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Youth of Promise: Academic Success and Future STEM Aspirations at an Alternative Education Program

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Approval of the Dissertation Committee

This dissertation has been duly read, reviewed, and critiqued by the Committee listed below, which hereby approves the manuscript of Anthony Peña as fulfilling the scope and quality requirements for meriting the degree of Doctor of Philosophy in Education.

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ABSTRACT

YOUTH OF PROMISE: ACADEMIC SUCCESS AND FUTURE STEM ASPIRATIONS AT AN ALTERNATIVE EDUCATION PROGRAM

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Providing an equitable science education to Black and Latinx youth who have dropped out of their traditional schools is a significant issue for three reasons: (a) it can provide a pathway to a quality employment opportunity, (b) success in science classes can support success in other academic courses, and (c) development of youth who have an efficient and critical understanding of science phenomena is an issue of social justice. The idea that education is the great equalizer depends on many factors, such as socioeconomic status, racial background, and the zip code in which you live. Students of color (i.e., Black and Latinx) drop out of school at higher rates than their peers at the national level. Further, compared to high school graduates, youth who drop out are less likely to find a job and earn a living wage, and more likely to be in poverty and suffer from a variety of adverse health outcomes. Lack of equitable learning opportunities in the traditional science classroom is a contributing factor to youth dropping out. Alternative education programs have the potential to support youth who have dropped out to re-engage in science. The purpose of this research was to better understand what factors contributed to the academic achievement of students in their class-based science courses at Youthbuild Charter School of California, an alternative education program for youth who have dropped out of their traditional high schools. In addition, this study sought to better understand what factors may impact student future STEM aspirations. Specifically, this study looked at how each of the

following areas—student perception of their science teacher, critical science education, student sense of agency to create knowledge in science class, student engagement in science class, and the relevance of science to the student—impact student academic achievement in their class-based science course and student future STEM aspirations.

The study utilized a mixed-methods approach, specifically structural equation modeling as a quantitative technique and thematic analysis as a qualitative technique to examine the factors that impact student academic achievement in their science classes and student future STEM aspirations. The study included 100 participants who completed the YCSC Adult Student Science Survey and 10 participants who were interviewed. This study found that each of the aforementioned factors had either a direct or indirect impact on student academic achievement in a YCSC science classroom and on student future STEM aspirations. The best predictor of student academic achievement came from the relevance of science to students, followed by student sense of agency to create knowledge, and critical science education. The best predictor of future STEM aspiration came from the critical science education, followed by relevance of science to the student, and student sense of agency to create knowledge. In addition, thematic analysis identified the theme of an equitable learning space that consisted of the following: educators who develop authentic supportive relationships with students, an epistemological pluriverse that is inclusive of multiple perspectives and values the knowledge students bring to the classroom, the use of culturally relevant science that empowers students to make informed decisions, a localized-critical-action based curriculum, and a wide array of equitable learning practices.

Findings from this study underscore that a paradigm shift must occur in STEM education for equitable learning opportunities to become commonplace. In the current “pipeline” approach of STEM education, the goal is to develop future STEM workers, epistemology is not inclusive of many worldviews, science content is taught through a banking model, competition among students is encouraged, and science content is decontextualized and removed from student experience. An equitable approach is necessary—one in which the goal of STEM education should be to develop young people who understand how to critically engage with science from a localized perspective, where they can use science to solve issues of social justice in their lives and their communities, where science is grounded in an epistemology that is inclusive of many worldviews, and where community building in the classroom is a classroom asset.

DEDICATION

I dedicate this work to the village that has molded me. My parents, Gudalupe Peña and Jose Maria Peña; Gracias por siempre apoyandome y empujandome. To my loving wife Jennifer Joann Yanga-Peña; for always loving me, encouraging me and believing in me. I am a better person because of you, tu eres mi otro yo. To my sisters Sonya Araceli Peña, Marielyn Peña, and Brigette Evelyn Peña thank you for always supporting me. To my nieces and nephews, this PhD is to show you that you are capable of things you have never imagined, don't ever let anyone tell you your limits. To my grandparents Daniel Lopez Perez (Papanani), Maria Refugio Gonzalez (Mamcuca) and Maria De Jesus Ramos (Mamachuy), desde el rancho hasta la Universidad estamos presente. To all of the homies, for always encouraging me and believing in me, thanks. To all of the students who I have had the privilege of sharing a classroom with, you have taught me so much, and your tenacity is inspiring. Lastly, to all those who struggled and fought oppression before me, I am here because of you. To all those that will come after me; I will continue to struggle for you.

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This study would not have been possible without the collaboration of Youthbuild Charter School of California. Thank you to the leadership team at YCSC: Founder, Phil Matero, Superintendant, Dr. Rudy Cuevas, Principal, Dr. Sonia Hernandez, Principal, Tizoc Brenes, and all the administrators, counselors and teachers. Also, a very special thank you to all the students that participated in this study; I appreciate your trust and openness to share your personal experiences, challenges, and successes.

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INTRODUCTION

A critical understanding and practice of scientific thought is imperative to the future of our global society. The issues we now face that are not remedied by those presently in positions of power will be solved by the youth. But as things stand today, participation in STEM fields is majority white and male (Landivar, 2013; National Science Foundation, 2019*)*. Representation is an issue because a more diverse STEM culture can more creatively and effectively identify and propose solutions to problems, drawing upon a range of life experiences and the lenses different people bring to the field. Given the lack of representation by students of color—such as Black and Latinx youth—in STEM fields, it is necessary to promote a culture of science that is more inclusive, diverse, and critical of oppressive ideologies. One arena for this is the science classroom. Supporting the success of Black and Latinx youth in the science classroom is crucial. We must contribute to the development of a generation that has the agency to not only understand the knowledge we currently have, but also contribute to it. Inequitable education hinders academic success.

Inequitable Education

The idea that education is the great equalizer depends on many factors, such as socioeconomic status, racial background, and the zip code in which you live (Garcia & Weiss, 2017; U.S. Commission on Civil Rights, 2018). A study by the U.S Commission on Civil Rights found that

> Low-income students and students of color are often relegated to low-quality school facilities that lack equitable access to teachers, instructional materials, technology and technology support, critical facilities, and physical maintenance. These absences can

> negatively impact a student's health and ability to be attentive and can exacerbate existing inequities in student outcomes. (p. 9)

It also found that "Many students in the U.S. living in segregated neighborhoods and concentrations of poverty do not have access to high-quality schools simply because of where they live" (U.S. Commission on Civil Rights, 2018, p. 10). Further, for many students of color, schools reproduce social inequality through the use of zero-tolerance disciplinary policies, curriculum that is not representative of students' experiences, and the reinforcement of oppressive ideologies. In *Social Class and the Hidden Curriculum of Work*, Jean Anyon documented differences in the curriculum between schools that served students from different socioeconomic backgrounds. She found that students from low-income schools were subjected to an overemphasis on rules and obedience at the expense of academics, while students from wealthy backgrounds were encouraged to think freely and prepared to take roles as society's leaders. Studies have shown that school systems in communities where low socioeconomic status is prevalent are often under resourced, which negatively affects students' academic progress and outcomes (Aikens & Barbarin, 2008). Inadequate education—in conjunction with increased dropout rates—have a deleterious effect on children's academic achievement, perpetuating the low socioeconomic status of the community. One way that social inequality is reproduced is when a young person drops out of their traditional high school.

Students Who Drop Out

Students who have dropped out of their traditional secondary educational programs are in a position to reintegrate and complete their secondary education; however, this population has historically struggled with completion of secondary education. Once a youth drops out of school, it is less likely that they will complete their secondary education (ACLU, 2017). This population is largely composed of students of color (Child Trends Data Bank, 2018; National Center of Education Studies, 2018).

Populations of youth who "drop out" of their traditional secondary education programs differ from their "non-dropout" peers in a number of ways. Youths who drop out generally struggle academically, have fallen behind in grade level, come from lower socioeconomic homes, are predominantly students of color (e.g., Black and Latinx), have had contact with the legal system, show poor attendance, and earn poor grades in core courses (Burrus & Roberts, 2012; Hirschfield, 2009). Moreover, they have also generally tested at lower levels than their "non-dropout" peers (Civil Rights Data Collection, 2014). Lastly, once youth drop out, they are at a higher risk of being funneled into a juvenile detention center (Sum, Khatiwada, McLaughlin, & Palma, 2009). Supporting youth who drop out is an issue of social justice in that those who dropout face very narrow economic and social prospects. Compared to high school graduates, they are less likely to find a job, earn a living wage; and more likely to be in poverty and suffer from a variety of adverse health outcomes (Rumberger, 2011).

Youth dropout for many reasons—being underserved in the classroom is just one of them. When students do not receive an equitable education, one that is engaging and provides them with support to succeed academically, they may become apathetic and lose the drive to stay in school. For many students who drop out, challenges in the science classroom only perpetuate the dropout phenomenon. These challenges are exemplified by lower test scores and lower credits earned in science class by Black and Latinx students compared to their White peers (Dalton, Ingels, & Fritch, 2018; National Research Council, 2011).

Why Science Education?

Providing an equitable science education to Black and Latinx youth who have dropped out of their traditional schools is a significant issue for three reasons: (a) it can provide a pathway to a quality employment opportunity, (b) success in science classes can support success in academics, and (c) development of youth who have an efficient and critical understanding of science phenomena is an issue of social justice. Developing effective pathways for youth who are interested in going into STEM careers is crucial. STEM pathways are a growing source of employment. According to the PEW Research Center, "Employment in science, technology, engineering and math (STEM) occupations has grown 79% since 1990" (PEW Research Center, 2018). Therefore, youth who have dropped out and are re-engaged to complete their high school diploma with a positive disposition and commitment to engaging in science may be encouraged to pursue a STEM career. Although a pathway to a STEM career should not be the main objective of science education, it does provide an opportunity for Black and Latinx youth from low-income communities.

In addition to employment opportunities, researchers have found that exposure to and achievement in STEM courses, such as science, improves critical thinking skills as well as achievement in other classes (Becker & Park 2011). Connections have also been made between high school completers and the science courses they have taken. According to a study by the National Science Foundation (2016), all ninth-graders who began high school in 2009 and completed it in 2013 took at least one science course, with 79% taking at least one general science course with no advanced science, and 21% taking at least one advanced science course; effectively, all students, 98% took biology, 76% took chemistry, and 41% took physics.

Lastly, an efficient understanding of science phenomena is an issue of social justice. According to Finkel (2018), attacks on science and scientific ways of knowing have contributed to a climate in which unsubstantiated claims permeate our ways of thinking and are accepted without question. Further:

> Over the past decade, attacks on science knowledge and attempts to legislate and restrict science teaching have again become a regular part of the U.S. landscape around a variety of issues that include the theory of evolution, human-caused climate change, and the safety of vaccinations. (Finkel, 2018, p. 42)

Therefore, in order to disrupt this phenomenon, every citizen must feel confident and willing to use science to make personal and societal decisions.

Taking all of this information into account, educators must develop science classrooms that support Black and Latinx youth who have dropped out of a traditional secondary education program in order to provide equitable learning opportunities. Alternative education programs have the potential to support youth who have dropped out. These programs provide an opportunity for completion of a secondary education for youth who have dropped out of their traditional secondary programs. Youthbuild Charter School of California (YCSC) is one such program. The YCSC science classroom is a space in which youth can be re-engaged and supported for academic achievement.

Purpose Statement

Youthbuild Charter School of California (YCSC) is a Western Association of Schools and Colleges (WASC) accredited, alternative education program for youth who have dropped out of their traditional schools. At the time of this study (2019), this alternative education program was providing a pathway for completion of the high school diploma for youth ages 16 to 29, thereby extending the age for admission. Such a consideration and its other approaches highlight the ways in which YCSC took a project-based approach rooted in social justice. A classroom-based program was provided for youth ages 16 to 26 and an independent studies program for youth ages 18 to 29. For many youth who came to YCSC, academic success had been foreign to them, even more so in their science classes. According to YCSC (2019), their students came from low-income families and underserved communities, and had left their traditional school systems. Many students enrolled over-aged, under-credited—or both—with the goal of completing their high school diploma. And, indeed, at YCSC many youth succeeded academically and completed their degrees. According to YCSC, 85% of youth who committed to YCSC for one and one half years graduated with a high school diploma.

The purpose of this research was to better understand what factors contributed to the academic achievement of students in their class-based science courses at Youthbuild Charter School of California. Specifically, this study looked at how each of the following areas—the student perception of teachers, critical science education, the student sense of agency to create knowledge, the student engagement in science class, and the relevance of science to the student—had an impact on student academic achievement in their class-based science course. Lastly, this study sought to contribute to a science pedagogy that will provide equitable learning opportunities to youth who have previously dropped out of a traditional secondary education program, encourage students to develop an understanding of science that is practical and relevant to their lives, and encourage a view of science through a social justice lens.

Research Questions

The primary research questions of this study were:

1. What factors contribute to the academic achievement of students in their YCSC science classes?
2. What factors may contribute to future STEM aspirations of YCSC students?

Implications of the Study

Studying academic success in science classrooms within an alternative education setting has many implications for research, policy, and practice.

Research Implications

Given the limited literature on supporting youth who have dropped out of traditional high schools in science education, this study presents a contribution to this field. Further, this study adds to research on science pedagogy that will (a) provide equitable learning opportunities to youth who have dropped out of a traditional secondary education program, (b) encourage students to develop an understanding of science that is practical and relevant to their lives, and (c) encourage a view of science from a social justice lens.

Policy Implications

In addition to contributing to a limited field of research, this study aims to shift the paradigm of the objectives of science education. For policy, this study seeks to promote effective ways to train science educators who work with students who have dropped out of a traditional secondary school and to shed light on how to develop effective alternative education programs and their importance. The study also hopes to contribute to the development of further evaluation measures for science curriculum at the secondary education level. Lastly, this research can provide evidence for future policy and practice that encourages the guidance of youth of color into effective STEM pathways.

Practical Implications

Lastly, the practical implications of from this study include exemplars of science classes in alternative education programs. This study may serve as a resource for science educators who work with youth who have dropped out of their traditional high schools. Moreover, this study can provide insight into the importance of grounding classroom science content in relevant student experiences.

Organization of the Dissertation

The next chapter presents a literature review that will cover the following: (a) a summary of the root causes why Black and Latinx may underperform in science classes; (b) the need for alternative education programs, such as YCSC; (c) the potential for equitable science pedagogy and its connection to the student perception of teachers, critical science education, the student sense of agency to create knowledge, the student engagement in science class, and the relevance of science to the student within alternative education spaces such as YCSC. The third chapter delineates the design on this study including the site where this study took place as well as detailed demographic information. It also discusses the data-collection procedure, data analysis procedures, and a discussion on my role as a researcher. The fourth chapter presents the findings of the study. The fifth chapter presents a discussion of the findings, implications for current education settings, and potential for future research.

LITERATURE REVIEW

The objective of this literature review is to consider the following: (a) why students drop out of their traditional secondary schools and the consequences of this phenomenon, (b) alternative options for students who drop out, (c) why is science education important and beneficial, and (d) what factors contribute to student academic achievement in science education?

The Drop-Out Phenomenon

Education has been said to be the great equalizer—meaning that education can be a means to changing the economic and social class into which one is born, if one so chooses. Education is meant to mold a person into an individual who has agency and an ability to participate and contribute to society. However, what we in fact see is that education—specifically, the school setting—treats students differently. School, ironically, can be a place where students are consistently denied an equitable education and support to succeed academically. This phenomenon can be seen when youth drop out of school.

If graduation with a high school diploma is seen as a crowning achievement of traditional secondary education, then dropping out of high school should be seen as a failure of the institution. In a 2018 news release by the California Department of Education, California state Superintendent Tom Torlakson announced that the graduation rates for California high schools remained at an all-time high. That same news release reported that, among students who began high school in 2014, 83% graduated with their class in 2018—an increase from the previous year's graduation rate of 82.7%. Further, it noted that the graduation rate had steadily increased since 2010, when the graduation rate was 74.7%. Table 1 shows graduation rate differences between 2017 and 2018 with regard to ethnic/racial identification, English learner status, foster youth, homeless youth, migrant education, students with disabilities, and socioeconomic status. Note that the graduation rate for students of color was lower than their white and Asian peers. The graduation rate for Latinx youth in 2018 was 80.6%, 73.3%, for African American youth, 87% for White students, and 93.6%, the highest graduation rate, for Asian youth,

While this increase in graduation rate is a positive, 2017 to 2018 also saw an increase in students who dropped out. As a state, California went from having a drop-out rate of 9.1% to 9.6% (California Department of Education, 2018). In 2017, 45,052 students dropped out; in 2018, 48,453 students dropped out. Further, significant disparities remain between student groups, specifically along ethnic/racial and socioeconomic lines. Table 2 shows dropout rate differences between 2017 and 2018 with regard to ethnic/racial identification, English learner status, foster youth, homeless youth, migrant education, students with disabilities, and socioeconomic status. Note an increase in the dropout rate from 2017 to 2018 for "socioeconomically disadvantaged" students from 10.8% to 11.1%; for homeless students from 16.6% to 17.9%; for Latinx students from 10.4% to 10.8%; and for African American students from 15.3% to 16.2%. This paradox partly reflects fluctuations in the number of students who continue after their senior year at alternative high schools. These students are classified as neither dropouts nor graduates.

Table 1

Graduation Counts and Rates by Student Group (California Department of Education 2018)

Ethnic/Racial Designation or Program	2018 Graduate Count	2017 Graduate Count	2018 Graduation Rate	2017 Graduation Rate
African American	22,851	23,191	73.3%	73.1%
American Indian or Alaska Native	2,203	2,302	70.5%	68.2%
Asian	43,984	39,948	93.6%	93.1%
Filipino	13,687	13,286	93.1%	93.0%
Hispanic or Latino	212,551	205,887	80.6%	80.3%
Pacific Islander	2,132	2,164	81.3%	81.8%
White	106,669	108,399	87.0%	87.3%
Two or More Races	11,579	11,213	84.1%	83.8%
Not Reported	2,549	1,734	46.1%	34.7%
English Learners	50,847	48,738	67.9%	67.1%
Foster Youth	4,091	3,666	53.1%	50.8%
Homeless Youth	23,771	27,845	68.9%	69.9%
Migrant Education	4,811	5,094	81.7%	80.4%
Students with Disabilities	38,414	36,421	66.3%	65.0%
Socioeconomically Disadvantaged	274,621	264,936	79.6%	78.8%
Statewide Total	**418,205**	**408,124**	**83.0%**	**82.7%**

Table 2

Dropout Count and Rates by Student Group (California Department of Education 2018)

Ethnic/Racial Designation or Program	2018 Dropout Count	2017 Dropout Count	2018 Dropout Rate	2017 Dropout Rate
African American	5,063	4,841	16.2%	15.3%
American Indian or Alaska Native	560	541	17.9%	16.0%
Asian	1,497	1,341	3.2%	3.1%
Filipino	474	418	3.2%	2.9%
Hispanic or Latino	28,555	26,531	10.8%	10.4%
Pacific Islander	304	276	11.6%	10.4%
White	8,787	7,836	7.2%	6.3%
Two or More Races	1,193	1,039	8.7%	7.8%
Not Reported	2,020	2,229	36.5%	44.6%
English Learners	13,275	12,234	17.7%	16.9%
Foster Youth	2,188	2,080	28.4%	28.8%
Homeless Youth	6,173	6,614	17.9%	16.6%
Migrant Education	621	610	10.5%	9.6%
Students with Disabilities	7,552	6,982	13.0%	12.5%
Socioeconomically Disadvantaged	38,437	36,288	11.1%	10.8%
Statewide Total	**48,453**	**45,052**	**9.6%**	**9.1%**

Students of color (i.e., Black and Latinx) drop out at higher rates than their peers at the national level. Students who drop out of a secondary education program can be categorized as a *status dropout* or an *event dropout*. A status dropout refers to a youth, ages 16 to 24, who was not enrolled in school and did not complete high school. In 2017, a combined 15% of Black (6%) and Hispanic (Latinx) (9%) were considered status dropouts, compared with 5% of non-Hispanic White youth (Child Trends Data Bank, 2018). An event dropout is when a youth, ages 15 to 24, enrolled in grades 10 through 12, drops out between October of a current academic year and October of the following academic year. In 2017, a combined 12% of Black (5.5%) and Hispanic (Latinx) (6.5%) were considered an event dropout, compared to 3.9% of their White peers (U.S. Department of Commerce, 2018).

A study by Gasper, Deluca, and Estacion (2012) looked at the relationship between school mobility and high school dropout rates of a nationally representative sample. What they found was that switching schools (i.e., changing high schools) was associated significantly with dropping out. As the number of schools a student attended increased so did their chance of dropping out. Further, they found that certain characteristics were positively correlated with a student switching schools. Some of those characteristics were lower socioeconomic status, more absenteeism and truancy, more suspensions, less sense of attachment to school, parents dropped out of high school, and completed fewer general science courses.

According to Love (2019), “Education is an industry that is driven by the realities that dark children and their families just survive” (p.11). She argued that a narrative continuously reminds the American public of an academic achievement gap between students of color and their White peers, but what is never mentioned is the role that systemic injustice has in creating this achievement gap. Further, she maintained that education reform and the quick-fix gimmicks that are proposed as "solutions" to the achievement gap are fueled by the narrative that dark children need saving in schools. These reforms in many urban schools offer survival tactics such as test-taking skills, acronyms, and character education. She cites that the four major testing companies in the United States make two billion dollars a year in revenue and spend 20 million dollars a year lobbying for more mandated student assessments. Therefore, the narrative of saving dark children in schools and the "reforms" offered work in tandem to fuel the test-taking industry. In sum, she asserted that, within a system of schooling that does not account for root causes of inequity, such as racism, discrimination, concentrated poverty, and other persistent structural barriers, students cannot be expected to succeed.

