning English, willingness to push herself in running and track, and her desire to learn and contribute in any way she could to the InvenTeam™. The hustle capital of all three participants and the hustle capital leveraged by their parents facilitated the development of their identities as inventors by encouraging them to work hard in their efforts to expand their learning and to take advantage of opportunities which could benefit them. Their families modeled hustle for these young women through their hard work, willingness to learn and improve, and in doing more than the “bare minimum”, which the participants brought with them and noted within their own experiences.

Hustle capital and risk taking capital, described above, are two forms of cultural capital this dissertation’s analysis can add to the CCW theory Yosso proposed in 2005. By expanding on Yosso’s (2005) CCW theory, I offer two new perspectives of how students draw on their cultural capital throughout the development of their identities as inventors. The two types of cultural capital I identified through inductive analysis in Chapter Five provide additional evidence of the assets Latina students contribute to invention. Through taking risks and demonstrating hustle, the participants strengthened their identities as inventors.

**Synthesis of Chapter Five**

In Chapter Five, I first presented a deductive analysis of the narratives of the three participants in order to identify the different types of cultural capital they draw on based on Yosso’s (2005) CCW theory. In the second part of the chapter, I introduced two additional types of cultural capital I identified through inductive analysis. The first was risk taking capital and the
second was hustle capital. As Yosso (2005) explains, the types of capital she introduced in her theory intersect with one another and are not mutually exclusive. The additional types of capital I introduced extend on Yosso’s theory (2005) and to intersect with each other and with the original types of cultural capital described in CCW.

Familial capital and social capital were the most prevalent sources of cultural capital which the participants drew on. Familial capital intersected the most with the other types of capital the young women described. Lesly traced her aspirational capital directly to her parents as did Ximena when she shared the aspirational capital of her parents in her narrative. Scholars in the field confirm the important role families play in the development of STEM identities for Latina students (Mercédez, 2015; Rodriguez et al., 2019a). Hustle capital also intersected significantly with familial capital, as both Lesly and Isabel use their parents as examples when I asked them to define hustle.

Social capital was prevalent as evidenced by educators who were a valuable source of social capital for the participants. All three young women discussed the role Katrina played as a source of social capital in their development of inventor identities. Social capital also intersects richly with navigational capital, as educators helped the participants navigate their way through schooling, academic growth, extracurricular opportunities, and educational institutions. For example, Katrina helped Lesly navigate the college admission process and continues to help Isabel as she navigates her way through college. Ximena also includes the example of Ms. Ruiz, who helped her successfully navigate her transition from a bilingual classroom to a second grade mainstream English-speaking class. Lesly also included the Lemelson Foundation as a source of social capital which affected the development of her identity as an inventor.
Ximena was the only participant to discuss resistant and linguistic capital in her narrative. Her resistance against her parents’ wishes for her to not participate in sports and her need to “protect” the InvenTeam™ experience reflects a larger theme identified by scholars in the field, which is the conflict between developing STEM identities and being a “good daughter” (Rodriguez et al., 2019a). Rodriguez and colleagues (2019a) found complications arose from Latina students’ unwillingness to identify with traditional gender roles within the home as they developed their STEM identities.

The potential conflict between being a “good daughter” and the development of an inventor’s identity is also connected to Isabel’s desire to educate more parents on IvE because of their lack of familiarity with the emerging field. She explained if parents knew more about IvE, they would trust the experience and their children more. Although parents might view IvE as a risk, Isabel explains it is worth engaging parents and educating them on IvE because of the benefits for students, citing her own experience as an example. Isabel also makes the case for exposing students to IvE earlier in schools, again providing her own story as a justification for her reasoning.

Through their unique life experiences, each young woman evoked various forms of cultural capital in different ways as they developed their identities as inventors. By identifying the various forms of cultural capital the three participants discussed in their narratives, I illuminated the assets Latina students bring to invention. Additionally, by introducing novel forms of cultural capital the students demonstrated throughout the development of their identities as inventors, I offer a new perspective in exploring the assets and cultural capital Latina students bring to invention.
CHAPTER SIX: CONCLUSION

By examining the narratives of three young Latina inventors, my dissertation offers a new perspective in understanding the life experiences of Latina students who have participated in IvE. I illuminated the assets Latina students bring to invention and demonstrated how the young inventors evoked their CCW throughout their identity work. I identified four unique themes within each of the three participant’s narratives to determine which life experiences contributed most directly to the development of their identities as inventors. After the narrative analysis was completed, I also identified commonalities among the narratives. Through comparing and contrasting the life experiences of the three participants, the commonalities I established are as follows: the impact of the InvenTeam™ on the development of their identities as inventors, an understanding of inventing as problem solving, the importance of recognition from others when identifying as an inventor, positioning family members as problem solvers or engineers, and a strength in math.