A report from America's Promise Alliance and its Center for Promise at Tufts University, *Don't Call Them Dropouts: Understanding The Experiences of Young People Who Leave High School Before Graduation* (2014) sought to better understand why some young people fail to graduate from high school in 4 years. The study used a mixed-methods approach in which researchers interviewed more than 200 young people in 30 facilitated group interviews in urban communities around the United States and received nearly 3,000 survey respondents from all 50 states. Three primary findings emerged from the study with regard to why students leave school before graduating: (a) clusters of factors, (b) environments are toxic, and (c) yearning for connectedness. With regard to cluster factors it was found that disengagement with school resulted from clusters of factors. There was no single reason or factor that drove students to leave school, nor was there a general, uniform profile for a student who failed to graduate on time.

Among some of the influences to leave school identified by students were support and guidance from adults, incarceration, death in the family, heath challenges in the family, gangs, school safety, school policies, peer influences, and becoming a parent. With regard to toxic environments, it was found that young people who leave school were often navigating toxic environments. Elements of this toxicity were violence at home, in school or in their neighborhood that they witnessed or personally endured, health trauma they or their family members experienced, and unsafe, unsupportive, or disrespectful school climates and policies. Further, a large number of students who left school reported being abused (30%), experiencing homelessness (22%), or spending time in juvenile detention (18%). With regard to yearning for supportive connections, researchers found that the presence or absence of connections directed many of the decisions young people made. Lack of connection with school staff (e.g., teachers), absent family members (e.g., parents), death in the family, familial abandonment, no engagement in school all were identified by students as reasons for leaving school before graduating.

Youth who drop out of their traditional secondary education programs do so for a number of reasons. Push, pull, and falling out factors have been used as a framework for understanding why students drop out (Jordan et al., 1994; Watt & Roessingh, 1994). A push factor is an adverse situation within the school that can lead to a student dropping out, such as tests, attendance, discipline policies, and consequences of poor behavior. Pull factors come from the student and can also lead to a student dropping out. Pull factors can be financial worries, out-of-school employment, family needs, family changes like childbirth or marriage, and illnesses that prevent students from prioritizing school. Falling out factors for dropping out occur when a student does not show academic progress in schoolwork and by extension becomes apathetic, unmotivated, or disillusioned toward completing school. Falling out can be seen as a byproduct of a lack of educational and individual support. A study by Doll, Eslami, and Walters (2013) looked at seven nationally representative studies that focused on dropout causes from a student's perspective and examined them together. Key findings from the study were that, from 1950 to 1980, the causes of dropping out were mostly due to pull factors; whereas from 1980 to 2002, the causes of dropping out had shifted more to push and fall out factors. However, in the most recent study (2002), both male and female students reported push factors as the most prevalent factor, an interesting finding as it evinces a shift that point at factors within the school as a major cause of students dropping out. Pushed out to where though?

Morris (2020) conducted a study on the criminalization of students of color, focusing on Black girls. Specifically, she wrote about how many educational policies and practices lead Black girls to be criminalized, rather than provide a safe space in which they become empowered. Morris emphasized how powerful narratives marred by negative stereotypes of Black girls influence how they are treated by educators, administrators, and their peers. Such narratives contribute to an alienating and punitive climate that provokes negative interactions between schools and black girls. Compounded by "school-based policies and practices that expose black girls to disproportionate application of discipline, that emphasize society's dominant and negative constructs of Black Femininity, or that seek to punish them for clothing and/or hairstyle choices"(Morris, 2020, p. 178), this characterization prioritizes discipline over education and contributes to a status quo of inequality In sum, Morris argued that zero-tolerance policies, school discipline, dress-codes, and increasing surveillance in schools creates a hyper-punitive educational environment that leads to the "pushout" of Black girls.

The “school-to-prison pipeline” refers to the policies and practices that push the nation's school children, especially the most at-risk youth, out of classrooms and into detention centers (ACLU, 2017). For youth who are pushed out of school and into juvenile detention centers, this process usually begins with inadequate resources in schools. Such inadequacy can arise from a lack of qualified educators or of educated counselors to provide guidance to students, overcrowded classrooms, insufficient or no support for students with learning disabilities, and excessive use of punitive discipline such as zero tolerance policies (ACLU, 2017). These inadequacies contribute to a second-rate education for youth who attend these schools and can lead to disengagement from school and increase the chances of leaving altogether (ACLU, 2017). Leaving school, or being pushed out of school—a more accurate term—greatly increases the chances of a young person being funneled into a detention center (Sum et al., 2009).

On a national level, Black and Latinx youth face punitive disciplinary actions at disproportionate rates in K–12 schools, are referred to law enforcement by schools at disproportionate rates, and are placed in juvenile detention centers at disproportionate rates. This phenomenon greatly affects their completion of a secondary education. With regard to punitive disciplinary actions in school:

- Black students represent 16% of the student population, but 32–42% of students suspended or expelled. By comparison, White students represent a similar range of between 31–40% of students suspended or expelled, but are 51% of the student population (Civil Rights Data Collection, 2014).

- Black students make up 20% of the out-of-school suspensions; Latinx students make up roughly 7% of out-of-school suspensions, while White students make up 6% of out-of-school suspensions (Civil Rights Data Collection, 2014).
- 12% of Black girls receive an out-of-school suspension, while 2% of White girls receive an out-of-school suspension. This finding is based on a sample size of 3.7 million Black girls and 12 million White girls (Civil Rights Data Collection, 2014).
- Black girls are suspended and expelled from K–12 schools at higher rates than other girls. For example, during the 2011–2012 academic year, 12% of Black girls were suspended from school; this rate is six times higher than for White girls as well as higher than any other group of girls (Civil Rights Data Collection, 2014).

With regard to referral to law enforcement by schools:

- While Black students represent 16% of student enrollment, they are 27% of students referred to law enforcement, and 31% of students subjected to a school-related arrest (Civil Rights Data Collection, 2014).
- Latinx students represent 24% of enrolled students, 24% of referrals to law enforcement, and 24% of school-related arrests (Civil Rights Data Collection, 2014).

The excessive use of punitive disciplinary actions, including referrals to law enforcement affects Black and Latinx youth at disproportionate rates and increases their chances of "dropping out" or being "pushed out" of a school (Civil Rights Data Collection, 2014). This persistent pattern of racial disproportionality is not due to coincidence, but rather due to institutional and societal biases.

Through a cultural capital framework, Black and Latinx youth who come from low-income backgrounds have a difficult time in school because they may not have the mindset, foresight, or social networks that allows them access to positions of success. According to Bourdieu (1986), cultural capital can exist in three forms: the embodied state, the objectified state, and the institutionalized state. In its embodied state, cultural capital can be seen as the characteristics and mindset of the individual, which hold significant value in society; for example, one's spoken language, dispositions, and style. This cultural capital contributes greatly to one's habitus, which Bourdieu described as a person's physical embodiment of cultural capital—one's habits, skills, and outlooks developed through their upbringing. Schools are seen as the central agents of social exclusion due to the pedagogy they reinforce, which favors the capital and habitus of "more educated" and affluent families. As Laureau (1987) stated, "Schools utilize particular linguistic structures, authority patterns, and types of curricula; children from higher social locations enter schools already familiar with these social arrangements" (p. 74).

For youth from wealthy families, these experiences in the home environment can better facilitate the child's adjustment to school and academic achievement. The academic world values certain cultural capital and habitus. Students who come from families with an accumulation of this valued type of cultural capital—which in turn reinforces a particular habitus—will do well in school because of the advantage they have of being able to perform in a manner valued by the school. Students who come from families that lack valued cultural capital, such as Black and Latinx youth from low-income families, will develop a different habitus. These students may not perform well in school due to lacking the mannerisms and understanding (i.e., the habitus) valued by school. This arrangement contributes to the social reproduction of inequality in schools, where certain students are valued more because of the capital and habitus they bring to school. If the habitus that youth of color bring to school is not valued, but in fact rejected in a school environment that young person may be neglected more often in the classroom. This neglect can then push the student to disengage from school. Disengagement can provoke suspension and eventually “dropping out” or being “pushed out.”

Alternative Education

Providing a viable alternative pathway for youth who do not find success on the traditional educational pathway is important. Youth who “drop out” of their traditional high schools may seek to return to school. For those young people who do, access to school may be a limiting factor; many schools have age limits or may not provide opportunities to earn a high school diploma. Alternative education programs are a potential pathway for young people.

There is no commonly accepted definition for alternative education/school, but for the purpose of this study we will use the definition set forth by Warren (2016) of the Public Policy Institute of California. According to Warren (2016):

> In California, “alternative school” refers to a set of schools that provide different educational settings for students who are “at risk” because they have dropped out, are pregnant or parenting, exhibit behavior problems, or need an alternative schedule to accommodate outside work. (p. 3)

There is no statewide system of alternative education; rather, there is a collection of schools developed for addressing student needs. In his report, *Accountability for California’s Alternative Schools,* Warren identified seven types of alternative schools in California (See Table 3); they are continuation school, independent charter schools, community schools, school of choice, community day schools, juvenile court schools, and opportunity schools. As Table 3 shows, there were 974 alternative schools in California in the 2013 to 2014 academic year. These alternative schools enrolled 136,587 students as of October 2013. Alternative schools represent 9.3% of all schools in California and 2.2% of all students. Further, alternative schools educate a significant number of students. According to Warren, they served almost 300,000 students, mostly high school juniors and seniors in the 2013 to 2014 academic year. In addition, about 12% of all seniors finished 12th grade at an alternative school. Nationally, 64% of districts reported having at least one alternative school or program for at-risk students; these programs served 646,500 students in the United States during the 2007 to 2008 academic year (Carver & Lewis, 2010).

Table 3

Types of Alternative Schools in California Identified by Warren (2016)

School type	Number of schools	Fall enrollment	Target population	Administrative entity
Continuation	468	62,830	Students ages 16 or older who are at risk of not graduating	Districts
Independent Charter	61	28,931	Students who have been expelled, suspended, truant, are pregnant or parenting, or who have dropped out of school	Independent
Community	68	15,202	Expelled students, students with behavior or attendance problems or who are on probation or parole	County offices of education
School of choice	38	13,283	Students who have been expelled, suspended, truant, are pregnant or parenting, or who have dropped out of school	Districts or county offices of education
Community day	234	7,353	Students who have been expelled or have behavior or attendance problems	Districts or county offices of education
Juvenile court	76	6,776	Students who are incarcerated in local juvenile detention facilities	Districts or county offices of education
Opportunity	29	2,212	Short-term intervention for students with attendance, behavior, or academic problems	Districts or county offices of education
Total	974	136,587		

SOURCES: California Department of Education, California Education Code.

Warren (2016) defined the seven types of alternative schools in California in the following manner. Continuation schools compose roughly half of the state's alternative schools and about the same proportion of enrollments in alternative schools. These schools serve students in grade 10–12 who are at risk of not graduating from high school. District and independent charter "schools of choice" enroll about 29% of all alternative school students. They are considered alternative schools when at least 70% of those enrolled fall under one of the following categories: expelled, suspended, or dropped out of school; living with a foster family; or habitually truant. Community schools, opportunity schools, and community day schools enroll roughly 19% of all alternative school students. They have been designed to support students with more significant behavior problems, attendance problems, or who have been referred by the county juvenile justice system. A small number of alternative schools serves incarcerated students. Juvenile court schools enroll roughly 5% of all alternative school students. Importantly, not all alternative schools are the same in terms of vision, mission, pedagogy, equity, and staff. I say this to note that students enroll in an alternative school for widely different reasons. Some students attend to a certain type of alternative school because they want to complete a high school diploma; some students are court mandated to attend a certain alternative school; and some students are minors in the eyes of the law and are required to attend school. Further, the length of time a student is enrolled at a certain type of alternative school can fluctuate. For example, at a juvenile court school, a student may only be enrolled for 6 months before they are no longer mandated to attend that school. Taking all of these factors into account make it difficult to determine the graduation rate for alternative schools.

Warren (2016) also explained why alternative schools are not likely to be held to the same metrics of achievement as traditional high schools. With seven types of alternative schools and no hierarchy or order of programs, calculating or assessing their performance is difficult. These schools, mostly independent of the others, are intended to support students in addressing academic or behavioral problems. It is difficult to gather data on the effectiveness of these schools in helping students to graduate high school for a few reasons. Alternative schools frequently work with students for only a few months; they serve small numbers of students relative to traditional high schools; and students enroll at different times of the school year, not just in the fall. In addition, because alternative schools serve a high number of juniors and seniors (95% of all alternative school students are considered juniors or seniors), traditional graduation rate calculators are not suitable to effectively give a graduation rate. A Policy Analysis for California Education study by Sublett and Rumberger (2018) compared the graduation rate in California from 2011 to 2013 by types of high school. The study used two different measures to calculate graduation rate: the traditional graduation rate, an Adjusted Cohort Graduation Rate (ACGR), and an alternative grade 12 graduation rate. For alternative schools and adult-serving schools, a grade 12 graduation rate is better suited because of the nature of these schools to serve older students who enroll predominantly at a grade 11 or 12 level. Table 4 shows a comparison of the graduation rates by types of high schools. Notice that the graduation rate for alternative schools using an ACRG was lower than the grade 12 graduation rate. Further, notice that the grade 12 graduation rate shows an increase from 2011–2012 to 2013–2014, from 47.8% to 59.6%. Although there is a difference between graduation rate from comprehensive schools and alternative schools and adult-serving schools, what is important to remember is that the students entering alternative schools and adult-serving schools are predominantly students who were not "successful" in comprehensive schools and who took a different path to complete a high school diploma.

Table 4

Cohort Graduation Rate vs. Grade 12 Graduation Rate by Type of High School in California

California State	2011-12	2012-13	2013-14
Total graduates	418,598	422,177	422,177
Cohort graduation rate	78.9%	80.4%	80.9%
Grade 12 graduation rate	82.8%	83.8%	84.7%
Comprehensive	**2011-12**	**2012-13**	**2013-14**
Total graduates	342,070	344,260	343,529
Cohort graduation rate	89.6%	90.8%	91.5%
Grade 12 graduation rate	90.8%	90.9%	91.1%
Charter	**2011-12**	**2012-13**	**2013-14**
Total graduates	29,081	30,162	32,780
Cohort graduation rate	57.9%	60.4%	62.5%
Grade 12 graduation rate	78.4%	76.6%	74.1%
Alternative	**2011-12**	**2012-13**	**2013-14**
Total graduates	47,447	47,755	45,868
Cohort graduation rate	41.9%	42.4%	40.9%
Grade 12 graduation rate	47.8%	54.2%	59.6%
Adult-serving	**2011-12**	**2012-13**	**2013-14**
Total graduates	3,453	4,024	5,110
Grade 12 graduation rate	39.3%	42.3%	47.4%

Data from California Department of Education Dataquest: http://data1.cde.ca.gov/dataquest/

Re-engaging Young People in Secondary Education

Providing pathways, such as alternative education programs, for young people to complete a high school diploma is essential to having an equitable society. With the understanding that young people who leave their traditional secondary schools do so for a number of reasons—lack of motivation, apathy toward academics, pregnancy, incarceration, financial hardships, family responsibilities, or whatever the reason may be—educators must make a concerted effort to provide supportive learning environments to re-engage young people. According to the Center For Promise, "Re-engagement is the process by which young people who have either left school without graduating or who are at risk of dropping out of school re-connect with systems that allow them to complete a high school diploma or equivalent" (America's Promise Alliance, 2014, p. 3). Programs that focus on re-engaging young people must provide a quality education and be designed to be malleable to the multiple contexts of each of its members. A study by Bloom (2010) sought to examine policies and programs designed to help high school dropouts improve their educational attainments and labor market outcomes. Bloom looked into 11 employment or education-focused programs serving youth who had dropped out of a traditional secondary school. One of his assertions was that a re-engagement program should not set out to "fix" its participants; rather, it should provide young people with multiple opportunities to succeed in and out of the classroom and to develop healthy relationships. The study by the Center For Promise (2014) sought to better understand what effective re-engagement programs across the United States were doing to support youth who had dropped out to complete a high school diploma and guide their transition to work and/or secondary education. The study conducted site visits, focus group interviews with young people, and one-on-one interviews with selected staff members in seven re-engagement programs across the United States. They provides a list of five elements that re-engagement programs should consider when deciding how to best educate and support their youth. Those elements are:

- Providing educational experiences that fit students' lives: this can include flexible schedules, smaller class sizes, individualized learning, and nonacademic courses that support life skills and youth empowerment.
- Encouraging supportive relationships with adults and peers: this can include caring relationships with adults who nurture, guide, and support young people, and the

development of positive peer relationship by building a community of support in the program.

- Providing reliable, consistent support and connection opportunities: this can include consistent follow-up and check-ins with young people when they are absent, providing on-site counselors, program-wide community building activities, and opportunities to foster one-on-one relationships between young people and staff members.
- Offering work-readiness strategies and practical work experience: this can include on-site workshops for job searches, resume building, and interview skills as well as paid internships, vocational programs, and partnerships with agencies that offer paid hours at various locations.
- Facilitating or providing access to comprehensive support services: this includes assessing the needs of the students in the community and providing support such as on-site meals, case management, day care, health care, and other social services via on-site services or partner organizations.

Morris (2020) has written about lessons for cultivating quality learning environments that emerged from her study on the hyper-criminalization of Black girls in schools. She gathered narratives from Black girls within detention centers from coast to coast; the six themes emerged:

- Protecting girls from violence and victimization in schools
- Proactive discussions in schools about healthy relationships
- Strong student-teacher relationships
- School-based wrap-around services

- An increased focus on student learning coupled with reduced emphasis on discipline and surveillance
- Consistent school credit recovery process between alternative schools and traditional district or community schools

Although, Morris's study focused on Black girls, these same themes should be applied in any school setting that works with young people who have had their secondary education disrupted.

Importance of Science Education

In *Empowering Science and Mathematics Education in Urban Schools*, Barton, Turner, Varley, and Tan (2012) argued that math and science hold a powerful place in our society, provide an opportunity for high-paying professions; allow for in-depth conversations with educators, health care workers, and community leaders; and elucidate issues with global importance like toxic dumping, water quality, and climate change. Therefore, providing an equitable science education to Black and Latinx youth who have dropped out of their traditional schools is a significant issue for three reasons: (a) success in science classes can support success in academics, (b) it can provide a pathway to a quality employment opportunity, and (c) development of youth who have a critical understanding of science phenomena is an issue of social justice.

First, science education can support success in other courses through the development of skills that can transfer disciplines. For example, critical thinking is a skill that can help youth make better decisions in their lives. Exposure to and achievement in STEM courses has been shown to improve critical thinking skills as well as achievement in other classes (Becker & Park 2011). When a student does not receive an equitable education—one that is engaging and provides them with support to succeed academically, they may become apathetic and lose the desire to continue in school, which may lead to a student dropping out. As was examined in the previous section, this phenomenon can:

> push a young person from a school to a detention center. For many students who drop out, challenges in the science classroom only serve to perpetuate the drop out phenomenon. In fact, an indicator for students at risk of dropping out at the end of ninth grade is having more than one failing semester in core subjects of which science is included. (National Research Council 2011)

Further, studies have found that that the more science classes required to graduate, the more likely a student is to drop out of their secondary education program (Plunk, Tate, Bierut, & Grucza, 2014). The Civil Rights Data Collection (2014) shows that schools with high Black and Latinx enrollment offer less access to high-level mathematics and science courses than schools with low Black and Latinx enrollment. For example, 56% of high schools with low Black and Latinx student enrollment offer calculus, compared to 33% of high schools with high Black and Latino enrollment (Civil Rights Data Collection, 2014). This reality can lead to disproportionate rates in science course enrollment, which in turn has an impact on high school completion. According to the National Science Foundation (2016), for all ninth-grade students who began high school in 2009 and completed by 2013, Asian students were the most likely to take advanced science courses, by a large margin. For example, 25% of Asian students took advanced chemistry, compared to 9% of White students, 3% of Black students, and 5% of Latinx students. With regard to high school completers who took general science, the statistics were 48.5% of Asian students, 76.6% of White students, 85.4% of Black students, and 84% of Latinx students.

With regard to employment opportunities, providing an equitable science education for youth who have dropped out of their traditional high school programs can provide a pathway for

Black and Latinx youth. According to the PEW Research Center (2018), Black and Latinx workers continue to be underrepresented in the STEM workforce. While Black people make up 11% of the U.S. workforce overall, they represent 9% of STEM workers; while Latinx people make up 16% of the U.S. workforce, they represent 7% of all STEM workers. Further, according to the U.S. Bureau of Labor Statistics, "Employment in STEM occupations grew by 10.5 percent, or 817,260 jobs, between May 2009 and May 2015, compared with a 5.2 percent net growth in non-STEM occupations" (Fayer, Lacey, & Watson, 2017). Moreover, according to U.S. Bureau of Labor Statistics, "STEM isn't only for people who have a bachelor's or graduate degree. Many occupations typically require an associate's degree, and a small number require either some college but no degree or a high school diploma or equivalent" (U.S. Bureau of Labor Statistics, 2014). I highlight these labor statistics to give context to a field in which there is opportunity for youth who choose to take the route of the science professional. However, teaching science for the sake of a preparing a workforce is not adequate. That is not to say that students who express the desire to go into a professional science field should be discouraged; they should be supported through this process.

Lastly, providing an equitable and critical science education to youth who have dropped out of their traditional high schools is an issue of social justice. The fact remains that not all students will want to become a science professional, but all students should be able to engage with science and develop an understanding of science that allows them to make informed decisions in their lives. Whether someone chooses to pursue a career in a STEM field, it is essential that we continue to find ways to maintain people's interest in science and support their ability and willingness to use scientific information as a part of individual and collective decision making (Finkel, 2018). We are living in a time when misinformation saturates our daily lives in many facets, be it social media, mainstream media, or day-to-day conversations. As statements become estranged from evidence, it is crucial that science classrooms provide young people with the tools and practice to engage, access, and utilize science based in evidence when making decisions that impact their lives. We are currently experiencing a pandemic due to SARS-CoV-2 Virus that causes the Covid-19 disease. An accurate understanding of science content regarding viruses and the ability to access data that provide evidence-based claims about viruses allow one to make informed decisions about their health and well-being. One of the impacts of misinformation is the ability for people with a platform to tie their agenda to science-based phenomena. A major issue arises when this practice is used to tie science phenomena to issues of race, as we are seeing in this pandemic. In an article posted on the Yale School of Medicine Website by their vice chair for diversity, equity, and inclusion for pediatrics, Dr. Marietta Vazquez (2020) speaks of a spike in discrimination and xenophobic attacks on Asian American and Asians around the world. Dr. Vazquez noted that when the virus that causes covid-19 is referred to as the "Wuhan Virus" or the "Chinese Virus," it can stigmatize people of Asian background and can create bias toward them. The reality is that viruses do not discriminate, and what someone looks like has no bearing on how likely they are to get sick from Covid-19. According to Dr. Vazquez, this stigma—and the behavior tied to it—can prevent people who may need medical help from getting it. This is just one example of how misinformation of science phenomena can spread negative effects.

Science has a long history of racism. It has been used to support racist thought and the actions that go with them. In *Superior*, Angela Saini (2019) talked about the social construct of race and how science is intertwined with it. She explained how modern ideas of race were formed during the height of European colonialism, and how White European men used race science were embedded with ideologies of social Darwinism and eugenics to justify the conquest, enslavement, and extermination of non-White people. Further, she explicated how race is an arbitrary way to categorize people motivated by political agendas, not scientific goals. Saini maintained that racism has never left science and, if left unchecked, can reinforce racist conclusions. As an example, she described researchers seeking a biological basis for African Americans' high rates of hypertension. Racializing this association to tie a predisposition of illness to the genetics of African American people reinforces an "inferiority" mindset. Saini further asserted that evidence supports that environmental factors, such as diet, stress, and poverty resulting from discrimination are the primary causes of higher rates of hypertension in African American communities. Looking at scientific phenomena through a critical lens allows students to access underlying messages, deconstruct them, and reformulate them in the context of their lived realities.

According to Finkel (2018), attacks on science and scientific ways of knowing have contributed to a climate in which unsubstantiated claims are accepted without question:

> Over the past decade, attacks on science knowledge and attempts to legislate and restrict science teaching have again become a regular part of the U.S. landscape around a variety of issues that include the theory of evolution, human-caused climate change, and the safety of vaccinations. (p. 42)

The World Resource Institute (WRI) is a global research institute that spans 60 countries and focuses on critical issues at the intersection of environment and development: climate, energy, food, forests, water, cities, and the ocean. According to WRI researcher Kelly Levin (2017), "Science and truth are under siege all around us. High-level decision makers in the United States are casting doubt on scientific understanding, defending false information and making decisions in the absence of evidence" (Levin, 2017). Ellingboe et al. (2015) gave an example based on climate change deniers in Congress: as of 2015, over 56% of Representatives either denied or questioned the science behind human-caused climate change, though a plethora of scientific evidence speaks to the human causes of climate change (NASA, 2019). Levin (2017) explained that a major issue is that "When facts are redefined, we find ourselves on a slippery slope. Data can be manipulated to support arguments, and policy is no longer informed by facts" (). Therefore, it is imperative that young people are given science classes that develop their understanding of scientific phenomena and the agency to engage with it.

Social justice science education encourages using science knowledge and skills to help make a world that is more just and fair. Social justice science teaching "perceives students as critical consumers and producers of knowledge capable and responsible for enacting their own sense of agency to bring about positive social change for themselves and their communities" (Rodriguez, 1998, 2015). The science classroom must be a space in which students practice social, political, and academic empowerment through science. Science education can be an arena where students navigate, critically question, and examine issues and their related social factors. Doyle-Morales (2017) has argued for a justice-centered science pedagogy, which fuses critical pedagogy and culturally relevant pedagogy as a means of social transformation through science education. That is, through this pedagogy of science young people can achieve academically, while taking up issues of urgent social and environmental justice identified in their communities. Doyle-Morales found that curriculum organized around an issue of environmental racism supported academic achievement and provided opportunities for youth to position themselves as transformative intellectuals.

Issues in Traditional Science Education

Traditional science curriculum consists of units, lessons, and assessments often unrelated to experiences of students' everyday life. Many schools still promote the goal of science education as preparing students for the next step of science education, a career in STEM, rather than using it to develop students who could come to see science as a way to investigate and make decisions about science-related personal and social issues (Finkel, 2018). Traditional science education is reflective of a view of scientific practice that is often too far removed from the students' experiences and the issues or questions they may face in their communities (Brickhouse, Lowery, & Schultz, 2000). Further, these forms of traditional pedagogy often ignore or reinforce a culture of science that has excluded and oppressed women and people of color. This is not an education that is inclusive and supportive of students of color.

Aksakalli (2018) has spoken to how the marketization of education has led to the transformation of schools into businesses, thus also changing science education. When science education is seen as an instrument to advance economically, rather than as a contribution to the development of a young person, it loses its social quality and becomes merchandise (Aksakalli, 2018). A major issue with current science education is that it emphasizes a focus on what Aikenhead (2006) has called the "pipeline" approach, which refers to the preparation of science professionals, such as engineers, doctors, and scientists. This model perpetuates a fallacy that understanding or engaging with science is only for those who want to go into those fields. Current trends in science education, such as standards and testing, are striving to meet global economic objectives, promoting a generic science education with no local ties and no relevance to the students in the class. Science education should be made local and relevant to all students. A science education from "nowhere"—that is not localized or made relevant to students—can act as “systemic colonizer” (Aikenhead, Calabrese, & Chinn, 2006). Aikenhead and his colleagues argued that school science driven by standards and high stakes exams is grounded in a specific worldview and way of knowing that continues to be reproduced in traditional schools, thus normalizing this culture, a monoculture. According to Pratt (1994), reproduction of a monoculture in school science, occurs through a process of “cultural transmission,” a perspective that maintains that the primary purpose of curriculum (in this case, traditional science curriculum) is to “transmit the best products of the intellectual culture” (p. 9). When schools value this culture, students who do not assimilate to it (i.e., perform well on exams and meet all standards), or educators who do not abide by it, are seen as “distractions” or “deviances” (Aikenhead et al., 2006) Aikenhead proceeded to develop a comprehensive case for an alternative to this “pipeline” approach of science education whereby students learn science for use in their everyday life—what he termed a “humanistic” approach. With this in mind, it has been argued that the science classroom should serve to develop students who challenge social inequality through teaching, curriculum, and social transformation (Dos Santos, 2009; Finkel 2018; Mutegi, 2011; Rodriguez, 1998). Further, Moje (2007) argued that teaching science for social justice “not only provides access to mainstream knowledge and practices but also provides opportunities to question, challenge, and reconstruct knowledge. Social justice pedagogy should, in other words, offer possibilities for transformation” (p. 4).

Academic Achievement

When looking at academic achievement in the science classroom, students of color, such as Black and Latinx students, test at lower levels than their White peers (National Science Foundation, 2016). According to the National Science Foundation (2016), with regard to the National Assessment of Educational Progress (NAEP), which provides the largest nationally representative and continuing assessment of what America's students know and can do in various subject areas, there is an achievement gap in science. The 2015 data is representative of all fourth-, eighth-, and 12th-grade students in both public and private schools. Focusing only on 12th-graders, the science assessment scale goes from 0 to 300. Socioeconomic status is accounted for by qualifying for free or reduced price lunch. What we see is that for students who qualify for free or reduced price lunch, White students, on average, scored 154; Asian students, on average, scored 148; Latinx youth, on average, scored 135; and Black youth, on average, scored 127. For 12th-grade students who did not qualify for free or reduced price lunch, we see that White students, on average score 171; Asian students, on average, scored 174; Latinx youth, on average, scored 154; and Black youth, on average, scored 146.

Lower socioeconomic status may play an important role in explaining science achievement gaps (Reardon, 2011). Children growing up in low-socioeconomic status families usually experience fewer early opportunities to learn about the natural and social sciences, in part because their parents often have lower educational levels and therefore less science knowledge themselves as well as fewer resources to support their children's cognitive and academic growth (Sackes, Trundle, Bell, & O'Connell, 2011). Black and Latinx "minorities" are far more likely to be raised in families experiencing economic disadvantages. For example, children who are Black and Latinx "minorities" are about twice as likely to live in poverty as those who are White (Murphey, Belford, Balding, & Beckwith, 2018). In addition, youth raised in poverty often attend poorly resourced and racially segregated schools that further limit their academic opportunities (Liu & Whitford, 2011; Ma & Wilkins, 2002).

Studies have shown that in the earlier years of education, there is no significant achievement gap in science; but as students transition to secondary science this gap increases.

Research has indicated that students from nondominant backgrounds, such as Black and Latinx, lose interest in learning science as early as middle school and that this loss of interest has an impact on student attitude toward future participation in science (Barmby, Kind, & Jones 2008). This finding informs us that, as youth progress through the academic years, something changes for them with regard to science. Student interest in science, support they receive in science, and overall opportunities to succeed seem to shift. This conclusion is supported by the fact that students of color also earned fewer credits than their White peers in science classes. According to the High School Longitudinal Study of 2009 (HSLS:09) *2013 Update and High School Transcript Study: A First Look at Fall 2009 Ninth-Graders in 2013*, ninth-grade Black and Latinx student earned fewer credits in science classes than their White peers, on average (Dalton et al., 2018).

The epistemology that grounds traditional science education can also contribute to lack of achievement by students. According to Kincheloe (2008), there is a standardized view of knowledge in traditional schools. FIDUROD is an acronym he coins for the basic features of the contemporary mechanistic epistemology used to shape the knowledge that permeates traditional schools. This entails a view of knowledge as:

- **Formal**: produced by a rigid adherence to a particular research methodology that never changes
- **Intractable**: grounded on the assumption that the world is a static entity
- **Decontextualized**: constructed by researchers who have removed phenomenon from the diverse of which it is a part
- **Universalistic**: what inquirers discover when following a certain epistemology and research method must apply to all domains of the world

- **Reductionist**: focusing only on those factors that lend themselves most easily to measurement
- **One Dimensional**: shaped by the belief that there is one true reality that can be discovered and completely described by following correct research methods

According to Kincheloe, schools typically teach a curriculum that employs a FIDUROD epistemology. Such curriculum then has certain "valid" body of knowledge, which it seeks to pass on to students. The science curriculum of traditional schools is no exception. This curriculum is geared toward teaching individuals the same knowledge in the same way regardless of who the students are. Tied to this curriculum are the standardized tests that serve to measure how well students are being molded. These standardized tests are pushed as the only true measure of how well students are performing academically. Such a model can prevent youth from marginalized backgrounds—such as Black and Latinx youth—from succeeding in traditional school science classrooms. That is, that when students do not perform well academically, it is assumed that they are not proficient or lack the academic ability to learn the science content. However, it might be that students from marginalized backgrounds do not succeed in a traditional science classroom because the knowledge it sees as valid does not place value on the lived experience, cultural background, or perspective they bring into the classroom or as an investment with long-term significance for them. Rather, it is a standardized knowledge that places value on a specific worldview that is Eurocentric and seeks to inculcate students with its universal science content (Kincheloe, 2008).

Taking all of these findings into account, it is important to develop equitable science classrooms that support Black and Latinx youth who have dropped out of traditional secondary education programs. Many factors have been shown to support academic achievement in a science classroom. However, regarding youth who have dropped out of school, there is limited literature on support for achievement in the science classroom. Within factors that may contribute to student academic achievement, I will look at student perceptions of science teachers, relevant science pedagogy, relevance of science to students, engagement in science class, and students' sense of agency to create knowledge.

Student-Perception of Science Teacher

In *Visible Learning*, John Hattie (2009) sought to understand the influences on achievement in students. To do so, he analyzed over 800 meta-analyses on factors that contributed to student academic achievement. Among the many findings, Hattie found that teachers played a major role in student achievement. With regard to achievement, Hattie found that the quality of the teacher and the nature of the teacher-student relationship had the highest effect, followed by teacher expectations of their students.

All the meta-analyses on the impact of quality of teacher on learning came from student ratings of teachers. Some of the most powerful indicators of quality of teacher from highest to lowest effect size were as follows: teacher had a deeper understanding of their teaching and its effect on student learning; teacher had high level of passion for teaching and learning; teacher had a deep understanding of their subject; teacher had a problem-solving disposition toward teaching; teacher promoted a positive climate; teacher had respect for their students, challenging and encouraging them to think (Hattie, 2009).

All data for the impact of teacher-student relationships on student academic achievement came from students, teachers, and schools. Some of the powerful affective outcomes for teacher-student relationship from higher to lower effect size were as follows: nondirectivity (i.e., student-regulated and student-initiated activities), empathy, warmth, encouragement, higher order thinking, encouraging learning, adapting to differences, genuineness, and learner-centered beliefs (Hattie, 2009).

Science educators play a pivotal role in students' academic success. The attitude an educator has with regard to who can and cannot succeed in school can be communicated in a number of ways, explicitly and implicitly, to students (Rosenthal & Jacobsen, 1968). This messaging can impact a student's success in the science classroom. Given this understanding, another reason students do not engage in school and underperform can be because of deficit thinking by teachers. If a teacher does not believe that students can do well academically or that they have a deficit when it comes to learning, then this can lead to the construction of a negative zone of development for the students (Diaz & Flores, 2001). From a deficit view, teachers can be influenced to create lessons that are focused on dead-end skills, instead of developing lesson plans optimal for advancing the student's zone of development (Diaz & Flores, 2001).

A support for students who have underperformed is to always have high expectations (Lemov, 2010). According to Vygotsky (1978), thinking begins as a social process that children gradually internalize; if one has high expectations for students, over time, those expectations will be internalized and become part of their self-identity. This positive disposition toward a science teacher can then support students to achieve academically. Research has also found that teacher support, such as teacher caring and encouragement, is predictive of student engagement (Wang & Eccles, 2013). Valenzuela (1999) argued for *authentic caring* by educators. Authentic caring is defined as a trusting relationship developed by educators with students that is the cornerstone for all learning (Valenzuela, 1999). She asserted that authentic caring needs to move beyond aesthetic caring that focuses primarily on nonpersonal content. In her study, she found a difference in how educators and students perceived caring. Educators understood caring in an aesthetic manner; for example, they expected students to care about school and achievement in school. Students expected educators to care about them, pushing for reciprocity and respect. She found that because students at the high school level experienced more aesthetic caring, as opposed to authentic caring, there was a disconnect between educators and students that led to sense of alienation for both groups. Authentic caring requires the development of a trusting teacher-student relationship, which includes an understanding of the students' cultural world and their structural positions (Valenzuela, 1999).

Educators must develop as transformative intellectuals (Giroux, 1988), which means that the educator must possess the knowledge, skills, values, and attitude to question, understand, critique, and act as a change agent of structural inequities. The transformative educator strives to develop discourse that unites the language of critique with the language of possibility, work to create conditions that give students opportunities to develop as democratic citizens, and support students in developing values that enhance their critical powers (Giroux, 1988).

Science educators must serve as transformative individuals in the classroom. Rodriguez (1998) provided a model for educators based on a sociotransformative constructivist orientation (STC), a vehicle that links multicultural education to social constructivism. Through this orientation, educators can provide a space in which science content and student experience can be collaboratively transformed to meet social justice goals. The STC orientation consists of four elements: (a) dialogic conversation, which refers to an understanding of "who is doing the talking?" and where is knowledge coming from; (b) authentic activity, where learners are provided opportunities to engage in activities relevant to their everyday lives; (c) metacognition, reflection on what and why students are being asked to learn something; and (d) reflexivity, which refers to a way of examining a culture of power with regard to knowledge and how it is produced and reproduced (Rodriguez 1998).

Relevant Science Pedagogy

According to Lee (2011) when "non-mainstream" students (i.e., students of color, from low-income families, and/or learning English as a new language) do not succeed in the science classroom, it can be attributed to a lack of equitable learning opportunities. An equitable learning opportunity occurs when school science "(a) values and respects the experiences that all students bring from their homes and communities, (b) articulates this cultural and linguistic knowledge with disciplinary knowledge, and (c) offers sufficient educational resources to support science learning" (Lee, 2011, p. 3). This approach can lead to engagement, relevance, sense of agency to create knowledge, and ultimately academic success in the science classroom. Using culturally relevant pedagogy in a science classroom can serve as a framework for maintaining student interests, engaging students, and supporting academic success in a science classroom. A synthesis conducted by Aronson and Laughter (2016) looked at culturally relevant education in several education fields, including math and science. Drawing from social-justice-oriented pedagogies, such as culturally relevant pedagogy (Ladson-Billings, 1995) and culturally responsive teaching (Gay, 2013), their synthesis found that culturally relevant education consists of the following:

- Using constructivist methods to develop bridges connecting students' cultural references with academic skills and concepts;
- Engaging students in critical reflection about their own lives and society;

- Facilitating students’ cultural competence, which entails supporting students to recognize value in their own cultural beliefs and practices while gaining access to STEM culture; and
- Unmasking oppressive systems through the critique of discourses of power.

Specifically, culturally relevant pedagogy, as proposed by Ladson Billings (1995) promotes the idea that science content be connected to students’ interests and concerns, meaningfully integrate students’ culture into the curriculum, and elevate students’ sociopolitical consciousness by investigating real issues in local contexts.

In addition, critical pedagogy, a teaching approach oriented for self and social change, can inform an equitable science education. Critical pedagogy, as proposed by Shor (1992), maintains that student growth is an active, cooperative, and social process and that it is a student-centered curriculum for multicultural democracy. According to Shor (1992), critical pedagogy strives to relate personal growth in the real world and for students to develop habits of inquiry with critical curiosity about power and inequality in society. Critical pedagogy as proposed by Aronowitz (1993) is centered on practical intent directed to changing conditions of everyday life and addressing the problem of power. Giroux (2006) informed us that critical pedagogy “is a discourse for asserting the primacy of the political and the ethical as a central feature of educational theory and practice” (p. 4). According to Giroux, critical pedagogy maintains that school practices must be directed toward the empowerment of young people, the development of a democratic space, rewriting the curriculum to address the lived experiences of students, educating teachers to be publicly engaged intellectuals, and creating new forms of knowledge by deconstructing disciplines and recreating them as responsive to the everyday knowledge of students’ lived experiences.

The problem-posing model of education, proposed by Paulo Freire (1970), can support students who have underperformed in a school. Incorporating this critical pedagogy into a classroom, through project-based learning, can make the content more applicable in the lives of students and, in turn, more engaging. Traditionally, schools have worked under what Freire (1970) calls the “banking model” of education. Under this model, the teacher is seen as the one who holds knowledge and the students are depositories for this knowledge. Under this model, students are not seen as creators of knowledge, rather as receivers.

In the problem-posing model proposed by Freire, educators and students see knowledge as something that allows them to be free and become agents of change. Knowledge is not received from a teacher only; rather, it is gained by critically analyzing what you study and the world you live in. According to this pedagogy, knowledge is not static, but constantly changing and being created. This pedagogy allows the student to develop a sense of agency in creating knowledge by encouraging praxis. Praxis is the action of putting knowledge to practice; that is to say, to actually apply the knowledge that one has on a given topic toward a purpose (Layton 1991). Another pedagogical model support for students who have underperformed in school can be the community of learners model in a science classroom. According to Rogoff (1994), “In a community of learners, all participants are active: no one has all the responsibility and no one is passive”; that is to say, teachers and students alike are participants in learning and share active roles in the management of this learning process. This model can be adapted to many different subjects, including a science classroom. Through this practice, students are socializing with their peers in order to learn and create knowledge.

An article by Alegria (2014) explains that critical pedagogy “is not a homogenous set of ideas or instructional techniques, but rather a myriad of heterogeneous principles and concepts” (p. 109). In addition, she reviewed four main themes of critical pedagogy:

- Identity/Personal Growth: teaching focused on the students’ culture, socioeconomic status, and identity.
- Academic/Cognitive: teaching that emphasizes skills and knowledge of the student as well as their development of critical thinking.
- Teaching that develops students’ critical understanding of society, power, and inequality in society.
- Teaching that develops students consciousness as to their own personal power to change their status and the world.

Barton et al. (2012) add to this pedagogy by defining a critical science literacy based on three main ideas: transformation of discourse and practices, transformation identities, and transformation of spaces for learning/doing science. This literacy implies “that students use the knowledge, practices, and context of these disciplines to develop empowering identities, to advance their positions in the world, and/or to alter the world toward what they envision as more just” (Barton et al., 2012, p. 40).

Relevance of Science to Students and Curriculum

It is critical that students feel a connection to science and that they find science relevant to them. When students feel that science is relevant to them, then they experience more success in the science classroom. A meta-analysis by Schroeder et al. (2007) found that in science education from 1998 to 2004 the largest impact on student achievement was teachers using “enhanced context strategies” in which they related learning to students’ previous experiences or knowledge or engaged students' interests by relating learning to the students'/school's environment setting. Further, a growing body of research shows that students who do not find personal meaning or relevance in science will not pursue science beyond what is required in school (Basu & Barton, 2007; McClure & Rodriguez, 2007).

Hattie (2009) argued, "It is less the content of the curricula that is important than the strategies teachers use to implement the curriculum so that students progress upwards through the curricula content" (p. 159). The science classroom is no exception. In analyzing two meta-analyses that consisted of 84 studies, he found that certain strategies had a higher effect size on academic achievement in the science classroom. Strategies that impacted academic achievement in science class in descending order were as follows: enhanced content strategies (e.g., relating topics to previous experience or learning and engaging students' interests), collaborative learning, inquiry, manipulation and laboratory experience, and instructional technology strategies.