I also deductively analyzed the participants’ narratives to identify the different types of CCW (Yosso, 2005) the Latina students drew on as they developed their identities as inventors. Results of the deductive analysis provided evidence of the significant role family and educators played as sources of CCW for the young inventors (Rodriguez et al., 2021; Verdin & Goodwin, 2019). I introduced two additional forms of cultural capital which I developed from the interview data, and which extend Yosso’s (2005) CCW theory. The new forms of cultural capital include risk taking capital and hustle capital.

The results of this narrative study, as summarized in the next section of this chapter, indicate the development of an inventor’s identity takes place over time. The findings also
indicate that the development of an inventor’s identity is a multifaceted process which is shaped by individual, axiological, and sociocultural factors (Couch et al., 2020, Kelly et al., 2017). I conclude this dissertation by discussing the implications for educators, policymakers, researchers, and Latina students in the field of invention.

**Multifaceted Inventor Identity Shaped by Individual, Axiological, and Sociocultural Contextual Influences**

Each of the participants’ identities as inventors were shaped through individual factors, axiological influences, and the sociocultural context of their lives. While each of these elements intersects, I separate them to highlight the nuanced web which shapes the inventor identity development in young Latina women. Below, I provide examples of the various individual, axiological, and sociocultural influences which influenced the development of an inventor’s identity for the participants.

**Individual Factors**

Individual factors played a role in influencing the development of an inventor’s identity for the participants. Individual factors which contributed to an inventor’s identity for Ximena was her growth mindset she demonstrated throughout her narrative. Her willingness to work hard and her belief that hard work would lead to growth and improvement was first captured by her desire and eagerness to learn English when she moved from Mexico to Salem, Oregon when she was in the second grade. Her growth mindset remained consistent throughout her participation on the InvenTeam™ and contributed to her persistence during the InvenTeam™ year, even though there were times she wanted to give up.
Another example of an individual factor which contributed to the development of an inventor’s identity was Lesly’s strategic decision to immerse herself in a community of aspiring engineers at Oregon State University who also identified as people of color. Through Lesly’s own agency, she sought out a community of people who are “like minded” and who also know what it is like to be an underrepresented minority in STEM. Researchers have found Latinx students made intentional “moves” to navigate through their college experiences by drawing on their CCW (Rincon et al., 2020; Verdin & Goodwin, 2019). The example of Lesly actively seeking out a community of engineers who are also people of color highlights the intersection between the individual choices Lesly made and the axiological factors which influence those choices. In the following section, I discuss the axiological influences as a bridge to the sociocultural contextual factors which influenced the identity development of Latina engineers.

Axiological Factors as a Bridge between the Individual and Sociocultural Contexts

Axiological factors include the influences which determined on what the participants placed value as they developed their identities as inventors. Each of the participants made the decision to participate in IvE for various reasons. Their reasons for participating in IvE and joining the InvenTeam™ are examples of how axiological influences affected the development of their identities as inventors.

Lesly joined the Mathematics, Engineering, Science, Achievement (MESA) club at her school in the seventh grade, because she had a friend who participated, and she wanted to spend more time with her friend. Lesly did not know what engineering was when she first joined the club. Isabel joined the InvenTeam™ because her best friend decided to join, and her friend
provided “security” for Isabel. Having someone she knew to go through the experience with her was valuable to Isabel. Both Lesly and Isabel placed value on spending time with friends and made the decision to participate in IvE based on their desire to be with friends.

Ximena decided to join the team because Katrina, her math teacher, encouraged her to participate. Katrina positioned Ximena as an inventor and an engineer and told Ximena the experience would be beneficial. Ximena trusted Katrina and valued Katrina’s perspectives. Ximena saw potential value of bettering herself through participating on the InvenTeam™ because Katrina brought it to her attention and believed in her. She was willing to take the risk because of Katrina’s encouragement. Lesly made the decision to join the InvenTeam™ because she had already participated in MESA and wanted to take advantage of another IvE experience. She was always looking for “what was next for her” in terms of opportunities and exploring how to “take it to the next level” with engineering and inventing. Like Ximena, Lesly also saw the potential of bettering herself though participating on the InvenTeam™ and made the decision to join because she had prior experience with IvE and understood the benefits of IvE.