Engagement in Science Education

Student engagement, as defined by Wang and Eccles (2013) refers to the quality of a student's involvement in academic settings and learning activities. Fredericks, Blumenfeld, and Paris (2004) conceptualized student engagement in three dimensions: (a) behavioral engagement, referring to the student's participation effort, attention, persistence and positive conduct; (b) emotional engagement, referring to the student's positive and negative reactions to teachers, peers, classroom activities, and value they find in learning; and (c) cognitive engagement, referring to students' self-regulated learning and exerting the necessary effort for the comprehension of complex ideas. Drawing from expectancy-value theory, which posits that engagement is most directly influenced by expectancy beliefs and subjective task, Eccles (2009) argued that individuals are more likely to participate in science learning activities when they have high perceptions of their chance of succeeding and also find these learning activities interesting, important, and compatible with their own experience.

Student engagement in math and science coursework is important to developing the preparation and persistence necessary to succeed in science and to pursue college education and/or a career in STEM (Maltese & Tai, 2010). Additionally, student engagement is positively correlated to teacher support—the more support given to a student by an educator, the more a student was engaged in class (Akey, 2006; Garcia-Reid, Reid, & Peterson, 2005). Further, it has been found that students who noted that their teachers were supportive and cared about their success were more likely to be engaged in the classroom as well as perform well academically (Akey, 2006; Heller, Calderon, & Medrich, 2003).

Students who are engaged in school are likely to achieve greater academic success (Skinner, Furrer, Marchand, & Kindermann, 2008). Educators can further support youth engagement by developing a classroom space that has a culture of achievement. Teachers can also contribute to student engagement by developing interactive and relevant lessons and activities and being encouraging and supportive of students. Akey (2006) found that students learn more when they are active, rather than passive, participants in the learning process and when they can relate to what is being taught. Also, drawing connections between information taught and real life can be an effective way of engaging students in lessons (Heller et al., 2003).

Students Sense of Agency to Create Knowledge

Support for student learning is imperative for success in a science classroom. From a constructivist perspective, learning occurs through an individual's prior knowledge and experiences (Cakir, 2008). Constructivism includes the importance of prior knowledge, existing cognitive frameworks, and the use of relevant information for conceptual change or learning to occur. Further, according to sociocultural theory, learning occurs through social interactions, where ways of thinking become internalized (Vygotsky, 1978). Learning is culturally and historically situated, meaning that a person's background will influence how they perceive and learn information (Vygotsky, 1978). With this understanding, making content relevant to learners is necessary for academic achievement. In addition to relevant content, it is important for students to be engaged in knowledge creation within the science classroom.

As Barton et al. (2012) have argued, "Learning is less about practicing the routines of knowledgeable others than it is about re-creating those practices in socially and culturally situated ways that confer the students with more agency with which to participate across communities". This is the epitome of knowledge creation. A student must be able to understand a science concept and have the agency to understand it in the context of their life, then be able to re-create that science content to add to it. Given that science is a community, as individuals join a community they bring with them resources in the form of experiences, which with their agency create knowledge that can transform the discourse and practices of that community (Barton et al., 2012). In supporting students to become critical consumers and producers of knowledge—and by supporting them to develop a strong sense of agency—students can experience a positive change for themselves and their communities (Lee & Buxton, 2010; Rodriguez, 2015).

Traditional education systems tend to keep students on predetermined paths to master set knowledge and skills as opposed to encouraging risk-taking, decision-making, and collective creativity (National Academy of Engineers, 2015). According to Chen and Zhang (2016), this framework treats knowledge as a static entity and educational objectives are based on student acquisition of a well-established body of knowledge. The acquisition of knowledge is guided through pre-sequenced learning contents and activities and pre-set performance measures to keep students on track.

To prepare youth to develop solutions to the issues that face us today and in the future, we must utilize a framework or method in which students are engaged in real-world knowledge practices. According to Bereiter (2002), it is necessary to develop models of education that support innovation, in which knowledge is treated as shared conceptual artifacts that are continually contributed to by members of a community. Bereiter (2002) argues that this should be at the center of education because it adopts the approach of knowledge-creating organizations. As Chen and Zhang (2016) have argued:

> Education in line with real-world knowledge processes should treat learning as a matter of collaboratively developing shared knowledge objects and artifacts through sustained inquiry and interactions, a practice absent in typical learning experiences in schools emphasizing efficient coverage of static-state knowledge and skills. (p. 141)

Knowledge building is pedagogy that promotes knowledge creation as the central goal of education, framing education around real-world knowledge-creating processes (Scardamalia & Bereiter, 2003).

Paavola and Hakkarainen (2005) proposed knowledge creation to describe an emerging form of learning that places dual emphasis on knowledge and practice. They argued that knowledge creation is a means of transcending a conflict between an acquisition approach to learning, in which one adopts subject matter knowledge, and a participation approach to learning, in which one learns through the process of participating in social communities and enculturation. Knowledge creation is “a process of creating and developing new material and conceptual artifacts” (Paavola & Hakkarainen, 2005, p. 7). Within an education setting, knowledge creation becomes practical when there are available tools to support individuals and their communities to work together for the advancement of knowledge. In this sense, the community can be the class itself.

Tlali (2017) has debated that for functional knowledge creation through the decolonisation and transformation of teaching and learning. In his article "Creating Sustainable Physical Science Learning Environments: A Case for Decolonised and Transformative Learning," Tlali argued that through service-learning projects students can be empowered and create knowledge. Tlali explained that because some cultures dominate discourses and, by extension, other cultures are subjugated and excluded, then knowledge is contextualized in a specific culture. Further, he argued that this cultural dominance and subjugation creates tension in the process of knowledge creation. Inclusion of learners' cultures—along with their diverse and multiple perspectives—is a means of decolonizing and transforming learning from a dominant culture perspective to an inclusive perspective. This decolonization and transformation can "create empowering and meaningful learning spaces and have the capacity to facilitate the generation of functional/relevant knowledge" (Tlali, 2017 p. 87).

Future STEM Aspirations

According to the report *Women, Minorities, and Persons with Disabilities in Science and Engineering* by the National Science Foundation and National Center for Science and Engineering Statistics (2019), women and people of color (i.e., Blacks or African Americans, Hispanics or Latinos, and American Indians or Alaskan Natives) have been largely underrepresented in most STEM fields; that is, that their representation in STEM education and STEM employment is smaller than their representation in the US population. When looking at

STEM degrees earned by "underrepresented minority" women and men as percentage of all STEM degrees awarded by each degree, by degree type, we see that following:

- STEM bachelor's degrees earned in 2016: 9% by men and 12.6% by women
- STEM master's degrees earned in 2016: 5.5% by men and 7.8% by women
- STEM doctorate degrees earned in 2016: 3.8% by men and 5% by women

These numbers continue to be low in relation to their White and Asian peers in the same fields of study (National Science Foundation and National Center for Engineering and Statistics, 2019).

All students should have the option of pursuing a postsecondary education in STEM or a career in a STEM field if they so desire; however, not all students feel they have the option or ability to do so. Researchers have identified a wide array of factors that affect individual differences in STEM motivation, performance, and educational and career aspirations. A literature review by Wang and Degol (2014) examined the current knowledge surrounding individual STEM aspirations. In Wang and Degol's literature review, STEM refers to the physical, biological, medical, health, and computer sciences as well as engineering and mathematics. They found that sociocultural, contextual, and psychological factors have an effect on individual motivation to pursue STEM. Below is an overview of each factor.

Psychological Factors

Intellectual ability. It has been found that individual differences in beliefs about intellectual ability have been linked to academic performance. According to Dweck (2007), when individuals believe that ability is an innate trait, they find it difficult to confront challenging tasks, give up easily, and use lack of talent as an excuse for failure. However, students who believe that effort and practice are determinants of success and that intelligence is something that can be developed have higher motivation and perform better academically.

Self-concept. It has been found that individuals were more likely to choose activities in which they had a higher expectancy for success (Eccles et al., 1998). Further, students who had lower self-efficacy in STEM courses were less likely to perform well in these courses. As an extension, students who had higher STEM self-efficacy were more likely to take more STEM courses and were more likely to pursue a STEM career (Dweck, 2008). In addition, students who were interested in STEM were more likely to take more STEM courses and by extension were more likely to aspire to a STEM career (Joyce & Farenga, 2000).

Sociocultural Factors

School. It has been found that the school environment—the classroom, learning experiences, and the educator—can play a role in student future STEM aspirations. With regard to the classroom students in smaller classrooms tended to show more academic growth over time, enhanced positive interactions between teacher and students, and increased opportunity for individual instruction (Arias & Walker, 2004; Deutsch, 2003). With regard to the learning experiences, it has been shown that tracking—where students are placed in prescribed course lists due to perceived ability—may have a negative effect on students' achievement due to a reduction in self-concept (Mulkey, Catsambis, Carr Steelman, & Crain 2005). That is to say, a student may feel that they are not intellectually adequate for certain courses that may contribute to a ceiling on their perceived ability. It has also been shown that curriculum based in a real-world, relevant, and challenging tasks, opportunities to develop self-generated academic work, group learning, and the use of assessments that promote student growth as opposed to judging ability have a positive effect on student motivation and achievement (Wang & Degol, 2014). With regard to the educator, it has been shown that expectations of students may affect students' self-expectations and performance (Metheny, McWhirter, & O'Neil, 2008). Further, those educator expectations, if low, may have a more powerful negative effect on students from lower socio-economic statuses (Jussim, Eccles, & Madon, 1996). Educators can also have an effect on student motivation through student-teacher relationships. McKown and Weinstein (2008) found greater growth in achievement for students who felt their teachers were supportive, listened to them, showed interest in them, and gave them praise.

Stereotype threat. Stereotype threat is a phenomenon that suggests that individuals may conform to negative stereotypes they may feel categorized by (e.g., gender or race) (Steele & Aronson, 1995). Researchers have asserted that when stereotyped individuals feel stressed during a testing situation, their ability may be undermined (Ben-Zeev, Fein, & Inzlicht, 2005). This can have a negative effect on student STEM aspirations after repeated failure in STEM-based courses. STEM fields, by and large, tend to be dominated by White males and as an extension of this are seen as a White male domain. This can impact student aspirations in STEM through stereotyping of who should and should not pursue STEM (Makarova, Aeschlimann, & Herzog, 2019) and has a greater impact on women, where a lack of self-identification in a STEM field can negatively impact their self-concept, interest, and motivation to pursue STEM. Makarova et al. (2019) found that among female students in secondary school, a strong masculine image of math and science decreases the likelihood of choosing a STEM major. Further, it was shown that this association of masculine traits to STEM and stereotypical beliefs of STEM as masculine can present an obstacle for the STEM career aspirations of young women.

According to a study by Vincent-Ruz and Schunn (2018), three conceptualizations drive a positive STEM identity. First is a match between school science and real science, where students must develop an understanding about how school science relates to real science. When their experiences in school science do not align with real science and they do not feel they can perform well in science, it can negatively affect their science identity. The second conceptualization is consistent extrinsic and intrinsic motivation, intrinsic motivation stemming from student interest in science and extrinsic motivation stemming from a student's strong perception of the value of science. The third conceptualization is a sense of community and affiliation when students feel part of the science community and when they are seen as affiliates of science by others.

A study by Martin-Hansen (2018) sought to better understand student STEM aspirations found that a strong and positive STEM identity is a predictor of future career choice in a STEM field. The researcher reviewed four studies and found factors that influence student STEM identity development within educational settings. Certain factors that may contribute to a positive science identity are the way individuals viewed themselves and could be affected by student performance in STEM courses. For example, if a student experiences success in STEM then there is a greater chance of developing positive STEM identity as agency, and vice versa. Therefore, it is important for educators to facilitate STEM classrooms with appropriate scaffolds so that students are not overwhelmed and perceive the class expectations as impossible. Other factors found to affect STEM identity were the educator and the curriculum; for example, creating a classroom in which the relevance of STEM to students is allowed to develop; and creating a learning experience that encourages students to engage in inquiry projects tied to authentic problems and allowing autonomy in designing investigations tied to student interests.

METHODOLOGY

The purpose of this study was to better understand what factors contribute to the academic achievement of students in their class-based science courses at YCSC. In addition, this study sought to better understand what factors may impact student STEM aspirations. Specifically, this study looked at how each of the following areas—the student perception of teachers, critical science education, the student sense of agency to create knowledge, the student engagement in science class, and the relevance of science to the student—impact student academic achievement in their class-based science course. A mixed-methods study was conducted with adult students from YCSC in order to understand their experience in science classes. The following sections will describe the population, location of study, mixed methods, sample, data collection, data analysis, ethical considerations, and the researcher's positionality.

Research Questions

There is two research questions that premises this research.

1. What factors contribute to student academic achievement in a YCSC science classroom?
2. What factors may contribute to future STEM aspirations for YCSC students?

Population

This research is focused on youth who have dropped out of their traditional high schools. According to the *National Center For Education Statistics,* a person aged 16 to 24 who is not enrolled in school or has not earned a high school credential (either a diploma or an equivalency credential such as a GED) is considered a status dropout (National Center for Education Statistics, 2019). In 2017, there were 2.1 million status dropouts, and the status dropout rate was 5.4%. The highest status dropout rate belonged to "American Indian/Alaska Native" youth, at

10.1%, followed by “Hispanic” youth, at 8.2%, “Black” youth, at 6.5 %, “White” youth, at 4.3%, and “Asian” youth, at 2.1% (NCES, 2019). The status dropout rate for males was also higher than for females, 6.4% to 4.4% (NCES, 2019).

Location of Study

The location of this study was Youthbuild Charter School of California (YCSC) because of the specific demographic it served. YCSC was a WASC-accredited alternative, project-based educational program rooted in social justice. YCSC consisted of 19 different school sites throughout Los Angeles, San Bernardino, Riverside, Fresno, and San Diego. At the beginning of the 2019–2020 academic year, YCSC had 1,135 total students enrolled, however only 621 of those students were adults enrolled in the class-based program. This number of students does change as students enter and exit YCSC. The majority of the students enrolled at YCSC were students of color; 64.5% Hispanic or Latino, 21.5% Black or African American, 1.3% American Indian/Alaskan Native, 0.6% Asian, 0.5% Middle Eastern, 4.3% White, and 7.3% unspecified. With regard to gender, 59.5% of students identified as male, 40.3% of students identified as female, and 0.2% of students identified as nonbinary. Roughly, 94.4% of YCSC students were classified as socioeconomically disadvantaged, as measured by qualifying for the national free or reduced lunch program. Students classified as English Learners totaled 20.6% across all sites.

A typical YCSC student was between the ages of 16 to 24 years old, came from a low-income family, underserved community, and had previously left or been pushed out of the traditional school system without a diploma. Youth who enrolled at YCSC were considered status dropouts prior to enrollment. Youth who enrolled at YouthBuild programs were generally over-aged, under-credited, or both. At YCSC, they received vocational training, counseling, leadership development, and an education (YCSC, 2019). Further:

> YouthBuild Charter School of California uses a project-based, interdisciplinary curriculum model that relies on authentic assessments and applied learning. Students are empowered to take what they learn in the classroom into their communities to promote social justice through volunteerism and advocacy. At the end of each trimester, YCSC students work together with teachers to create a culminating community action project. (YCSC 2019)

Mixed Methods

This study was conducted using a mixed-methods approach, specifically a concurrent triangulation design (Creswell et al., 2003). This design consisted of a survey and semistructured interviews. A mixed-methods concurrent triangulation design was selected in order to cross-validate findings using both quantitative and qualitative data. While most of the research presented in this study had been either qualitative or quantitative in nature, this study employed both methods as a way to inform the researcher of the way in which student perception of teachers, critical science education, the student sense of agency to create knowledge, the student engagement in science class, and the relevance of science to the student impact student academic achievement in their class-based science course. The survey was the dominant quantitative method, which allowed the researcher to better understand the ways in which survey respondents felt about their experience in YCSC science courses with regard to student perception of teachers, the YCSC science curriculum, the student sense of agency to create knowledge, the student engagement in science class, and the relevance of science to the student. The qualitative methodology was selected because it provides a narrative description of a social or human area of interest within a natural setting (Creswell, 1998). The semistructured interview was the primary qualitative method, which allowed the researcher to better understand the student experience within the YCSC science classroom.

YCSC Adult Student Science Survey

The survey consisted of a total of 51 questions (Appendix A). Of the 51 questions, 44 were statements that asked students to respond on a Likert scale as to how they felt on topics pertaining to aspects of their science classes at YCSC. For this section, students could respond with *strongly agree, agree, disagree*, or *strongly disagree*. Primarily, the statements revolved around student perception of teacher, critical science education, student engagement, sense of agency to create knowledge, and relevance of science to students (Table 5). Following the statements were four demographic questions that asked for age of student, gender of student, ethnic background of student, and grade point average of student. Lastly, the survey consisted of three open-ended questions that asked the students what YCSC location they attend, how many science classes have they passed through YCSC, and why they came to YCSC.

For the responses to all of the variables the Likert scale was coded as follows:

- *strongly agree* was coded as 4
- *agree* was coded as a 3
- *disagree* was coded as a 2
- *strongly disagree* was coded as a 1

For age group:

- “18–20” was coded as 1
- “21–23” was coded as 2
- “24 or above “ was coded as 3

For gender:

- “Male” was coded as 1
- “Female” was coded as 2
- “Other” was coded as 3

Responses to ethnicity data were not coded because students were asked to check all that apply or to input their own response. The options were as follows:

- “White”
- “Black or African American “
- “American Indian or Alaskan”
- “Asian or Asian American”
- “Native Hawaiian or Pacific Islander”
- “Hispanic/Latino”
- “Decline to state”
- “Other”
- “More than one ethnicity”

Key variables and their operational definitions can be seen in Table 5. *Sense of agency to create knowledge* is operationally defined as the ability one feels they have to create knowledge and contribute knowledge. *Academic achievement* is operationally defined as the number of science classes passed by the student. *Engagement* is operationally defined as a student being actively involved in the class content and activities as well as the student’s interest in the course (i.e., You feel that you are gaining from and contributing to the science class). *Student perception of science teacher* is operationally defined by the support, encouragement, and overall positive relationship that a student experiences with respect to their science teacher. *Science relevance* to student is operationally defined as the student's understanding and relevance of science education with respect to their worldview and experiences. *Critical science education* is operationally defined by the YCSC science curriculum philosophy and the impact it has on student's disposition to academics. *STEM future goals* are operationally defined by a student's self-identified future persistence in STEM education and career.

Table 5

Factors, Operational Definitions, and Measures

Variable	**Operational Definition**	**Variables Used as Measures**
Student Achievement in Science Class	How successful a student has been in completing YCSC science classes.	● Number of science classes the student has passed
Student Engagement in Science Class	A student being actively involved in the class content and activities as well as the students interest in the course.(i.e., you feel that you are gaining from and contributing to the science class).	● When I am in my YCSC science class I am focused ● When I am in my YCSC science class I am interested ● When I am in my YCSC science class I want to succeed ● When I am in my YCSC science class I participate ● When I am in my YCSC science class I feel motivated ● I share my opinion in science class ● I participate in discussions in my YCSC science class

Student Sense of Agency to Create Knowledge in Science Class	The ability one feels they have to create knowledge and contribute knowledge.	● I can contribute to science knowledge ● When I learn a science topic, I feel I can add what I know to that topic ● I can create knowledge in my YCSC science class (i.e., contribute to what we are learning in class) ● When I am in science class I feel empowered (e.g., I can contribute and have value)
Student Perception of Science Teacher	The support, encouragement, and overall positive relationship that a student experiences with respect to their science teacher.	● My YCSC science teacher encourages me. ● My YCSC science teacher is patient. ● My YCSC science teacher wants me to succeed academically. ● My YCSC science teacher has high expectations of me. ● My YCSC science teacher respects my contributions to science class. ● My YCSC science teacher supports all students. ● My YCSC science teacher uses content relevant to my life. ● My YCSC science teacher is engaging.

Science Relevance to Student	The student's understanding and sense of relevance of science education with respect to their worldview and experiences.	● Science knowledge is relevant to my life. ● I use science outside of school in my everyday life. ● When I learn a new topic in science, I can connect it to my life. ● I can use science to solve issues in my life. ● I can use science to solve issues in my community. ● In my YCSC science class, I learn science that I can use to solve problems important to me.

Critical Science Education	YCSC science curriculum philosophy and the impact it has on student's disposition to academics (i.e., project-based, social-justice oriented).	● In my YCSC science class, I see things from different perspectives (e.g., how people see things differently). ● In my YCSC science class, I conduct science investigations. ● My YCSC science class is based in social justice (e.g., it encourages a view of equality). ● In my YCSC science class, we use evidence to support conclusions. ● In my YCSC science class, my voice and experience is valued. ● When I work on Authentic Performance Tasks (APT), I am creating knowledge. ● My YCSC science class encourages me to think of social issues (e.g., inequality and oppression).
STEM Future Goals	Student's self-identified future persistence in STEM education and career.	● I want to study a science in college. ● I want to work in a science-based career.

Interviews

The semistructured interview consisted of 18 questions and was split into two parts. First, the students were asked questions designed to capture their background. This consisted of student age, gender, ethnicity, amount of science classes taken, amount of science classes passed, and reason why they decided to enroll at YCSC. The second part of the interview focused on the students' academic achievement in the science classroom and what they felt contributed to it. Specifically, questions asked about the students' experience within the YCSC science classroom, whether they considered themselves high achievers in science, their perception of the science teacher and their perception of the YCSC science curriculum, and student relationship to science (See Appendix C for interview questions).

Sample

There was a total of 115 participants in the study. I received 105 responses for the survey portion of the study, of which only 100 were completed; five surveys were completely blank. If I estimate that all, roughly 621 adult students, were given the survey then the response rate was 16.1%. A total of 10 students participated in the interview portion of the study.

Data Collection

The sampling strategy used was a convenience sample gathered from the 18 locations across the YCSC network. The sample consisted of adult students from YCSC. The concurrent design employed focused on distributing surveys to adult YCSC students while at the same time recruiting and interviewing participants.

YCSC Adult Student Science Survey

The distribution of the YCSC Adult Student Science Survey was conducted in two phases, from September 2019 through November of 2019. A list of all current adult students and their school email was provided to the researcher by YCSC administration. In the first phase of survey distribution, the survey was emailed to each adult student individually via an anonymous link and was prefaced with an informed consent form (Appendix D). A follow-up email was sent out every two weeks, for a total of four emails to students. The second phase of survey distribution consisted of emailing all YCSC science teachers and asking that they post the informed consent form along with the anonymous link for the survey on their class website.

Interviews

Recruitment and interviewing of participants was conducted in two phases, from September 2019 through November 2019. The first phase entailed the researcher emailing counselors at all YCSC locations and asking for their support in identifying adult students for potential participation in the study. The candidates sought for the interviews were adult students who had passed at least two YCSC science classes with an A or B grade. Once the counselor responded with a list of potential students, the researcher emailed the students directly and asked if they would be willing to be interviewed. Once a student agreed to be interviewed, a consent form was sent via email to the students. Once a student agreed to the consent form, a time was set up for a phone interview, as this was most convenient for the student. Each interview was audio-recorded. The audio-recorded interviews were then transcribed verbatim. (Appendix C)

Data Analysis

YCSC Adult Student Science Survey

To analyze the survey data, two conceptual models (Figure 1, pg. 80 & Figure 2, pg. 81) were developed. The conceptual models were evaluated using structural equation modeling (SEM). One model links together the factors that either directly or indirectly affect student academic achievement in the YCSC science class. The second model links together the factors that either directly or indirectly affect student future STEM aspirations. The conceptual models have six factors. The key variables being used to measure each factor can be seen in Table 5. To create each factor, I selected a set of items for that factor and performed a principal components analysis of those items only. Each factor that was indicated in the structural equation model yielded an eigenvalue greater than one. All items in the factor yielded a factor loading greater than 0.3. Further, all items in each factor were tested for internal consistency and yielded a Cronbach's Alpha greater than 0.8. The conceptual model in Figure 1 and Figure 2 were used to evaluate a sample of mixed male and female respondents. A stepwise algorithm was used to predict path coefficients. Lastly, IBM SPSS Statistics Version 25 was used to analyze these data.

Interviews

To cross-validate the data, I transcribed all the interviews verbatim and used thematic analysis to search for themes related to student academic achievement (Miles, Huberman & Saldaña, 2019; Saldaña 2016). The audio recordings were initially recorded on a smartphone and uploaded to the researcher's Google drive, to which only the researcher had access.

I used Braun and Clarke's (2006) six-step thematic analysis guideline for qualitative research to guide my coding analysis. First, I familiarized myself with my data as I developed and conducted the interviews. Braun and Clarke emphasized repeated reading in an active way and jotting down initial thoughts and notes, which I did by listening to all the interviews and reading all the transcribed interviews twice. I took notes on broad patterns that emerged in the data. The second guideline Braun and Clarke suggested is generating initial coding of ideas that emerge from the transcripts. I chose to code the data myself rather than use a software program. I used an Excel document to record all my codes. Once I coded all the data, I looked for themes. According to Braun and Clarke, this is the third guideline to qualitative data analysis. I sorted the codes into themes by drawing out a thematic map. The fourth step in data analysis is to review the themes as suggested by Braun and Clarke. I reviewed themes to ensure that they were clear, coherent, and supported by the data. The initial thematic map was revised to produce the final thematic map. The fifth guideline Braun and Clarke suggested is to define and name themes. The purpose of this step is to identify the essence of each theme. There was a total of five themes, which were color coded on an Excel spreadsheet. Braun and Clarke's final guideline to qualitative thematic data analysis is to produce the report.

Ethical Guidelines

Ethical guidelines provided by the Claremont Graduate University Institutional Review Board (IRB) were used throughout the entire research portion. Several steps were taken to protect participants' privacy and inform them of the study. First, participants were provided a voluntary informed consent form that explained the purpose of the research and the expected duration of their participation (Appendix D). Second, they received a description of the procedure that explained their role in the study. Third, all participants were informed that their participation was voluntary and that refusal to participate would not result in any repercussions. Participants were also informed that they did not have to answer all questions and that they could stop at any point during the survey or interview. Fourth, participants were assured that their information would remain anonymous for survey respondents and confidential for interview participants. Anonymity was maintained because survey respondents did not have to give their name. Confidentiality was maintained through protection of the participant's identity and because interview participants selected pseudonyms. Lastly, all participants were provided my contact information so they could reach me for any questions.

Statement of Researcher Positionality

My parents, Jose Maria Peña and Guadalupe Peña, immigrated to Los Angeles from Ruiz, Nayarit and Los Alvarados, Michoacan, in Mexico, respectively. They settled in Los Angeles and, within 2 years of meeting each other, they married, settled, and grew into a family of six. I am Anthony Peña, the youngest of their four children. Growing up in Los Angeles in an immigrant family shaped my life and my passion for education. My experience as a first generation U.S.-born citizen helped me to learn how important education is and how difficult it can be to access and navigate it. My parents were instrumental in my academic success. Although they could not understand much English, they understood that school was a positive thing so they supported me in every aspect of it. School was important in their eyes. The way the put it was “O vas a la escuela o te quebras la espalda como un burro”—either you go to school, or you break your back like a mule. My father has been a mechanic for the last 40 years, and my mother is the hardest worker I know; although she does not get paid, she has been a stay-at-home mom since she had her first child. The work ethic that my parents instilled in my sisters and me has guided me through the most difficult education endeavors I have had to face and will no doubt continue to guide me as I continue throughout my life.

I was raised in the inner city and educated formally by the Los Angeles Unified School District. The education that was provided for me by the Los Angeles Unified School District consisted of some positive experiences as well as some negative ones. I remember having few educators that were very involved, and they motivated me to succeed academically because they were dedicated and supportive. However, I also remember educators who could care less about how much we learned and grew as students. The outlook they had on our education discouraged many of my friends and classmates from reaching their full educational potential. As I look back at the friends I grew up with, only a handful made it through high school and even fewer made it to college. Some of them dropped-out of school and ended up in the "justice" system. Growing up, I never thought I would go to college because I had never seen anyone in my family go through that process; however, I saw many people I grew up with "drop-out" of high school or be incarcerated. As I was successful in academics, I was able to go to college. I went to UC San Diego and entered a world that was foreign to me. It was culture shock to enter the realm of higher education. Growing up in the predominantly Latinx neighborhood of Highland Park, I had rarely had personal experiences with people of different ethnicities. UC San Diego was a place where I found myself a minority, as less than 10% of the student population was Latinx. Within this institution, I struggled to adapt because I felt ill-prepared in terms of study skills and navigating the university. However, as I developed my academic tool belt, with the help of student organizations and some supportive professors, I began to succeed. As I did so, I developed a sense of responsibility to give back to my community. I began to mentor youth from two different high schools in the city of San Diego through the UC San Diego Upward Bound Program. Upward Bound is a program that promotes college readiness and academic support to potential first-generation college students. As my college experience was coming to an end, I decided to go into the practice of science education, and I applied to a dual master's and credential program at UCLA. I was admitted and began to develop as a science educator with the intent on creating a socially just classroom. An important component of my teaching and research interests is working with probation and "at-risk" youth to close the educational achievement gap, specifically within the discipline of science.

It is a belief of mine that all students, given the opportunity and proper support, can succeed academically and in their own defined goals. With regard to education, I believe that when students receive equitable learning opportunities, they can succeed in any academic setting. The person I was raised to be does not allow me to be content while it is within my power to serve others. So I will continue to work toward social justice in any classroom I have the pleasure of entering. I will continue to develop equitable science curriculum through a critical lens. I will continue to reflect, remix, and grow as a social justice educator, and I will continue to research, study, and contribute to the development of equitable science education. To the students I serve, I dedicate my academic endeavors and my full support and, in the words of George Jackson, "to the destruction of the forces that oppress them I dedicate my life."

RESULTS

In this chapter, an in-depth review of the researchers data analysis is provided. The chapter is composed of two main sections. The first section will focus on results from the YCSC Adult Student Science Survey data analysis; the second section assesses results from the semistructured interview portion of the study.

YCSC Adult Student Science Survey

The sample consisted of 100 survey responses. Based on the 100 completed surveys, the demographics of the sample were as follows: with regard to gender (Table 6), the sample was composed of 54 (54%) respondents who identified as "Male" and 45 (45%) respondents who identified as "Female," and 1 (1%) who identified as "Other."

Table 6

Frequency of Gender

Gender	**Sample Size**	**Valid % of Total**
Male	54	54
Female	45	45
Other	1	1
Total	**100**	**100**

With regard to age group (Table 7), the sample was composed of 53 (53%) respondents between the ages of 18 and 20; 22 (22%) respondents between the ages of 21 and 23; 19 (19%) respondents age 24 or above; and 6 (6%) respondents provided no response.

Table 7

Frequency of Age Group

Age Group	**Sample Size**	**Valid % of Total**
18–20	53	53
21–23	22	22
24 or above	19	19
No Response	6	6
Total	**100**	**100**

With regard to ethnicity (Table 8), respondents were asked to “check all that apply”; further, they were given the option to self-identify or decline to state. The sample was composed of 3 (3%) respondents who identified as “White”; 17 (17.2%) respondents who identified as “Black or African American”; 2 (2%) respondents who identified as “Asian or Asian American”; 2 (2%) who identified as “Native Hawaiian or Pacific Islander”; 72 (72.7%) respondents who identified as “Hispanic/Latina/o”; 2 (2%) respondents who identified as “Other”; and 1 (1%) respondent who declined to state their ethnicity. One (1%) respondent did not respond.

Table 8

Frequency of Ethnicity

Ethnicity	**Sample Size**	**Valid % of Total**
White	3	3
Black or African American	17	17
Asian or Asian American	2	2
Native Hawaiian or Pacific Islander	2	2
Hispanic/Latino	72	72
Other	2	2
Decline to State	1	1
No Response	1	1
Total	**100**	**100**

With regard to grade point average (GPA) (Table 9), the sample was composed of 14 (14%) students who self-identified as having a GPA below 2.0; 19 (19%) respondents who self-identified as having a GPA between 2.0 and 2.4; 19 (19%) respondents who self-identified as having a GPA between 2.5 and 2.9; 21 respondents who self-identified as having a GPA between 3.0 and 3.4; and 27 respondents who self-identified as having a GPA between 3.5 and 4.0.

Table 9

Frequency for Grade Point Average

Grade Point Average (GPA)	**Sample Size**	**Valid % of Total**
Below 2.0	14	14
2.0–2.4	19	19
2.5–2.9	19	19
3.0–3.4	21	21
3.5–4.0	27	27
Total	**100**	**100**

With regard to number of science classes, the respondents were asked to state the number of science classes they had passed at YCSC (Table 10). This included courses such as life science, natural science, biology, physical science, or chemistry. The sample was composed of 22 respondents who provided no response; 13 (16.7%) respondents who had passed zero science classes; 24 (30.8%) respondents who had passed one science class; 32 (41%) respondents who had passed two science classes; 9 (11.5%) respondents who had passed 3 science classes.

Table 10

Frequency of Number of Science Classes Passed at YCSCS

Number of Science Classes Passed	**Sample Size**	**Valid % of Total**
Zero Classes	13	16.7
One Class	24	30.8
Two Classes	32	41.0
Three Classes	9	11.5
Total	**78**	**100**

YCSC was partnered with 18 different Youthbuild programs throughout Los Angeles, San Bernardino, Riverside, San Diego, and Fresno counties. The sample was composed of 94 respondents who identified their YCSC partner location and six respondents who left this question blank (Table 11). Note that the three sites that contributed the most respondents were the South L.A. site, with 15 (15.95%); the Palmdale site, with 15 (19.95%); and the East L.A. site, with 9 (9.57%). The sites that contributed the least amount of respondents were the Canoga Park Site, with 1 (1.06%); the FREE LA High site in South Central L.A., with 1 (1.06%); and the Citadel Youthbuild site in San Bernardino, with 0 (0%).

Table 11

Frequency of Participants by YCSC Location

YCSC Location	Sample Size	Valid % of Total
Avalon Site at Mary B. Henry Academy	3	3.19
Canoga Park Site at R.U.T.H. YouthBuild	1	1.06
Compton YouthBuild	4	4.25
East LA Site at LA CAUSA YouthBuild	9	9.57
El Monte Site at San Gabriel Valley Conservation Corps	8	8.51
FREE LA High site at the Youth Justice Coalition	1	1.06
Fresno EOC Local Conservation Corps	6	6.38
Hollywood Site at ITEA YouthBuild	2	2.12
Lennox Site at SBWIB YouthBuild	7	7.44
Moreno Valley Site at Rising Stars Business Academy	6	6.38
Norwalk Site at Field of Dreams Learning, Inc.	3	3.19
Palmdale Site at Antelope Valley YouthBuild	15	15.95
Pomona Site at San Gabriel Valley Conservation Corps	5	5.31
San Bernardino Site at YouthBuild Inland Empire	1	1.06
San Diego Site at Heartland Coalition	5	5.31
South LA Site at CRCD Academy (located at LA Trade Tech College campus)	15	15.95
Whittier YouthBuild	3	3.19
YouthBuild Citadel	0	0
Total	**94**	**100**

Descriptive statistics about the key variables in this study are represented below in Table 12. Note that all variables had a mean of 2.73 or above, indicating a strong affinity agreeing or strongly agreeing with the statements by the respondents. The three variables with the highest means were “My YCSC science teacher wants me to succeed academically” (3.61), “When I am in my YCSC science class I want to succeed” (3.58), and “My YCSC science teacher supports all students” (3.54). The three variables with the lowest means were “I want to work in a science based career” (2.73), “I want to study a science in college” (2.80), and “I use science outside of school in my everyday life” (2.99).

Table 12

Descriptive Statistics For Variables in Study (% in parentheses)

Variable	Strongly Disagree	Disagree	Agree	Strongly Agree	Mean	Standard Deviation
When I am in my YCSC science class, I am focused.	2 (2%)	4 (4%)	47 (47%)	47 (47%)	3.39	.665
When I am in my YCSC science class, I am interested.	1 (1%)	4 (4%)	45 (45%)	50 (50%)	3.44	.625
When I am in my YCSC science class, I want to succeed.	0 (0%)	0 (0%)	42 (42.4%)	57 (57.6%)	3.58	.497
When I am in my YCSC science class, I participate.	0 (0%)	4 (4%)	54 (54%)	42 (42%)	3.38	.565
When I am in my YCSC science class, I feel motivated.	1 (1%)	7 (7%)	45 (45%)	47 (47%)	3.38	.663

I share my opinion in science class.	1 (1%)	9 (9%)	53 (53%)	37 (37%)	3.26	.661
I participate in discussions in my YCSC science class.	1 (1%)	13 (13%)	52 (52%)	34 (34%)	3.19	.692
I can contribute to science knowledge.	0 (0%)	7 (7%)	63 (63%)	30 (30%)	3.23	.566
When I learn a science topic, I feel I can add what I know to that topic.	0 (0%)	8 (8.1%)	52 (52.5%)	39 (39.4%)	3.31	.617
I can create knowledge in my YCSC science class (i.e., contribute to what we are learning in class).	1 (1%)	11 (11%)	52 (52%)	36 (26%)	3.23	.679
When I am in science class I feel empowered (e.g., I can contribute and have value).	0 (0%)	16 (16%)	53 (53%)	31 (31%)	3.15	.672
My YCSC science teacher encourages me.	0 (0%)	4 (4%)	43 (43%)	53 (53%)	3.49	.577
My YCSC science teacher is patient.	1 (1%)	3 (3%)	42 (42%)	54 (54%)	3.49	.611
My YCSC science teacher wants me to succeed academically.	0 (0%)	1 (1%)	37 (37%)	62 (62%)	3.61	.510
My YCSC science teacher has high expectations of me.	0 (0%)	6 (6%)	43 (43%)	51 (51%)	3.45	.609

My YCSC science teacher respects my contributions to science class.	0 (0%)	2 (2%)	57 (57%)	41 (41%)	3.39	.530
My YCSC science teacher supports all students.	0 (0%)	5 (5.1%)	36 (36.4%)	58 (58.6%)	3.54	.594
My YCSC science teacher uses content relevant to my life.	1 (1%)	11 (11.1%)	49 (49.5%)	38 (38.4%)	3.25	.690
My YCSC science teacher is engaging.	0 (0%)	9 (9%)	40 (40%)	51 (51%)	3.42	.653
Science knowledge is relevant to my life.	3 (3%)	15 (15%)	42 (42%)	40 (40%)	3.19	.800
I use science outside of school in my everyday life.	0 (0%)	11 (11.1%)	57 (57.6%)	31 (31.3%)	2.99	.870
When I learn a new topic in science, I can connect it to my life.	1 (1%)	15 (15%)	52 (52%)	32 (32%)	3.31	.617
I can use science to solve issues in my life.	4 (4%)	19 (19.2%)	47 (47.5%)	29 (29.3%)	3.02	.802
I can use science to solve issues in my community.	5 (5%)	14 (14%)	51 (51%)	30 (30%)	3.06	.802
In my YCSC science class, I learn science that I can use to solve problems important to me.	0 (0%)	11 (11.1%)	57 (57.6%)	31 (31.3%)	3.20	.622

In my YCSC science class, I see things from different perspectives (e.g., how people see things differently).	1 (1%)	4 (4%)	55 (55%)	40 (40%)	3.34	.607
In my YCSC science class, I conduct science investigations.	0 (0%)	14 (14%)	59 (59%)	27 (27%)	3.13	.630
My YCSC science class is based in social justice (e.g., it encourages a view of equality).	2 (2%)	14 (14%)	59 (59%)	24 (24%)	3.06	.682
In my YCSC science class, we use evidence to support conclusions.	1 (1%)	4 (4%)	50 (50%)	44 (44%)	3.38	.618
In my YCSC science class, my voice and experience are valued.	0 (0%)	5 (5%)	53 (53%)	42 (42%)	3.37	.580
When I work on authentic performance tasks (APT), I am creating knowledge.	0 (0%)	9 (9%)	53 (53%)	38 (38%)	3.29	.624
My YCSC science class encourages me to think of social issues (e.g., inequality and oppression).	4 (4%)	19 (19%)	48 (48%)	29 (29%)	3.02	.804
I want to study a science in college	6 (6%)	32 (32%)	38 (38%)	24 (24%)	2.80	.876
I want to work in a science-based career.	7 (7%)	32 (32%)	42 (42%)	19 (19%)	2.73	.851

Structural Equation Modeling

To analyze the data, I developed two conceptual models that were evaluated using Structural Equation Modeling (SEM). The first model links together the factors that either directly or indirectly affect student academic achievement in a YCSC science class. The second model links together factors that either directly or indirectly affect student future STEM aspirations. Those models are presented as a before path diagram in Figure 1 and Figure 2, respectively. I used the conceptual model to evaluate a sample of mixed male and female students. A stepwise algorithm was used to determine path coefficients.

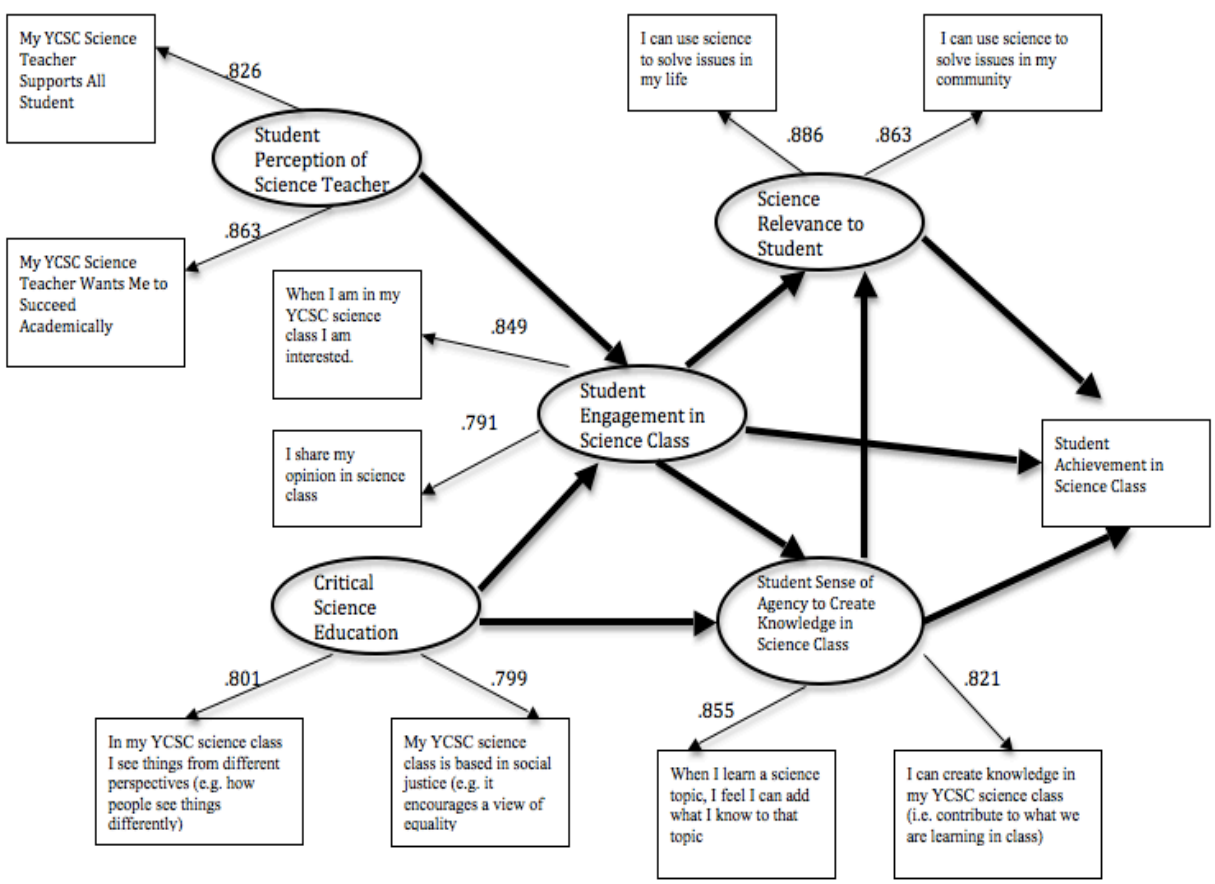

Figure 1. Path diagram for student academic achievement in science class.