Isabel revealed an example of an axiological influence on the development of her inventor’s identity when she explained what she saw as the most important take aways from the InvenTeam™ experience. Isabel described how meeting the family members of individuals with dysphagia was a valuable experience for her because it allowed her to connect on a personal level with the people closest to those individuals affected by the condition. While Isabel acknowledged the technical skills she learned, including 3D printing and modeling, as important take-aways from her InvenTeam™, she found the greatest value in helping people. She also
described her personal growth and discovering the value of her voice as more important than the “math and science” she learned through her participation on the team.

By identifying the axiological influences in the narratives of the participants, I gained a deeper understanding of what the participants valued as they developed their identities as inventors. The axiological factors provided a bridge from the individual to the sociocultural factors which influenced the development of inventor identities for the participants. In the following section, I discuss the sociocultural influences in the participants' lives. Values participants revealed show the importance of the multifaceted points of entry for students who choose to participate in IvE and how their values can be fostered through new experiences, such as IvE.

Sociocultural Factors

**Invention Education as a Sociocultural Influence**

The sociocultural influences in the participant’s lives shaped the development of their identities as inventors. Before participating on the InvenTeam™, Lesly was already part of the IvE community through her involvement in Mathematics, Engineering, Science, Achievement (MESA) club, which she joined in the 7th grade. Because she had participated in IvE longer than the other two participants, Lesly had the most confidence in her self-identification as an inventor. She explained hearing the word “inventor” used to describe people who are problem solvers through her participation in MESA contributed to her knowing she was an inventor. Lesly’s confidence identifying as an inventor because of her participation in IvE supports the findings of
Couch and colleagues (2018). Couch and co-authors found that participating on an InvenTeam™ led to female students identifying as an inventor.

Once they began their involvement on the InvenTeam™, Ximena and Isabel also became members of a community of inventors. Just as MESA provided Lesly with opportunities to develop her identity as an inventor, the InvenTeam™ experience provided opportunities for the participants to engage in identity work on both ontological and epistemological levels (Couch et al., 2019, Kelly et al., 2017). The young inventors developed their epistemological identities as they learned technical skills and the content area knowledge necessary to design and construct the cup for individuals with dysphagia. The participants also developed their ontological identities socially, through discourse and interaction within the field of inventing (Kelly et al., 2017). Through social discourse and interaction in invention, the participants developed a common understanding of inventing as problem solving. By defining inventors as problem solvers, all three participants demystified invention not as an act only done by those who hold patents or by the “big names”. Ximena explained “anyone can be an inventor,” and Isabel agreed, noting inventions do not have to be something “revolutionary”.

The participants were also provided with opportunities to be recognized as inventors within the IvE community, which contributed to their identity development (Carlone & Johnson, 2007, Rodriguez et al., 2019a) on an ontological level. Isabel explained speaking to the Lemelson Foundation about her InvenTeam™ experience contributed to her development of an inventor’s identity by receiving validation and recognition as an inventor from those in the field. Each time the participants spoke publicly about their experiences, the participants strengthened
and (re)constructed their own identities as inventors through discourse and interaction with others (Kelly et al., 2019).

The sociocultural influence of the InvenTeam™ strengthened their identities as inventors through establishing a common discourse around their understandings of who inventors are, what inventors do, and what invention is. Speaking about the InvenTeam™ with experts in the field also provided opportunities for the participants to receive recognition as inventors, which strengthened their identities as inventors. Beyond the participation in IvE through MESA and on the InvenTeam, the participants were also influenced by multiple intersecting sociocultural factors, including their families. In identifying and examining the various and multilayered sociocultural influences within students’ lives, I gained a deeper understanding of how to connect the lives of Latina students to inventing and problem solving in a meaningful and authentic way.

Family as a Sociocultural Influence

Families are another example of a sociocultural factor which influenced the development of an inventor’s identity for the participants. Lesly’s family’s aspirations and the early consistent support contributed to the development of her identity as an inventor by reassuring her she was not alone as she participated in extracurricular invention activities such as MESA and the InvenTeam™ (Yosso, 2005). The support of Isabel’s siblings was also a sociocultural influence which contributed to the development of Isabel’s identity as an inventor. Influenced by their own experiences of not being able to participate in extracurricular activities, Isabel’s siblings encouraged and supported her when she chose to participate on the InvenTeam™.
Family as a sociocultural influence provided Ximena with examples of problem solving and the engineering design process. When Ximena described her brother and father as “natural engineers” and problem solvers, she positioned herself as someone who has been exposed to engineering and problem solving through her own experiences and the experiences of her family member. Like Lesly and Isabel, the sociocultural influence of Ximena’s family members affected her identity development.