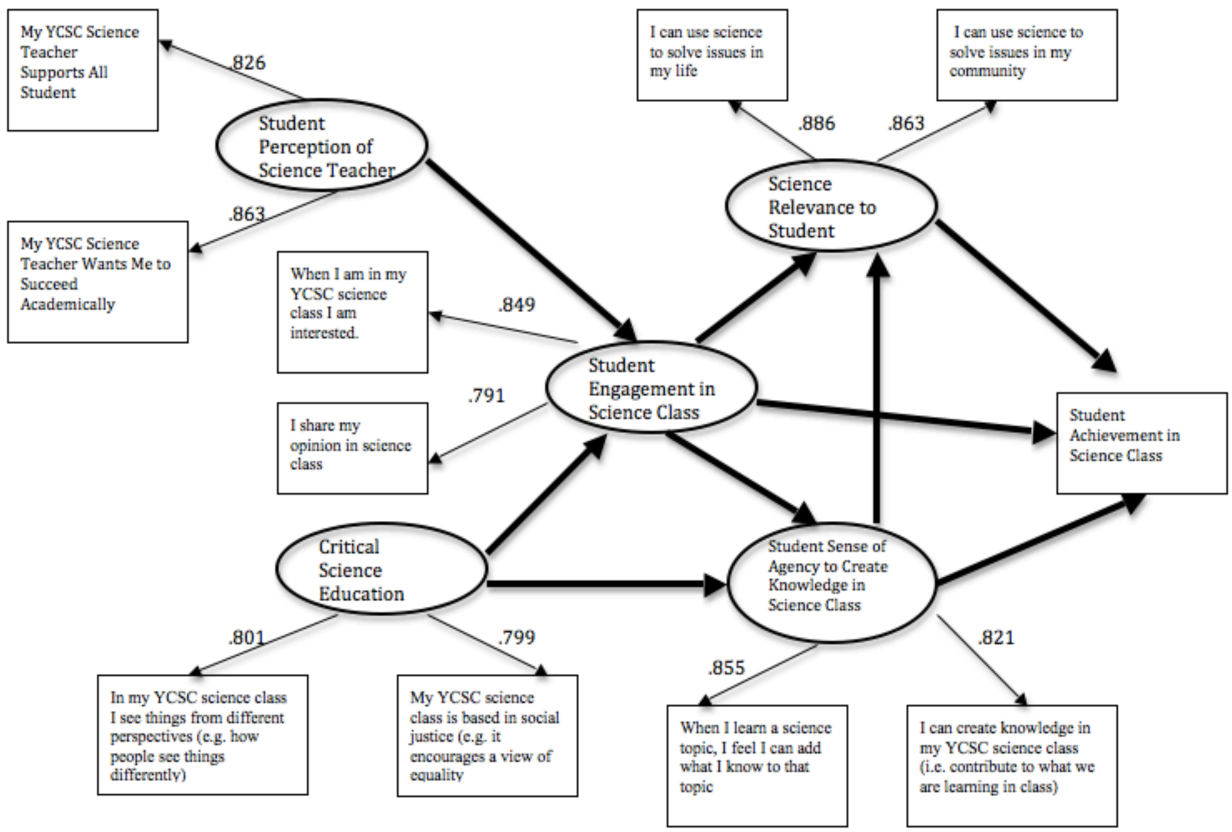

Figure 2. Path diagram for student future STEM aspirations.

The conceptual models have six factors. The key variables defining each factor are shown on each conceptual model. To create each factor, I selected a set of items for that factor and performed a Principal Components Analysis of those items only. Each factor indicated in the structural equation model yielded an eigenvalue greater than one. All items in the factor yielded a factor loading greater than 0.3. Further, all items in each factor were tested for internal consistency and yielded a Cronbach's Alpha greater than 0.8. The six factors and the items used to create them are listed below in Table 13.

Lastly, IBM SPSS Statistics Version 25 was used to analyze this data.

Table 13

Factors and Items Used to Create Them

Factor	Items (Factor Loadings)	Cronbach's Alpha (**α**)
Student Engagement in Science Class	When I am in my YCSC science class, I am focused. (.803)	**α**=0.885
	When I am in my YCSC science class, I am interested. (.849)	
	When I am in my YCSC science class, I want to succeed. (.696)	
	When I am in my YCSC science class, I participate. (.771)	
	When I am in my YCSC science class, I feel motivated. (.696)	
	I share my opinion in science class. (.791)	
	I participate in discussions in my YCSC science class. (.779)	
Student Sense of Agency to Create Knowledge in Science Class	I can contribute to science knowledge. (.834)	**α**=0.863
	When I learn a science topic, I feel I can add what I know to that topic. (.855)	
	I can create knowledge in my YCSC science class (i.e., contribute to what we are learning in class). (.821)	
	When I am in science class I feel empowered (e.g., I can contribute and have value). (.856)	
Student Perception of Science Teacher	My YCSC science teacher encourages me. (.824)	**α**=0.925
	My YCSC science teacher is patient. (.829)	
	My YCSC science teacher wants me to succeed academically. (.863)	
	My YCSC science teacher has high expectations of me. (.788)	
	My YCSC science teacher respects my contributions to science class. (.805)	
	My YCSC science teacher supports all students. (.826)	

	My YCSC science teacher uses content relevant to my life. (.674)	
	My YCSC science teacher is engaging. (.825)	
Science Relevance to Student	Science knowledge is relevant to my life. (.633)	**α**=0.895
	I use science outside of school in my everyday life. (.784)	
	When I learn a new topic in science, I can connect it to my life. (.856)	
	I can use science to solve issues in my life. (.886)	
	I can use science to solve issues in my community. (.863)	
	In my YCSC science class, I learn science that I can use to solve problems important to me. (.866)	
Critical Science Education	In my YCSC science class, I see things from different perspectives (e.g., how people see things differently). (.801)	**α**=0.902
	In my YCSC science class, I conduct science investigations. (.786)	
	My YCSC science class is based in social justice (e.g., it encourages a view of equality). (.799)	
	In my YCSC science class, we use evidence to support conclusions. (.820)	
	In my YCSC science class, my voice and experience is valued. (.823)	
	When I work on Authentic Performance Tasks (APT), I am creating knowledge. (.802)	
	My YCSC science class encourages me to think of social issues (e.g., inequality and oppression). (.757)	
STEM Future Aspirations	I want to study a science in college. (.947)	**α**=0.885
	I want to work in a science-based career. (.947)	

Structural Equation Model for Student Academic Achievement in YCSC Science Classes

The conceptual model presented in Figure 3 uses structural equation modeling (SEM) to evaluate factors that either directly or indirectly affect student academic achievement in YCSC science classes for a sample of mixed female and male students (N = 78). For this SEM, I used a sample of 78, because 22 participants did not give a response for the ultimate endogenous variable "Achievement in Science Class." Therefore, I filtered out cases in which respondents did not provide a response to how many YCSC science classes they had passed. That model is presented as a before path diagram.

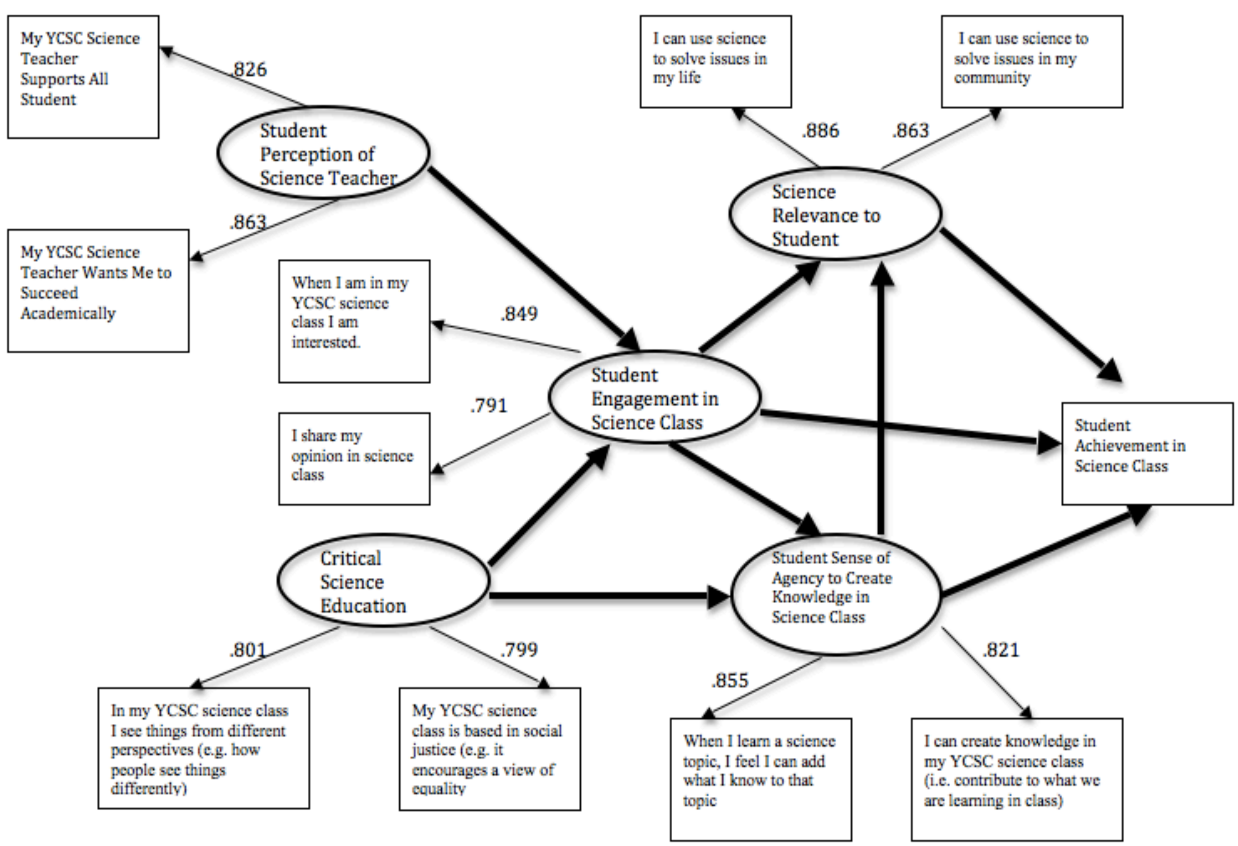

Figure 3. Before path diagram for student academic achievement in science class.

As can be seen from the before path diagram (Figure 3), there are four endogenous variables and two exogenous variables. This means that in order to identify the path coefficients, I computed four regressions. Table 14 indicates the dependent and independent variables for each of those four regressions as well as the Pearson Correlation Coefficient and other significant statistics for dependent and independent variables. The resulting post model diagram is presented in Figure 4. This final diagram includes path coefficients for each variable that entered a regression equation as well as the R2. If a variable did not enter an equation, its arrow, reflecting nonsignificant effects, was removed; therefore, I also removed those variables.

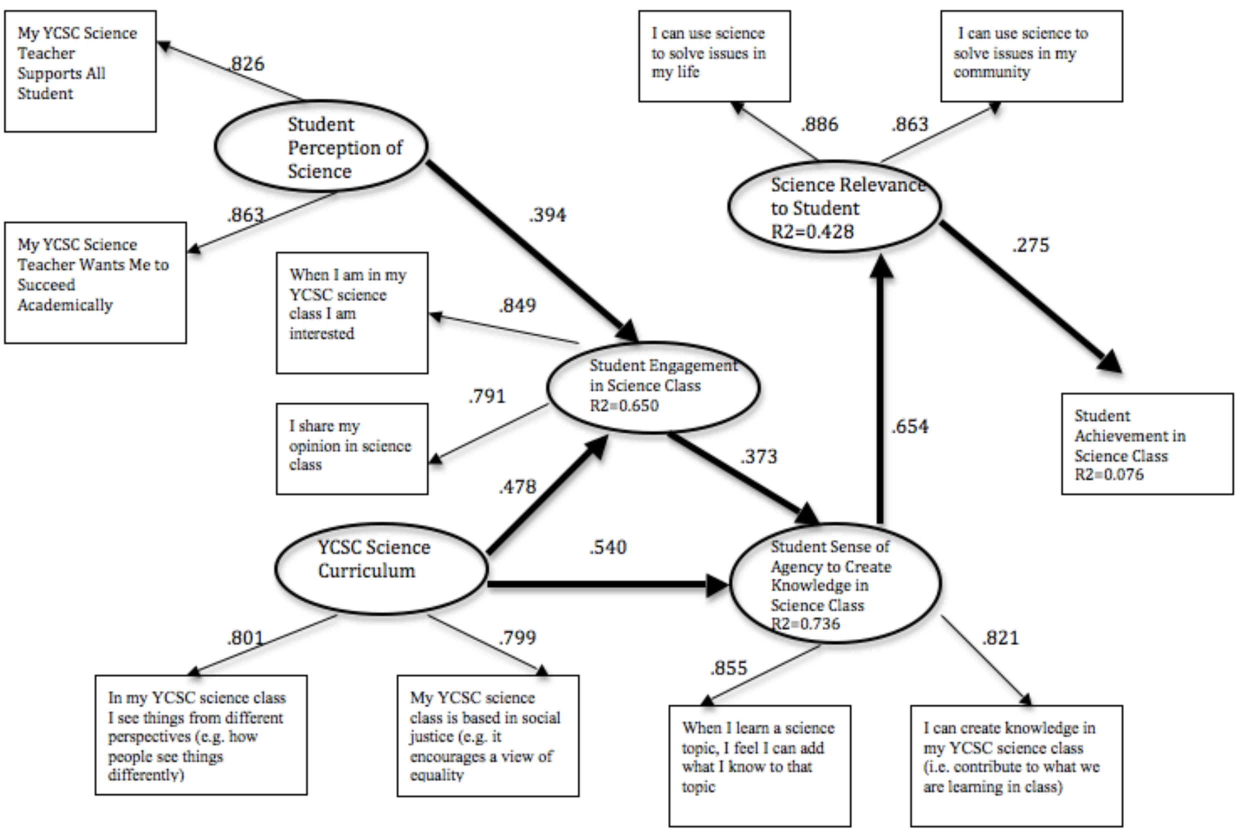

Figure 4. Final path diagram for student academic achievement in science class.

Table 14 shows the significant statistics for each regression I ran in the SEM. If no statistics are present for a variable it means that variable did not enter the equation. Notice that for regression 1, where “science relevance to student,” “student engagement in science class,” and “student sense of agency to create knowledge in science class” were used to predict “student academic achievement in science class,” the R^2 was 0.076. This indicates that 7.6% of the variance in “student academic achievement in science class” was predicted by “science relevance to student,” the only independent variable that made it into the equation. This R2 indicates a weak fit. The Beta for “science relevance to student” was 0.275. Notice that for regression 2, where “student engagement in science class” and “student sense of agency to create knowledge in science class” were used to predict “science relevance to student,” the R^2 was 0.428. This indicates that 42.8% of the variance in “science relevance to student” was predicted by “student sense of agency to create knowledge in science class,” the one independent variable that made it into the equation. This R2 indicates a moderately strong fit. The Beta for regression 2 was 0.654. Notice that for regression 3, where “student engagement in science class” and “critical science education” were used to predict “student sense of agency to create knowledge in science class,” the R^2 was 0.736. This indicates that 73.6% of the variance in “student sense of agency to create knowledge in science class” was predicted by the two variables that made it into the equation. This R2 indicates a strong fit. Examination of the Betas shows that the best predictor was “critical science education,” with a Beta of 0.540. Notice that for regression 4, where “student engagement in science class” was predicted by “student perception of science teacher” and “critical science education,” the R^2 was 0.650. This indicates that 65% of the variance in “student engagement in science class” was predicted by the two independent variables that made it to the equation. This R2 indicates a strong fit. Examination of the Betas shows that the best predictor was "critical science.

Table 14

List of Regressions and Significant Statistics for Mixed SEM with Student Academic Achievement in YCSC Science Class as Ultimate Endogenous Variable

Number	Dependent Variable	Independent Variables	r Between DV and IV	Beta	t	Sig t	R	R2	Adj R2	F	Sig F
1	Student achievement in science class	Science relevance to student	r=+.275	.275	2.496	.015	.275	.076	.064	6.229	.015
		Student engagement in science class	r=+.070	-	-	-	-	-	-	-	-
		Student sense of agency to create knowledge in science class	r=+.185	-	-	-	-	-	-	-	-
2	Science relevance to student	Student engagement in science class	r=+.574	-	-	-	-	-	-	-	-
		Student sense of agency to create knowledge in science class	r=+.654	.654	7.544	<0.001	.654	.428	.421	56.908	<0.001
3	Student sense of agency to create knowledge in science class	Student engagement in science class	r=+.784	.373	4.119	<0.001	.858	.736	.729	158.968	<0.001
		Critical science education	r=+.823	.540	5.964	<0.001	.858	.736	.729	158.968	<0.001
4	Student engagement in science class	Student perception of science teacher	r=+.731	.394	4.086	0.003	.806	.650	.640	101.395	<0.001
		Critical Science Education	r=+.756	.478	4.965	<0.001	.806	.650	.640	101.395	<0.001

The decomposition of bivariate covariation based on the post model diagram is presented in Table 15. The clearest measure of which variables have the greatest impact on student academic achievement in science class, the ultimate endogenous variable, would be the total causal statistic. Note that the two variables that had the greatest impact on student academic achievement in science class were “science relevance to student” and “student sense of agency to create knowledge in science class,” with a total causal value of 0.275 and 0.179, respectively. Also, notice that the greatest direct effect (Beta = 0.275) on student academic achievement in science class came from “science relevance to student,” and the greatest indirect effects (Beta = 0.179 & 0.129) came from “student sense of agency to create knowledge in science class” and “critical science education,” respectively. The noncausal statistic represents the influence of variables outside of the model. The noncausals from the decomposition of bivariate covariation show some excellent fits for “science relevance to student” and “student sense of agency to create knowledge in science class” and some weak fits for “student engagement in science class,” “student perception of science teacher,” and “critical science education.” Overall, these parameters indicate that the model provides a moderate fit.

Table 15

Decomposition of Bivariate Covariation for Mixed Sample Predicting Academic Achievement

Factor	Student sense of agency to create knowledge in science class	Science relevance to student	Student engagement in science class	Student perception of science teacher	Critical Science Education
Original Covariation	0.185	0.275	0.070	0.210	0.309
Direct	0.000	0.275	0.000	0.000	0.000
Indirect	0.179	0.000	0.067	0.026	0.129
Total Causal	0.179	0.275	0.067	0.026	0.129
Non-Causal	0.006	0.000	0.003	0.184	0.180

Structural Equation Model For Student STEM Aspirations

The conceptual model presented in Figure 5 uses structural equation modeling to evaluate factors that either directly or indirectly affect student STEM aspirations for a sample of mixed female and male students (N = 100). That model is presented as a before path diagram.

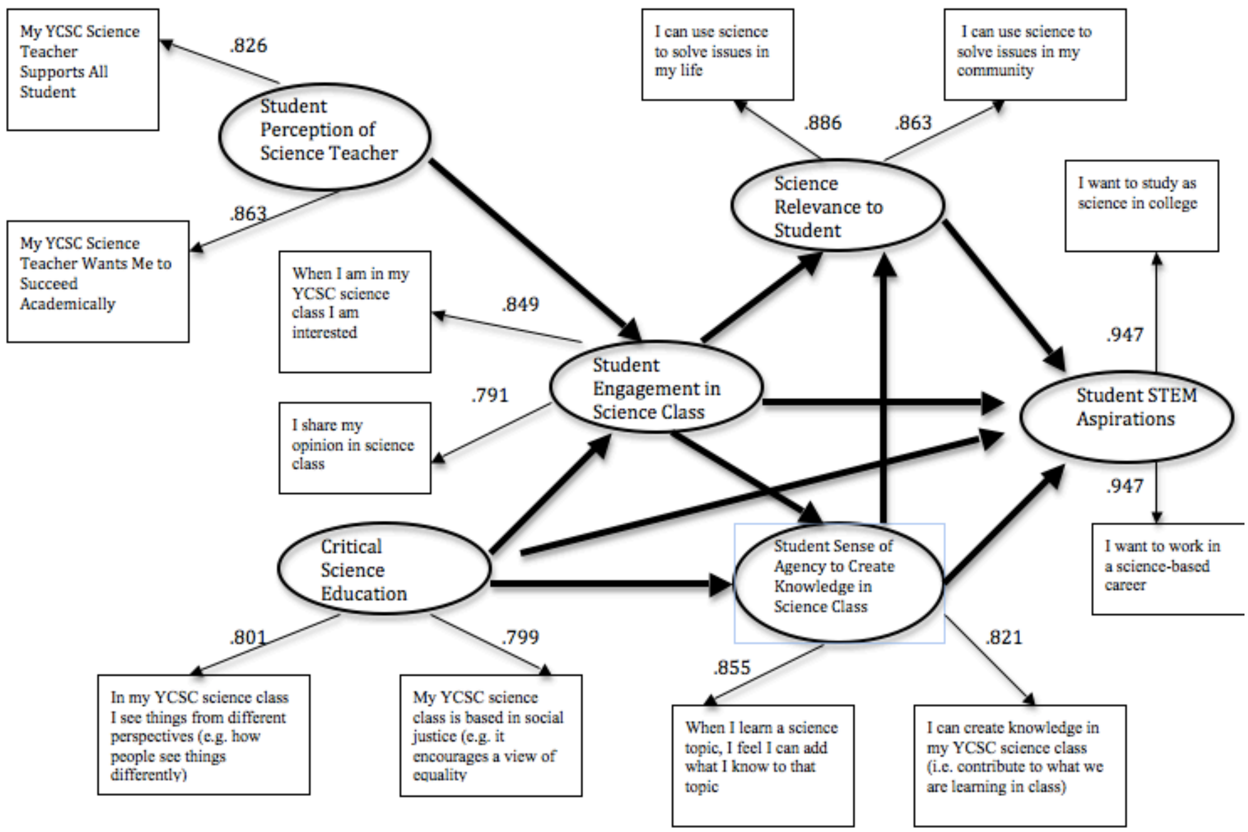

Figure 5. Before path diagram for student future STEM aspiration.