A growing body of literature has illuminated the CCW (Yosso, 2005) and funds of knowledge (Moll et al., 1992) students from communities of color are exposed to through their families and communities (Calabrese-Barton & Tan; 2008, Rincon et al., 2020; Rodriguez et al., 2021; Wilson-Lopez, 2016). Lesly and Isabel’s examples demonstrate how family members serve as sociocultural influences as they offered support and encouragement throughout the young inventors’ educational journeys. Authors have also examined how Latinx students’ funds of knowledge connect to engineering and problem solving (Calabrese-Barton & Tan, 2008; Wilson-Lopez et al., 2016). Through Ximena’s example, my study adds to this body of literature by providing evidence of the problem solving skills Latina students have been exposed to through family members who solve problems out of necessity. Ximena’s family solving problems out of necessity connects problem solving with the sociocultural context of their lives. As Ximena’s narrative indicates, the intersection of ethnicity and socioeconomic class affected how her family addressed problems they encountered.
Invention as Sociocultural

Ximena situated herself as part of a “Hispanic family” and explained many of her friends who come from Hispanic families also have family members who are natural engineers and problem solvers. She explained her parents and the parents of her friends are problem solvers because they lack the financial means to pay others to solve their problems for them. In positioning her family as part of a community who has learned to solve their own problems out of necessity, Ximena highlighted the sociocultural context of invention and problem solving (Calabrese-Barton, 1998). Like Ximena, Isabel, Isabel also described her father as a problem solver who “fixed things and improved things”, both at home and at work.

As I describe in Chapter Two, Calabrese-Barton (1998) defined invention as socially contextual and connected invention to embodied agency. According to Calabrese-Barton (1998), “embodied agency refers to the way in which individuals and groups engage in inventing as a lens to challenge existing social conditions, locations, ideas or self” (p.142). Calabrese-Barton’s (1998) conceptualization of invention as socially contextual and connected to embodied agency, reframed invention as something people do to improve their lives through solving problems they encounter. Ximena’s father, and the parents of other Hispanic friends she described, are problem solvers, because they enact their embodied agency to solve problems and improve their lives and the lives of their families.

The results of my study underscore the importance of recognizing the sociocultural context of students’ lives and understanding how students’ life experiences may connect to invention and problem solving. My study builds on the work of Barton and Tan (2009) and Wilson-Lopez and coauthors (2016) who identified and examined the assets and Funds of
Knowledge Latinx students bring to engineering and problem solving. I also contribute to the field by illuminating the problem solving skills students are exposed to through family members who solve their own problems out of necessity as an asset Latinas contribute to invention and engineering.

**Community Cultural Wealth and the Assets Latinas Bring to Invention**

As I discussed in the previous section, exposure to problem solving through their family members is an asset the participants brought to IvE. The participants also demonstrated multiple sources of CCW throughout their narratives. My dissertation supports the results of Rincon and Rodriguez (2021) study which found evoking CCW throughout the development of STEM identities contributed to the persistent and resilience of Latina students. The participants in my study drew on their CCW throughout their educational journeys and while participating on the InvenTeam™. The narratives of the participants also revealed additional types of cultural capital not included in Yosso’s (2005) CCW.

Scholars who study Latina students and their CCW have emphasized the influence of families as students develop STEM specific identities (Mercédez, 2015; Rodriguez et al., 2021). The results of my study also captured the critical role families played as sources of CCW for young Latina inventors. Literature in the field has revealed the influential role of parents as Latina students develop their STEM identities (Rodriguez et al., 2019a). I also identified siblings as both sources and recipients of familial capital for each other. Lesly was a source of familial capital through being a role model and an example for her younger brothers (Yosso, 2005). She also provided access to education for her younger brother when he would join her for the
InvenTeam™ meetings (Yosso, 2005). Lesly explained because she was involved in invention, her brother also had the opportunity to be exposed to invention and engineering and will most likely work in a STEM field. Siblings also were important in Isabel’s journey. Isabel explained that because her siblings did not have the opportunity to participate in extracurricular activities, they supported her and served as valuable sources of familial capital throughout her educational journey.

The first new form of cultural capital I introduced is risk taking capital. I defined risk taking capital as the willingness to take on a new or unfamiliar experiences, which may or may not lead to potential benefits. The participants drew on risk taking capital as they “said yes” to opportunities throughout their educational experiences, even though they had doubts or experienced pushback from their families. One example is each of the girls saying yes to the InvenTeam™, another example is Ximena taking the risk to participate in sports even though her parents did not approve.

The second form of cultural capital I introduced is hustle capital. I defined hustle capital as effort and energy exerted to learn or achieve a goal. All three of the girls demonstrated hustle capital consistently throughout their narratives and each participant described their parents as a model of hustle capital in their lives, which is evidence of how familial capital and hustle capital intersect. Hustle capital is an asset the participants in my study brought to inventing. They were all willing to put in the hard work required to learn and accomplish a goal. They drew on hustle capital as they actively sought out ways to learn more and took advantage of opportunities they were presented.
My study brought to light the valuable cultural capital and assets Latina students bring to invention. Latina students provide a unique perspective to invention because they as women and as Latin are doubly underrepresented in the field. When Latina students understand the value of their voices and perspectives in invention, they empower themselves to persist and feel confident in sharing their unique perspectives with others, as each of the three participants did throughout their narratives. IvE experiences, such as MESA and the InvenTeam™, provided opportunities for the participants to contribute their unique perspectives and CCW to invention. Each of the girls described the InvenTeam™ as an experience where they felt their perspective and voice was valued.

**Invention Education as an Opportunity to Engage Students in Problem Solving and Inventing**

IvE programs have the potential to increase the participation of underrepresented groups in the innovation ecosystem. IvE programs, such as MESA and the InvenTeam™, expose students to the recursive process of inventing while drawing on the knowledge and skills of underrepresented students in inventing and STEM (IvERC, 2019). IvE teaches youth to identify problems within their own communities, which simultaneously positions students as problem finders and solvers, and as capable catalysts for change within society (IvERC, 2019). As my study has demonstrated, students from low income, Latinx families may be exposed to problem solving through their family members. By acknowledging and connecting the problem solving skills students are familiar with to invention processes, educators may encourage students to contribute their own experiences and knowledge to invention.
Perry and Estabrooks (2019) argued invention is a process that must be practiced and developed. If students practice developing their abilities to find and solve problems at a young age, they will be better equipped to take on complex issues that require innovation within their communities. Root-Bernstein and co-authors (2018) also argue inventiveness can be developed through early and consistent exposure to invention. As scholars in IvE argue, if students are exposed to IvE from a younger age, they have more opportunity to develop the skills necessary for problem solving and inventing while simultaneously bringing their own cultural capital and assets to academic settings (IvERC, 2019; Yosso, 2005). I argue Lesly self-identified as an inventor most confidently out of the three participants, because she began participating in IvE programs earlier and has spent more time inventing than the other two young women.

Isabel suggested IvE be implemented in elementary and middle school and cited her own story to capture the impact IvE can have on a student’s life. She described the InvenTeam™ as a life changing experience in which she developed confidence and discovered the value of her own voice. My study confirmed the results of Couch and co-authors’ (2019) study which found participating on an InvenTeam™ led young female inventors to see themselves in new ways and as “being able to do more” than before they joined the team. Implementing IvE in the school day would provide opportunities for more students from diverse backgrounds engage in invention and connect their own assets and knowledge to invention and envision new possibilities for themselves. To accomplish this goal, major changes are needed at the policy level.

**Implications**
Implications and Future Directions for Policymakers

Researchers in the field have called for embedding IvE within the school day to increase access to invention and increase the number of diverse patent holders in the U.S. (Couch et al., 2019a; Zhang et al., 2019). Based on the results of my dissertation and empirical evidence presented by authors in the field, I concur with other IvE scholars (Committee for the Study of Invention, 2004; Zhang et al., 2018) and argue IvE should be embedded within the school day. By embedding IvE into the school day, policymakers may democratize access to IvE experiences, which are typically limited to after school extracurricular activities, such as MESA and the InvenTeam™ and thus may not be accessible to students unable to stay after school for varied reasons. Isabel also emphasized the importance of educating parents on IvE to gain more parental support for students, which could also be considered by policymakers.