As can be seen from the before path diagram (Figure 5), there are four endogenous variables and two exogenous variable, which means that in order to identify the path coefficients we computed four regressions. Table 16 indicates the dependent and independent variables for each of those four regressions as well as the Pearson Correlation Coefficient and other significant statistics for dependent and independent variables. After running these regressions, the resulting post model diagram is presented in Figure 6. This final diagram includes path coefficients for each variable that entered a regression equation as well as the R2. If a variable did not enter an equation, its arrow, reflecting nonsignificant effects, was removed; therefore, I also removed those variables.

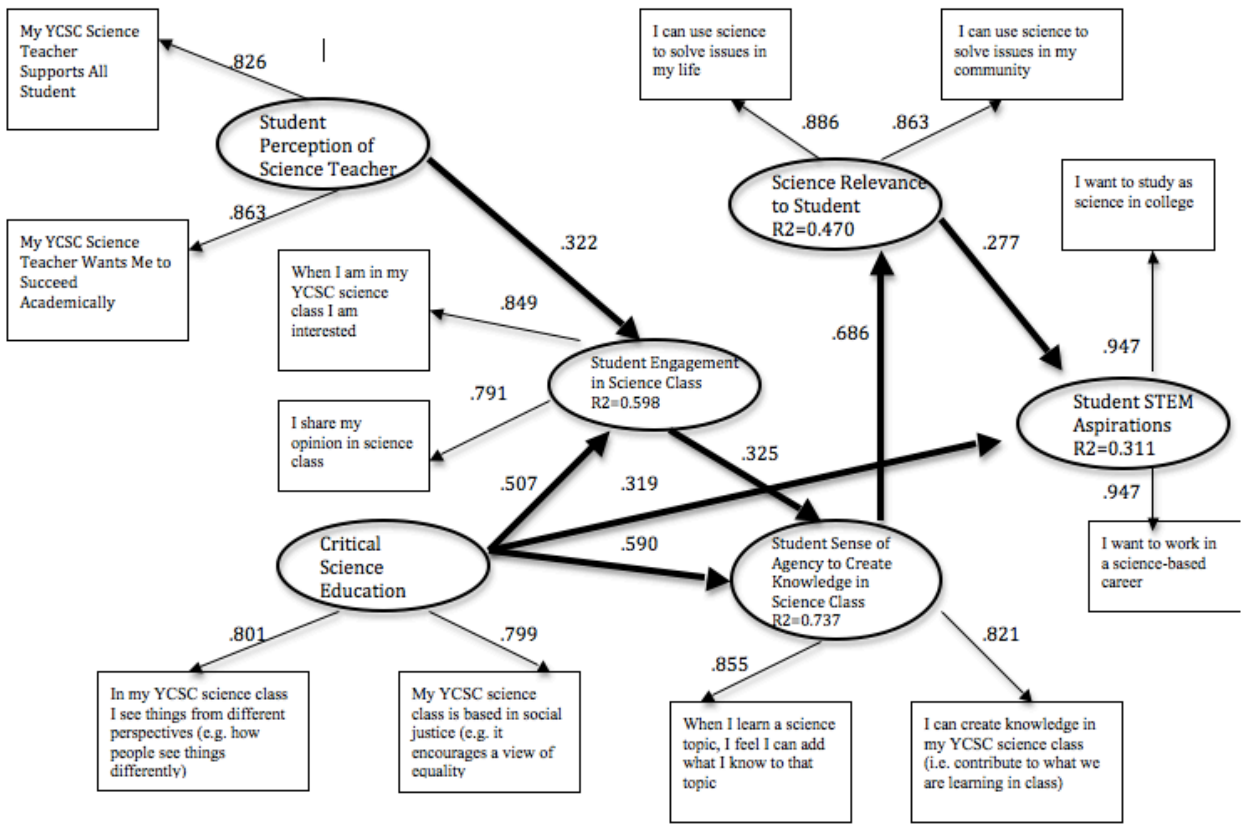

Figure 6. Final path diagram for student future STEM aspiration

Table 16 shows the significant statistics for each regression ran in our SEM. If no statistics are present for a variable, it means that variable did not enter the equation. Notice that for regression 1, where "science relevance to student," "student engagement in science class," student sense of agency to create knowledge in science class," and "critical science education" were used to predict "student STEM aspirations," the R^2 was 0.311. This indicates that 31.1% of the variance in "student STEM aspirations" was predicted by the two independent variables that made it into the equation. This R2 indicates a moderately strong fit. Examination of the Betas shows that the best predictor was "critical science education," with a Beta of 0.319. Notice that for regression 2, where "student engagement in science class" and "student sense of agency to create knowledge in science class" was used to predict "science relevance to student," the R^2 was

0.470. This indicates that 47% of the variance in “science relevance to student” was predicted by “student sense of agency to create knowledge in science class,” the only independent variable that made it into the equation. This R2 indicates a moderately strong fit. The Beta for “student sense of agency to create knowledge in science class” was 0.686. Notice that for regression 3, where “student engagement in science class” and “critical science education” were used to predict “student sense of agency to create knowledge in science class,” the R^2 was 0.737. This indicates that 73.6% of the variance in “student sense of agency to create knowledge in science class” was predicted by the two independent variables that made it into the equation. This R2 indicates a strong fit.

Examination of the Betas shows that “critical science education” was the best predictor, with a Beta of 0.590. Notice that for regression 4, where “student engagement in science class” was predicted by “student perception of science teacher” and “critical science education,” the R^2 was 0.598. This indicates that 59.8% of the variance in “student engagement in science class” was predicted by the two independent variables that made it to the equation. This R2 indicates a strong fit. Examination of the Betas shows that the best predictor was “critical science education” with a Beta of 0.507.

Table 16

List of Regressions and Significant Statistics for Mixed SEM With Student Future STEM Aspirations As Ultimate Endogenous Variable

Number	Dependent Variable	Independent Variables	r Between DV and IV	Beta	t	Sig t	R	R2	Adj R2	F	Sig F
1	Student STEM Aspiration	Science relevance to student	r=+.517	.277	2.163	.033	.528	.311	.297	21.892	<0.001
		Student engagement in science class	r=+.376	-	-	-	-	-	-	-	-
		Student sense of agency to create knowledge in science class	r=+.487	-	-	-	-	-	-	-	-
		Critical Science Education	r=+.527	.319	2.448	.015	.528	.311	.297	21.892	<0.001
2	**Science relevance to student**	Student engagement in science class	r=+.583	-	-	-	-	-	-	-	-
		Student sense of agency to create knowledge in science class	r=+.686	.686	9.322	<0.001	.686	.470	.465	86.894	<0.001
3	**Student sense of agency to create knowledge in science class**	Student engagement in science class	r=+.762	.325	4.197	<0.001	.859	.737	.732	136.207	<0.001
		Critical Science Education	r=+.831	.590	7.620	<0.001	.859	.737	.732	136.207	<0.001
4	**Student engagement in science class**	Student perception of science teacher	r=+.689	.322	3.449	0.001	.773	.598	.589	72.051	<0.001
		Critical Science Education	r=+.740	.507	5.431	<0.001	.773	.598	.589	72.051	<0.001

The decomposition of bivariate covariation based on post model diagram is presented in Table 17. The clearest measure of which variables have the greatest impact on student future STEM aspirations, the ultimate endogenous variable, would be the total causal statistic. Note that the two variables that had the greatest impact on student STEM aspirations were “science relevance to student” and “critical science education,” with a total causal value of 0.277 and 0.462 respectively. Also, notice that the greatest direct effect (Beta=0.462) on student STEM aspiration came from “critical science education,” and the greatest indirect effect (Beta=0.190) came from “student sense of agency to create knowledge in science class.” The noncausal statistic represents the influence of variables outside of the model. The noncausals from the decomposition of bivariate covariation shows a moderate fit for “critical science education” and some weak fits for “science relevance to students,” “student sense of agency to create knowledge in science class,” “student engagement in science class,” and “student perception of science teacher.” Overall, these parameters indicate that the model provides a weak fit.

Table 17

Decomposition of Bivariate Covariation for Mixed Sample Predicting Future STEM Aspirations

Factor	Student sense of agency to create knowledge in science class	Science relevance to student	Student engagement in science class	Student perception of science teacher	Critical Science Education
Original Covariation	0.487	0.517	0.376	0.338	0.527
Direct	0.000	0.277	0.000	0.000	0.319
Indirect	0.190	0.000	0.061	0.019	0.143
Total Causal	0.190	0.277	0.061	0.019	0.462
Noncausal	0.297	0.240	0.315	0.319	0.065

In summary, our first model links together the factors that either directly or indirectly affect student academic achievement in a YCSC science class. After evaluating our SEM, it was determined that the three factors with the greatest impact on student academic achievement in a YCSC science class were “science relevance to student,” which had a direct effect; “student sense of agency to create knowledge in science class,” which had an indirect effect; and “critical science education,” which had an indirect effect, respectively. Our second model links together the factors that either directly or indirectly affect student future STEM aspirations. After evaluating our SEM, it was determined that the three factors with the greatest impact on student future STEM aspirations were “critical science education,” which had a direct effect; “science relevance to student,” which had a direct effect; and “student sense of agency to create knowledge in science class,” which had an indirect effect, respectively.

Qualitative Data Results

The purpose of this thematic analysis was to explore the experiences of Adult YCSC students within their YCSC science classes, specifically with regard to their academic achievement. In this study, there was one source of qualitative data, 10 Adult YCSC student’s semistructured interviews. The participants consisted of five currently enrolled students and five YCSC alumni. These interviews provided detailed information about the student’s experience with class based science courses at YCSC. Demographic information for the interview participants is provided in Table 18.

Table 18

Demographic Information for Interview Participants

Participant	Age	Race/Ethnicity	Gender	GPA	YCSC Science Classes Passed	Status
Xochitl	18	Mexican American	Female	2.48	4	Graduated
Nicole	22	Black	Female	3.00	3	Graduated
Miguel	18	Hispanic	Male	2.58	4	Current Student
Jacob Mendoza	21	Hispanic	Male	3.45	2	Current Student
Ariyan Parker	21	Black/African American	Female	No Response	2	Graduated
Zacharie	19	Hispanic	Male	3.41	3	Graduated
Erendira	24	Hispanic and Latina	Female	2.90	3	Graduated
Paola	18	Hispanic	Female	3.02	2	Current Student
Jason	18	White	Male	3.09	3	Current Student
Felipe	27	Latino	Male	1.67	2	Current Student

The following is an overview of each participant's background. Each participant was asked to self-select a pseudonym to use throughout the study. In writing each participant's background, I felt it was important to stay true to each participant's story. Throughout the section, when highlighting participant quotations, there will be grammatical and sentence structure errors.

Xochitl

Xochitl identified as a Mexican American woman and was 18 years old. She was a student at the El Monte YCSC site from September 2017 to June 2019, when she graduated with her high school diploma. During her time at YCSC, she completed four science classes:

Chemistry A with an A grade, Chemistry B with an A grade, Physical Science A with a C grade, and Biology A with an A grade. Review of her transcripts shows that she attended one high school prior to enrolling at YCSC. At her previous high school, she completed one science class: Animal Biology A with a D grade. Further, at her previous school she received an F grade in Animal Biology B and Earth Science. Xochitl identified wanting to go to pursue a career in the medical field as a licensed vocational nurse.

Nicole

Nicole identified as a Black woman and was 26 years old. She was a student at the Avalon Youthbuild YCSC site from September 2017 to June 2019, when she graduated with her high school diploma. During her time at YCSC, she completed three science classes: Physical Science A, with an A grade; Biology B, with an A grade; and Biology A, with an A grade. Review of her transcripts showed that she attended one high school and one community college prior to enrolling at YCSC. While at her previous high school, she completed three science classes; Chemistry A with a C grade; Physics A with a C grade; and Biology with an A grade. Further, at her previous school she received an F grade in Physics B and Chemistry B. Lastly, Nicole identified wanting to pursue a career in nursing or occupational therapy. When asked what led her to YCSC, Nicole's response was: "Once I found out that the diploma I received from a previous school was not accredited I had randomly come across and ad for the school (YCSC) on social media."

Miguel

Miguel identified as a Hispanic man and was 18 years old. He was a current student and had been at the Palmdale YCSC location since September of 2017. During his time at YCSC, he had completed four science classes: Chemistry A, with an A grade; Earth Science A, with a B grade; Biology A, with a B grade; and Physical Science A, with an A grade. Review of his transcripts showed that he attended five high schools prior to enrolling at YCSC. At his previous high school, he completed zero science classes. Miguel identified wanting to serve in the Navy after he graduated. When asked what led him to YCSC, Miguel's response was:

> I heard about this school and how they help you catch up faster, more opportunity to get a job and do community service a lot faster and have an opportunity to get a career after and that's something that interest me and I wanted to come here.

Jacob Mendoza

Jacob Mendoza identified as a Hispanic man and was 21 years old. At the time of this study, he was a student and had been at the Fresno YCSC location since September of 2018. During his time at YCSC, he had completed two science classes: Conservation of Natural Resources, with an A grade; and Biology A, with a B grade. Review of his transcripts showed that he attended zero high schools prior to YCSC. When asked what led him to YCSC, Jacob's response was:

> Oh well I was a salesman for the for the newspaper article out here in Fresno and then that's the reason why I left (school) you know I was just working making, money and . . . I got distracted and just kept working just left school, dropped out...then dropped on this program here. I could do both, I could just work and get money you know by working.

Ariyan Park

Ariyan Park identified as a Black, African American female and was 21 years old. She was a student at the Fresno Youthbuild site from September 2018 to June 2019, when she graduated with her high school diploma. Ariyan did not provide a transcript for review. At the time of the interview Ariyan had completed her high school diploma with YCSC and had begun taking courses at a local community college. Lastly, Ariyan identified a few career interests. Among them were a counselor, therapist, modeling, and/or a YouTube career. When asked what led her to YCSC, Ariyan's response was: "It was too stressful for me . . . because, you know, I was transitioning into adulthood and I wasn't ready to go to college yet."

Zacharie

Zacharie identified as a Hispanic man and was 19 years old. He was a student at the East Los Angeles YCSC site from April 2017 to June 2019, when he graduated with his high school diploma. During his time at YCSC, he completed three science classes: Physical Science A, with an A grade; Biology A, with a B grade; and Biology A, with an A grade. Review of his transcripts showed that he attended two high schools prior to enrolling at YCSC. At his previous high school, he completed two science classes: Intercoordinated Science, with a B; and Physics A, with an A. Zacharie identified a motivation to go into stem after completing his high school diploma with YCSC: he wanted to become a veterinarian. When asked what led him to YCSC, Zacharie's response was: "I was dealing with depression and everything. So I didn't want to go to like public school anymore. So I told my mother if I can do online schooling. . . . then we found this school."

Erendira

Erendira identified as a Hispanic and Latina woman, and was 24 years old. She was enrolled at the Compton Youthbuild YCSC site from February of 2016 to October of 2019, when she graduated with her high school diploma. During her time at YCSC, she completed three science classes: Biology A, with a B grade; Earth Science A, with a B grade; and Physical Science A, with a B grade. Review of her transcript showed that she attended zero high schools prior to enrolling at YCSC. Erendira identified wanting to pursue an education in cosmetology and business. She aspired to have her own cosmetics line. Lastly, when asked what led her to YCSC, Erendira's response was: "Wanting to continue my knowledge and achieve more knowledge."

Paola

Paola identified as a Hispanic woman, and was 18 years old. She was currently a student and had been at the Moreno Valley YCSC location since May of 2019. During her time at YCSC, she had completed two science-based courses: Earth Science A, with an A grade; and technology, with an A grade. Review of her transcript showed that she attended one high school prior to enrolling at YCSC. While at her previous high school, she completed one science class: Biology A, with a B grade. She also received a D grade in Biology B. Paola identified wanting to pursue education in the medical field after she completed her high school diploma. Paola aspired to be a doctor. Paola expressed that the reason she left her previous High School was due to family issues. When asked what led her to YCSC, Paola's response was: "A friend told my mom that I could graduate early and I decided to go."

Jason

Jason identified as a White man and was 18 years old. He was a current student and had been enrolled at the Moreno Valley YCSC location since September of 2018. During his time at YCSC, he had completed three science-based courses: Physical Science A, with an A grade; Earth Science B, with a B grade; and Biology A, with an A grade. Review of his transcript showed that he attended three high schools prior to enrolling at YCSC. At his previous high schools, he completed one science course: life science, with a B grade. Further, he received an F in biology. Jason identified wanting to pursue an education in psychology or business after he completed his high school diploma. Jason aspired to work in the medical field. When asked why he left his previous schools, he expressed that it was due to personal problem and a lack of connection to the school.

Felipe

Felipe identified as a Latino man and was 27 years old. He was a current student and had been enrolled at the Compton YCSC location since December of 2018. During his time at YCSC, he had completed two science-based courses: astronomy, with an A grade; and biology, with an A grade. Review of his transcript showed that he attended two high schools prior to enrolling at YCSC. While at his previous high schools, he completed zero science courses. Further, he received and F in Biology A and an F in Biology B. Felipe cited wanting to pursue college once he completed his high school diploma, but did not have any particular course of study in mind. When asked why he left his previous High Schools, he expressed:

> I was kind of out of focus. I was, you know, kind of being rowdy out of a really loud annoying kid just you know wouldn't really put school as my first priority and it was mostly attendance as well. And eventually I got kicked out. And after that I just gave up and you know, I didn't really try to go to school my parents weren't really pushing me either at the time. I tried adult school a little bit after but I kind of did it just to do it. Later I was a bit more stable living, started working and I wanted to improve upon myself. When I started looking up for other options and my cousin actually came across a flyer and I said that I'll look into it. I called and gave it a try and I've been here for a year and a month.

Interview Questions

The interview questions used in this study are presented in Table 19 below. In addition to this survey protocol, the semi-structured interview format allowed for probing questions throughout the conversation with the participant. Although all probing questions are not listed, they followed in line with the interview questions.

Table 19

Interview Questions Used in Study

Interview Questions
1. Do you consider yourself a "high achiever in school"? In science class?
2. Has your achievement in school changed from your other schools to YCSC? In science class?
3. Do you feel engaged in science class?
4. What do you feel contributes to you being engaged in science class?
5. What do you feel takes away from your engagement in science class?
6. Do you feel that you can create knowledge in science class?
7. What are some examples of you creating knowledge in science class?
8. How would you describe your science teacher?
9. What are the qualities (both positive and negative) that your science teacher brings into the classroom?
10. How would you explain your relationship to science?
11. Do you feel that science is relevant to you? Please explain.
12. What is your opinion of the YCSC science classes?
13. What is your opinion of the Authentic Performance Tasks?
14. When you work on Authentic Performance Tasks, do you feel you are creating knowledge?
15. Do you think that science can be used to solve issues in your community? In your life?
16. Which YCSC location do you attend?
17. Why do you feel you stopped attending your previous High School?
18. What led you to enroll at YCSC?
19. What do you identify as ethnically/racially?
20. What gender do you identify as?
21. What are your future educational goals?
22. What are your future career goals?
23. Do you have any questions for me?

Themes

This section provides a narrative of the themes that were constructed from analysis of the qualitative data. The subthemes that emerged from the semistructured interviews were organized into thematic categories and represent a rich description of how students viewed their experience in YCSC science classes. Once these themes were identified, interview transcripts were again reviewed to code statements belonging to these themes.

Through principal component analysis with the quantitative data gathered from the YCSC Adult Student Science Survey, I identified six factors: student engagement in science class, student sense of agency to create knowledge in science class, student perception of science teacher, science relevance to student, critical science education and STEM future aspirations. Those factors were then placed into two Structural Equation Models (SEM), one of which focused on understanding what factors may have an impact on student academic achievement in YCSC science class; and the second of which focused on understanding what factors had an impact on student future STEM aspirations. The purpose of this thematic analysis was to better support the findings of the quantitative data.

The researcher identified one theme from the qualitative analysis of participant interviews—that of an equitable learning space. Figure 7 provides a brief description of the themes and the components of each theme; a detailed discussion of the themes follows the figure.