Policymakers may also consider the language used when implementing IvE initiatives. The ambiguity around the terms inventor and invention is a problem for the field of IvE. My study sheds light on the duality of the word and why using consistent language is important, which is critical if changes are to be made at the policy level. Through participation in IvE, the three participants each developed an understanding of invention as problem solving and defined inventors as problem solvers. If policymakers establish the connection between invention and problem solving explicitly through the use of consistent discourse from early elementary through twelfth grade, students may understand inventors are not only the “big names” or “people going for patents” as my participants explained through their narratives. Students understanding problem solving as a way of thinking about solutions and invention can demystify the word ‘inventor’ for students, as it did for the participants in my study.
As I explained above, of the three participants, Lesly was most confident in her self-identification as an inventor. She traced the strength of her self-identification as an inventor to hearing the word *inventor* and being part of a community of people who know that inventors are problem solvers. Lesly also described her participation in IvE through MESA in middle school as what “hooked” her into becoming an inventor and an engineer. If IvE is implemented into the school day starting in the elementary grades, more students will have the opportunities to take part in invention and develop identities as inventors, engineers, and STEM people.

**Implications for Educators**

Educators have the potential to influence the identity development and serve as valuable sources of social capital for their students. As the example of Katrina captured, when strong relationships with students are formed, students may develop trust in educators and draw on educators as sources of CCW. By getting to know students individually and recognizing the unique life experiences of their students, teachers may become familiar with the unique assets and CCW students contribute to their classrooms. In doing so, educators may be able to connect the skills and assets which students bring to schools to the curriculum.

When the valuable cultural capital Latinas bring to invention is recognized by others, Latina students are more likely to self-identify as inventors (Carlone & Johnson, 2007). As captured by Ximena’s narrative, if teachers position students as “inventors,” it can contribute to the students’ self-identification as inventors. Educators may also serve as social capital through relationships they establish with the parents of students. Ximena’s mother’s friendship with Ms. Ruiz provided an example of how educators can establish trust with parents when relationships...
are formed. When relationships with parents are established and trust is built, educators can serve as CCW for students and their families. Educators, at all levels, can provide assistance and guidance for students as they navigate educational institutions, specifically those students who have immigrated from other countries, whose parents may not speak English, or are unfamiliar with the education system in the United States.

Isabel’s example provided evidence of the value of including “outside perspectives” in STEM. Teachers could engage students who do not identify as “STEM people” in invention by explaining why outside perspectives are valuable in invention. Educators may also emphasize the importance of including students who seek personal connection with others through the invention process, as Isabel did. Engaging students who do not identity as “STEM people” in IvE may also facilitate a mindset shift, as it did for participants in Couch and colleagues (2020) study. Female students who previously disliked STEM came to enjoy engineering and expressed a desire to pursue computer science (Couch et al., 2020).

Implications for Latina Students

Latina students contribute valuable cultural capital and assets to inventing and problem solving. My study illuminated the exposure to problem solving skills as an asset Latina students may contribute to invention. The young Latina inventors also demonstrated hustle capital and risk taking capital which contributed to their resilience and persistence throughout their academic journeys. If Latina students recognize the CCW and assets they contribute to invention, they empower themselves to persist and share their unique perspectives with others. Latina students could also consider how their own experiences in school shape the experiences of their siblings.
My study captured how Latina students may share their learning with their siblings and bring them along for the journey as Lesly did for her younger brother Oscar. Also, when the participants in my study connected their own values and individual factors the young Latina inventors made visible multiple access points and the need for diverse perspectives in IvE and STEM.

Implications for Researchers

Rich narrative and other kinds of qualitative studies in the field of IvE are needed. In sharing their stories, the participants had the opportunity to (re)construct their identities as inventors through discourse. To date, no narrative studies have explored the identity development of underrepresented minority students in inventing. A need for more scholarship which examines the role of discourse in IvE settings also exists. A lack of common discourse surrounding invention, inventing, and what it means to be an inventor has created barriers in moving the field forward. In studying how language is used within IvE settings, researchers may come closer to reaching a consensus in how key terms are conceptualized, utilized, and enacted by the students and teachers engaged in IvE.

Narrative should also be considered as a methodology because of positive relationships researchers may form with participants through getting to know one another over time. Before meeting with the participants for our final interviews, I sent a draft of the study to the participants, so they could provide feedback to me. Lesly said she felt “seen” in reading her narrative. Isabel told me she felt her narrative captured her experiences, and said she felt I “understood her”. She also shared that being able to reflect on her InvenTeam™ experience
through her participation in this study was “so valuable” to her. Ximena said she has never seen
her story on paper and expressed her gratitude for being selected to participate in the study. The
personal connection established through narrative methodology allowed me to gain a deeper
understanding of their life experiences and the contextual elements of their lives. In learning
more about their unique life experiences, I was able to shed light on the different experiences
which contributed to their identities as inventors and how the participants described them, in
their own words, and in the context of their own lives.

My study contributes to the growing body of literature which calls for increasing access
and opportunities for diverse students to participate in IvE. Analysis of the narratives of three
young Latina inventors also holds the possibility to expand CCW theory by revealing two
additional sources of cultural capital Latina students bring to educational settings and their
identity development. By taking part in the iterative and recursive process of inventing, the
participants were given opportunities to engage in identity work as inventors, which strengthened
their self-identification as inventors (Kelly et al., 2017). While participating in extracurricular
IvE activities contributed to the development of an inventor’s identity, limited opportunities are
available to students, especially those who have been historically underrepresented as inventors.
I argue policymakers should democratize access to IvE by embedding IvE within the school day.
APPENDIX A: IRB APPROVAL
January 25, 2022

Dear Cristina Saenz:

On 1/25/2022, the IRB determined the following submission to be human subjects research that is exempt from regulation:

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<thead>
<tr>
<th>Type of Review</th>
<th>Initial Study, Initial Study</th>
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</thead>
<tbody>
<tr>
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<td>Exploring the Life Experiences of Young Latina Inventors</td>
</tr>
<tr>
<td>Investigator</td>
<td>Cristina Saenz</td>
</tr>
<tr>
<td>IRB ID</td>
<td>STUDY000003691</td>
</tr>
<tr>
<td>Funding</td>
<td>None</td>
</tr>
<tr>
<td>Grant ID</td>
<td>None</td>
</tr>
<tr>
<td>Documents Reviewed</td>
<td>HRP-251, Category: Faculty Research Approval; Data collection sheet, Category: Other; Explanation of Research/informed consent, Category: Consent Form; Follow up interview, Category: Interview / Focus Questions; Interview Guide 1, Category: Interview / Focus Questions; Interview guide 2, Category: Interview / Focus Questions; Interview guide 3, Category: Interview / Focus Questions; Media Consent Form, Category: Other; Recruitment email, Category: Recruitment Materials; Saez-HRP-255-FORM, Category: IRB Protocol</td>
</tr>
</tbody>
</table>

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made, and there are questions about whether these changes affect the exempt status of the human research, please submit a modification request to the IRB. Guidance on submitting Modifications and Administrative Check-in are detailed in the Investigator Manual (HRP-103), which can be found by navigating to the IRB Library within the IRB system. When you have completed your research, please submit a Study Closure request so that IRB records will be accurate.

If you have any questions, please contact the UCF IRB at 407-823-2301 or irb@ucf.edu. Please include your project title and IRB number in all correspondence with this office.

Sincerely,

Gillian Benal
Designated Reviewer
APPENDIX B: CONSENT FORM
EXPLANATION OF RESEARCH

Title of Project: Exploring the Life Experiences of Young Latina Inventors

Principal Investigator: Cristina Saenz

Faculty Supervisor: Dr. Audra Skukauskaite

You are being invited to take part in a research study. Whether you take part is up to you. Before you begin, please note the following information:

The purpose of this research is to study the life stories of select Latina students who participated in invention education in order to gain a deeper understanding of how their life experiences contributed to the development of an inventor’s identity. An additional purpose of this study is to examine how young Latina inventors draw on cultural capital throughout their lives and experiences as inventors. Cultural capital refers to the assets and resources you have gained through your experiences in school and growing up in your family and community.

If you agree to be a part of this study, you will be asked to take part in an introductory Zoom call with the other selected participants and three individual interviews via Zoom. The introductory Zoom call with not be recorded but I will ask that your camera be on. During the interviews you will be asked about your InvenTeam™ experiences, how you think of yourself as an inventor, and what may have influenced your thinking and experiences. If you choose to participate you will also be asked to contribute any other data you consider relevant to conversations during the interviews. Data may include photographs, family stories, documents, journals, communication trails such as emails, and/or links to social media pages. If you are contributing additional materials that include other people, you will need to remove all identifiable information and ask the individuals in the photos and/or documents for permission to share the materials with the researchers. You will also be asked to complete a document and photo release form to indicate that permission was granted from people included in the photos or documents you provide for this research study. The three individual interviews will be audio and video recorded and with transcriptions.

To meet the qualifications of this research you must be:


2. A 10th grade student at the time of your participation on the InvenTeam™.
3. 18 years or older.

4. Amount of prior experience with out-of-school science, technology engineering and mathematics activities. I will be recruiting one participant with no experience, one participant with some experience, and one participant with extensive experience.

If you do not want to be recorded, you will not be able to participate in this study. If you provide additional documents such as photographs, journals, etc. you may be asked to participate in a follow up interview. Please discuss this with me or my research advisor, Dr. Audra Skukauskaite. My faculty advisor and I will be the only individuals with access to the data. All data will be stored for 5 years after study closure per Florida law. After the 5 year required period the data will be stored on a password protected external hard drive for 10 years including the 5 years after the study closure.

**Time required:** In addition to an introductory zoom call with the other selected participants from the McKay InvenTeam™, there will be three individual interviews. The introductory Zoom call should take 20 minutes. I expect that the individual interviews should take approximately 45-90 minutes. The interviews will be audio and video recorded. I will also be transcribing the interviews. I will use the automated Zoom transcription capability for the initial transcription and I will correct the transcript manually for anything not captured accurately through the automated transcription. All data will be stored on the password protected university issued OneDrive space/UCF protected server.

**Confidentiality:** Narrative studies provide participants an option to remain anonymous, or to be identified by name. If you choose to remain anonymous, you can select a pseudonym. If you elect to be identified, I, as the primary researcher, will determine if the use of your name is of benefit to you; otherwise, pseudonyms will be used. Based on my knowledge of the literature and involvement in invention education, I will make this decision. Your name will be used if the findings show you in a positive light and illuminate the importance of your individual contribution to invention education or society. It is your choice where you would like to be when the interviews take place. A quiet, private space is suggested. Please select one of the options.

- [ ] I choose to remain anonymous for all purposes of this research.
- [ ] I want my real name to be used when it is of benefit to me, as determined by the researcher.

Your participation in this study is voluntary. You are free to withdraw your consent and discontinue participation in this study at any time without prejudice or penalty. Your decision to participate or not participate in this study will in no way affect your relationship with UCF or your relationship with the individuals who may have an interest in this study.

**Study contact for questions about the study or to report a problem:** If you have questions, concerns, or complaints please contact Cristina Saenz, Doctoral Candidate, Education
Department, College of Community Innovation and Education, at cristina.saenz@ucf.edu or faculty supervisor, Dr. Audra Skukauskaite at audra@ucf.edu.

**IRB contact about your rights in this study or to report a complaint:** If you have questions about your rights as a research participant, or have concerns about the conduct of this study, please contact Institutional Review Board (IRB), University of Central Florida, Office of Research, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901, or email irb@ucf.edu.

Participant name and signature

___________________________________________ __________________

__________________________________________________________________
APPENDIX C: INTERVIEW GUIDES
Interview guide for Interview 1

General goals of 1st interview:
- Develop rapport and build on the initial introduction established through the Zoom call with all three girls.
- Gain an overview of their experiences on the InvenTeam™.
- Develop an initial understanding of how the participants self-identify as an inventor.

Questions for interview 1:

Tell me a little bit about yourself.
What brought you to the InvenTeam™?
How would you describe your role on the team?
How would you describe invention?
Do you consider yourself an inventor? If yes, please explain, if no, also please explain.
How did you contribute to the invention?

This will be an unstructured, informal interview. The interview will be conversational. Some additional questions may be asked depending on how the participants' answer.
Interview Guide for Interview 2

Goals for second interview:
- focus on generating data for research question two
- address the student’s academic experience since participating on the InvenTeam™
- gain an understanding of the family background of the participants.

1. What are the life experiences of young Latina inventors which contribute to the development of an inventor’s identity?

2. How do young Latina inventors draw on cultural capital in the development of an inventor's identity?

Questions:

Tell me about your family.
What was school like for you when you were younger?
What did your family think about you participating on the InvenTeam™?
Who supported you during your InvenTeam™ experience?
What are the assets that you brought to the team?
What have you been up to since you participated on the InvenTeam™?
What did you learn about yourself from the experience?

As with the first interview, the second interview will be an unstructured, informal interview. The interview will be conversational. Some additional questions may be asked depending on how the participants' answer.
Interview Guide for Interview Three

The goal of the third interview is to re-visit relevant topics of interest established through the first two interviews. I will be using the two-sentence interview format in the third interview to extend on areas that the participants focused on in the first two interviews (Kim, 2019). The third interview will also be an opportunity for my first member-check with the girls, as I will be reviewing preliminary analysis and findings with the participants.
REFERENCES