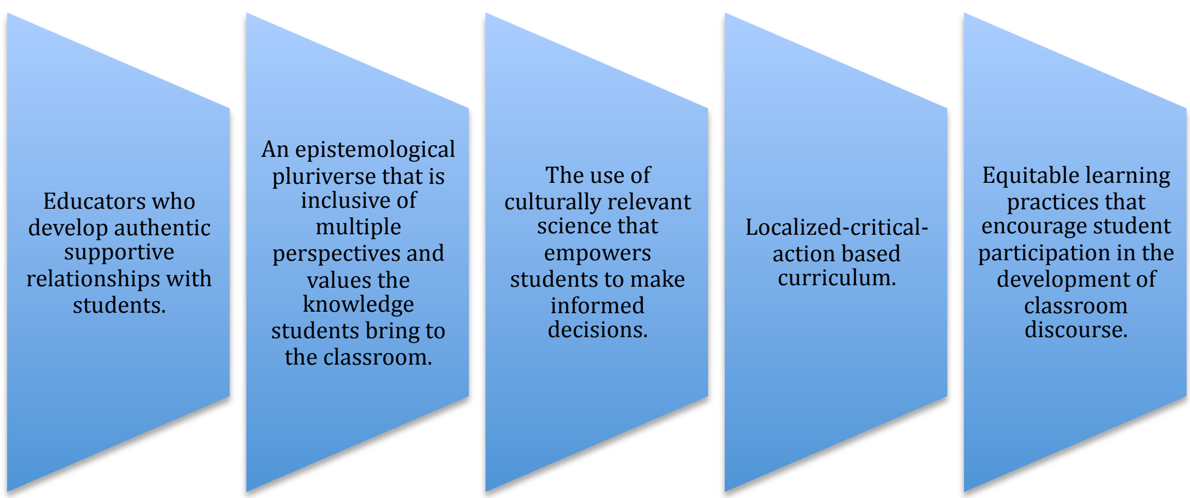

Figure 7. Equitable learning space.

Students who have dropped out of their traditional secondary educational programs are in a position to reintegrate and complete their secondary education; however, this population has historically struggled with completion of secondary education. Once a youth drops out of school, it is less likely that they will complete their secondary education (ACLU, 2017). This population was largely composed of students of color (Child Trends Data Bank, 2018; National Center of Education Studies, 2018; U.S. Department of Commerce, 2018). In analyzing the data, students expressed experiencing a transformation when it came to academic achievement in their science classes. They described a change in academic achievement in transitioning from previous schools to YCSC and current academic achievement in YCSC science classes. This transformation was supported by an equitable learning space that consisted of the following: educators who develop authentic supportive relationships with students, an epistemological pluriverse that is inclusive of multiple perspectives and values the knowledge students bring to the classroom, the use of culturally relevant science that empowers students to make informed decisions, a localized-critical-action based curriculum, and a wide array of equitable learning practices.

Change in Achievement

Youth who switch schools are more likely to be more disengaged and perform worse academically than their peers who do not switch schools, according to higher levels of absenteeism, lower grades, and more frequent school suspensions (Rumberger & Larson, 1998). Further, it has been found that fewer than 30% of high school students attend more than one high school, and the students who change schools are more likely to drop out (Gasper et al., 2012). Nine of the ten participants we interviewed had a record of changing High Schools more than one time. However, when transitioning to YCSC they all noted a change in their academic achievement their pre-YCSC school experiences to their YCSC school experiences.

This change came in the form of academic success and motivation. With regard to change in academic success, Xochitl stated, “I went from D's and F's to A's and B's honestly.” When asked what supported this change, she explained, “Honestly, I would never pay attention, I just didn't find interest or pay attention or anything in that environment [at YCSC] Well the teachers are more real with you and are getting to know you and are making sure that you get to participate." Further, in reference to her previous school, prior to enrolling at YCSC, Xochitl stated:

> The only other science class I had was in the other school. I did not perform well because I didn't feel like I needed to pay attention. I really didn't feel like they cared if I paid attention or not. So it wouldn't really motivate me to keep trying. So I would just not pay attention on participant anything I see.

When asked if she experienced change in academic achievement and what they felt contributed to it, Nicole stated "having better instructors. They were more focused on students, individually." Ariyan expressed, "My teacher understands that, you know, I have a life and it's not just school that my life revolved around." With regard to change in motivation to achieve academically, Jacob stated: "Well, I mean, back then I didn't really care much. Now it's like, you know, I had to do is to better myself, you know, to be successful in life, you know, and to move forward, you know, get a better education" Miguel stated, "I have more motivation because they stay on top of me and they want to see me progress and when I do something right they notice it and they call it out and it inspires me to do more." With regard to change motivation to succeed academically, Felipe offered:

> Yes because there's more of a personal decision this time, like I decided I might actually want to be more focused. So, when I went to YouthBuild, you know, I just was more motivated, and, you know, this is what I'm gonna do, and I'm gonna stay on it . . . I feel like I have to do it and I want to do it. So it's helping me, you know, succeed better.

Current academic achievement. All participants were currently experiencing success in YCSC science courses or had experienced success if they had already graduated from YCSC. Students identified a number of factors they felt contributed to their academic success in YCSC science classes; among them were self-motivation, family motivation, feeling good when they succeeded, they could help others if they themselves performed well, interest in science, seeing science as a source of empowering knowledge, and relevant curriculum. When asked what contributed to his academic success, Zacharie stated:

> Well, I know I want to always do my best. Anything that I can do I know, my entire life my mother has always been proud of my academic achievement and I feel like it's something that I'm good at. So I feel like it makes me feel good to be able to like make my mom feel good.

Zacharie added, “Science is like, so interesting to me. Like it’s always evolving and changing. And it helps us like understand.” Ariyan expressed an understanding that succeeding academically would help her in life; she stated, “I want to be successful in life.” Xochitl stated that she considered herself successful academically “because I like to help people out like if they don't get it, so I like to understand it faster so I could help them out.” Miguel stated, “They (the teacher) tries to connect what they are talking about to actual everyday life. So, like learning about science and stuff has always caught my attention and I kind of like it so that kind of helps too.” With regard to what had supported her current academic success, Paola expressed, “Asking questions and getting the correct response back (from teacher).” She explained that she felt at YCSC that they were teaching her the “correct way . . . they were taking time to explain and answer questions she had . . . also small classes . . . always having support. When I want to ask questions, the teacher helps me right away and explain to me correctly.”

Equitable Learning Practices

Student engagement, as defined by Wang and Eccles (2012), refers to the quality of a student's involvement in academic settings and learning activities. Frederick et al. (2004) conceptualized student engagement by three dimensions: (a) behavioral engagement, referring to the student's participation effort, attention, persistence and positive conduct; (b) emotional engagement, referring to the student's positive and negative reactions to teachers, peers, classroom activities, and value they find in learning; and (c) cognitive engagement, referring to students' self-regulated learning and exerting the necessary effort for comprehension of complex ideas. Based on thematic analysis, I found that science educators at YCSC incorporated equitable learning practices into their courses. Among the factors students identified as equitable learning practices were hands-on activities, visual stimulation, doing while someone teaches, simplified topics, dialoguing with peers and teacher, scientific topics relevant to them, experiments and science labs, activities that encourage students to get to know each other, and science based on a real-life perspective.

When asked what engaged them in their science class, Zacharie stated, "Well, I really love like hands on projects . . . I prefer more visuals and like doing things because I know for me like if I actually do the things while someone teaches me I learn better that way." Ariyan contributed, "When I asked questions, she answers them . . . she doesn't just like, push it to the side." She added, "Sometimes we'll go off topic and we'll talk about other scientific things like in the world, and it'll open our eyes . . . they (the teacher) have stories to go with it, like personal experience." For her part, Xochitl stated, "I think it's more hands on than in other schools . . . in YCSC it's more doing experiments." Further, Xochitl addressed a connection to a real-world perspective of science, describing "using different chemicals and to create certain things like for example pennies, we use a lot of acids and, and Clorox and all that to clean different objects." Felipe explained, "The teacher was really friendly, so she got everyone to talk. And she had fun activities where we compete against each other members making it into a game and really interactive." Jason expressed:

> Different places that that the School goes for trips and stuff like that, like the STEM fair. That was a really fun trip that we went on one time. Um, I mean, the labs are very engaging, I'm able to really get involved in those, very hands on stuff like that.

With regard to teacher perception and engagement, Xochitl stated, "Because they actually care about your opinion and your participation so I feel very engaged." Nicole stated: "The ice breakers and getting to know one another." Further, she explained, "I feel like hands-on things and when they allow us to work in groups . . . pretty much they allow us to work together and communicate." Angel stated that he liked "when she asks a question and it opens people's eyes on how the world is looked at from different peoples perspective." He added that when science is made relevant to his life, it supports engagement:

> Like right now we are learning about fast foods and what type of chemicals . . . it's bad for your health to eat a lot of that and that also opened up my eyes because I like to eat Taco bell and McDonalds and stuff like that and now I'm thinking about making my own food at home.

Lastly, he spoke about how dialogue and different students' experiences supported engagement. He stated, "It's engaging because it gets everybody's opinion and thinking like debating on how things are handled or produced from like fast foods and how electronics are produced."

Participants also identified factors that reduced equitable learning spaces and contributed to students feeling removed from science class, distracted, or having a lack of interest. Among these were other students talking and class disruptions, lack of sleep, confusing lessons, use of slideshows by teacher, educator not engaging students in dialogue, and boring topics. When asked what was going on in science class when they found themselves disengaged, Zacharie stated, “It’s always like if people are talking or like being disruptive, like other than that, like it’s nothing.” Paola explained, “When the teacher isn’t on the right track or when the teacher’s seems lost . . . it just isn’t interesting.” Ariyan said:

> If I can’t get enough sleep, I can't get engaged . . . just like wordy, like wordy things that has too many words when it can be said in a simple way . . . Well probably like, going through like a slide or something and she's talking about like, she’s reading off the slide and talking about the slide, that’s pretty much when I get bored.

Angel explained, “Her [teacher] not asking questions for everybody . . . Like when they just give you an assignment and they expect you to do it . . . there is not class conversation. Angel also added, “The room is quiet and there is not a lot of engagement going on and the room is like just focusing on work . . . It’s boring because it feels like you are just doing a test and your not really learning.” Jason expressed that he feels a lack of engagement when:

> We’re just told to do something rather than explained why you're doing something and explained how it supposed to work and stuff like that . . . I mean, usually I get bored whenever it’s a worksheet that is on your desk, just fill out this worksheet.

Felipe expressed that he felt a lack of engagement when he was tired and when his classmates were too loud; he explained:

> I’m tired, I feel less engaged, I just kind of want to put my head down, I can't focus on the class. Sometimes the other members could be a little loud. And I try to stay focused and I'm more of the quiet one. You know, just trying to get my work done. I mean, I’m

> friendly . . . you know, have a little conversation but some people get a little distracted and loud.

Evelyn simply stated, “Probably just the Power Points.” When asked about disengagement in science class, Nicole responded “1. It’s mostly when people interrupt the class . . . maybe it’s just when I have trouble getting interested in it.”

Epistemological Pluriverse

According to Kincheloe (2008), an epistemological pluriverse is space in which students and teachers can juxtapose their personal experiences with multiple types of knowledge. It is a space in which many social worlds can mingle and a praxiological space where action based on multiple realities can come to fruition. Research suggests that by engaging students with opportunities to be critical consumers and producers of knowledge, and by supporting them to develop a strong sense of agency, they can experience positive change for themselves (Lee & Buxton, 2010; Rodriguez, 2015). Based on my thematic analysis, I found that the YCSC science classroom was aligned with the principles of an epistemological pluriverse in that it encouraged the juxtaposition of student personal experience and science knowledge. With regard to students’ sense of agency to create knowledge, one component emerged from analysis of the data: student knowledge creation. Participants identified student knowledge creation as consisting of the following factors: a student’s interpretation, a student realization, a student experience, a connection to the student, something different that has not been seen before, learning something then changing it, and a visualization of how content can be applied in a real-world setting.

When asked if they felt that they could create knowledge in science class, all the participants said they could. When asked if they could explain how they created knowledge in science class, Zacharie stated, “What I learned from the teacher and like putting my own interpretations into what you're saying and giving my own feedback and like what I think about it." Ariyan explained, "So when I create knowledge in class, it's usually like an epiphany or something that I realize." Further, she spoke on how class collaboration can lead to knowledge creation, "So the whole class, we all come together and just like think about it [a topic] and talk about it and tell our different experiences and stuff." She also expressed that when you create knowledge, you make a connection of a topic to your life, "Then you kind of connect it (science topic) to your life and say oh, yeah, this is how I see this." Xochitl stated, "We all [students] sometimes put our thoughts together and come up with something different." As an example, she explained:

> For example, making candles we put different fragrances which contain different chemicals in them and made them react different sometimes . . . something different that no one really saw was how the candle would react . . . so I think a lot of people would now know how it would react if you put that certain substance in it.

Jason stated, "Learning new things about the world, experiencing new things, I guess is a better way to put it. When you experienced it, it kind of ingrained in my mind a little bit more." And Felipe asserted, "I start to visualize whatever is being taught in my head. You know how it works in the real world because I'm actually trying to understand how I can apply those things yet."

Authentic Educators

Science educators play a pivotal role in student academic success. The attitude an educator has about who can and cannot succeed in school can be communicated in a number of ways, explicitly and implicitly, to students (Rosenthal & Jacobsen 1968), which can in turn impact a student's success in the science classroom. As such, sometimes students do not engage in school and underperform because of deficit thinking by their teachers. Valenzuela (1999) argued for a practice of authentic caring by educators, which she defined as the development of a trusting relationship between educators and students that constitutes the cornerstone for all learning. The theme of an authentic educator emerged from the data analysis. Educators are viewed as authentic when they are committed to the development of supportive and trusting relationships with students and where students are shown that they matter. Further, authentic educators are willing to go above and beyond to support student success in and out of the classroom.

All of the participants all shared a very positive disposition of their YCSC science educators. Participants described an authentic educators' classroom practice as knowledgeable in the field, describing topics step by step, answering all questions, having a fun learning perspective, providing extra support, working with students individually, and dialoguing with students. When asked the qualities they liked about their science educator, Zacharie stated, "He like took into consideration like every student . . . like how they learn, so I really like that too . . . I know he was very knowledgeable in his field . . . just overall . . . he understood people and you have to teach them." Jacob offered:

> They [teachers] try to describe it to you and show you step by step, you know, how it's done everything properly, so you won't make a mistake, especially when we do our projects, you know, we have to do research in and, you know, take notes for everything to come out accordingly.

Further, he added, "And the positive things about it, sometimes they demonstrate it in different ways . . . they also break it down for certain people that don't understand it, like, instead of using a lot of words, break it down so people can have an understanding of it." Xochitl stated, "She's a really good teacher . . . she tries to explain the hardest she could and if not she would do the most to get you to understand the subject . . . she works with you to complete whatever you have to do.” Nicole stated, “Really great teacher and very helpful . . . he would answer any questions that we had...he was someone there to assist you, pretty much at all times.”

The relationship between students and authentic educators was described by participants as friendly/positive vibe, taking consideration of all students, motivating, encouraging, connects with students on a personal level, understanding students have personal lives with issues that come up, and determined to see all students succeed. When asked what qualities they liked about their science educator, Zacharie stated, “My science teacher really like gave off like a friend, like a very positive and friendly vibe, which I really like . . . overall my science teacher was like a really nice guy and he understood people.” Ariyan explained, “She’s very connected [to students] . . . she gets with the students on a personal level. She talks to them; she doesn't just treat them like children, but that you know are in high school. She actually tries to help us.” Jacob stated:

> Motivation, you know, motivation or they may try to push you, you know, like, Oh, I can do it. If I don't know how to do something, they’re [teacher] like–oh yeah you can– and then if you can't do it, you know, you always have them [teacher] here or you can just go to the lab, and whatever you need help on, they help you with.

Xochitl explained, “She understands people pretty well, especially in certain events. Other teachers will not understand you because they have not gone through the things that you have gone through. She works with whatever you have to do.” Miguel stated:

> She has like a lot of fun learning perspective and like she is a grounded person . . . we would talk about funny topics like how certain chemicals work. Some positive qualities

she has she is always determined to see an assignment or pass a test in a high percentage. Like she is so engaging.

Culturally Relevant Science

Culturally relevant pedagogy, as described by Ladson Billings (1995), posits that content should be connected to students' interests and concerns, meaningfully integrate students' culture into the curriculum, and elevate students' socio-political consciousness by investigating real issues in local contexts. The theme of culturally relevant science emerged from the data. Students expressed that science that was culturally relevant to them empowered them to make informed decisions and conduct effective problem solving. All participants expressed that they felt science related to them to some extent. When describing how they saw science as relevant to themselves, participants expressed the following: supports you to take action, informs decisions, relevant to some careers or future education, awareness of issues, and provides evidence. When asked why they felt science was relevant to them, Zacharie stated:

> I'm pretty sure science is relevant to anyone in my opinion. Okay, so probably like a prime example is probably like climate change. That's relevant to everybody because like, if, like we know about our planet, like we know what we have to do to fix it. And without science, we probably wouldn't have known that. Yeah, science can be used to solve a lot of things. Okay, so all I can think about is like climate change right now, because I know since we already know about climate change, we can take action about it.

Ariyan responded:

> Yeah, I feel like it's relevant to everybody. I find value in science because it teaches a lot to different people and in a format where everybody can understand, it's not just for one

person. Everybody can read it and understand it because it's facts. You know, it's not an opinion. Well some of them are, but mostly facts.

Jacob stated:

> It's relevant because, I mean, sometimes we might need these stuff, you know, knowing such as chemicals, you know, because you mix certain chemicals and you can just like blow up or catch on fire something or make something small to really flammable. There's a procedure of knowing what you're doing so you won't mess it up later on in the future or in life.

Felipe stated: "Oh, I think it can solve issues with anything. Especially when it comes to liking the environment, which I care about." Further, Jacob explained:

> You know, all the sciences and all the new stuff that's coming out, you know, could stop pollution in a way you know, have more of a clean air environment than it is when people driving cars and polluting the air...and then oils too. Oils, burning, factories, stuff like that . . . leaks in the ocean . . . science can support people that would try to clean it up.

Xochitl stated:

> It's relevant, I think you will need it. For example, I'm trying to be in the medical field. So I think I would need it to study medicine and all that. So I think far along it is going to help me.

Jason stated that teachers support relevance because "They always tie into the class. I know that for sure. Yeah. And it's always a way to connects the science that we learned in class to the outside world." Paola expressed, "Yeah . . . so like if people knew what the pollution was like then they would pick up more or they would understand how to reduce pollution." Nicole stated, "Because I'm interested in the medical field I have more interest in learning about science.

Especially if that is one of the classes you need to take for your major. I can actually apply it towards the future." Miguel commented:

> It helps me to be aware of what I eat or what I use because I might learn something about technology or radiation like something that can hurt me. Or whatever I eat might not be good for me as well and like . . . if I eat something healthy or drink more water it might help me feel better and its important to me because it helps me as a person.

Further, Miguel stated:

> Science can be used to open people's awareness to see how certain stuff is bad for us. Instead of wasting power from circuit power we can use solar power for electricity because it's easier on the environment and like pollution because pollution contributes to global warming and it makes it speed up much faster and knowing this knowledge it will get them [people] more aware and it will get them more active to help make a difference.

Localized-Critical-Action-Based Curriculum

In the problem-posing model proposed by Freire (1970), educators and students see knowledge as something that allows them to be free and become agents of change. Knowledge is not seen as something that is gained from a teacher only; rather it is gained by critically analyzing what you study and the world you live in. According to this pedagogical model, knowledge is not static, but is constantly changing and being created. This pedagogy allows the student to develop a sense of agency in creating knowledge by encouraging praxis. Praxis is the action of putting knowledge to practice—that is to say, to actually apply the knowledge that one has on a given topic toward a purpose (Layton, 1991). YCSC encouraged a project-based approach in the classroom through the completion of authentic performance tasks (APT), and it emphasized the inclusion of social justice. A localized-critical-action-based curriculum emerged from the data, and was identified by students as relevant, supportive, and action based. All participants expressed a positive disposition to the YCSC science curriculum.

Relevant and supportive curriculum. Participants described that the YCSC science curriculum was relevant to them and supportive of their experience. Factors they felt contributed to this relevance were: that it was open to their experience, used topics they could relate to, it allowed them to work in collaboration with classmates, and it allowed them to learn at their own pace. When asked what their experience with the YCSC science curriculum was, Zacharie stated, "I take what my teacher taught me and I put like my own flair into it . . . I also put my own experience into the class topics." Ariyan remarked:

> Sometimes I study things that I never knew before and learn something different . . . last time I was doing something that has to do with the water where you know, sometimes it's not safe to drink water from the like, out of the water hoses because it could be contaminated with other stuff chemicals and stuff and then yet yeah, taken into get it cleaned and filtered and I didn't even know about that.

Miguel stated, "It's the most fun class to be in because everybody can learn it at the same pace or they can help each other to catch up and stuff." Miguel added, in reference to the APT:

> It's pretty good because it helps people socialize more with their fellow students and it makes leaders develop because some people might take charge with google slides or help people learn how to express what they have learned or what they feel inside and it will show in their APT and she will look at it. So, it's like having an opinion to talk to her about after she reads it and it makes it a little bit more fun.

Action-based curriculum. Participants described YCSC science curriculum as action-based because it encouraged them to frame science issues in their own lived experience, critically analyze its impact, and use that understanding to take action. When asked what they thought of the project-based approach of YCSC, Zacharie stated:

> Oh, I enjoy them. I like them. I feel like, I know some students hate tests. I honestly don't mind tests, but I know tests are mostly about memorization, you know? And I don't really think that's like, really good to help people learn when you just have to memorize it. I like the idea of creating a project. So because it shows what you learned. And you like show it instead of bubbling in what I remembered, you know? So I honestly enjoy doing that. One assigned APT that I remembered was the storybook we made. I think I did it on like, cloning. Yeah, I remember it's like on cloning. I find it really fun because I put what I learned about cloning but I also put my own drawing into my own story, which I really liked it

Jason stated, with regard to the YCSC science curriculum:

> Plenty of ways that science can connect to the outside world, which can also connect to the community and you're always able to tie it in somehow. I mean, Yeah, I know the city that we live in is very, it’s not the nicest city . . . and science can help us fix that.

Destiny commented:

> Those [APTs] are also interesting. Before we actually started I felt like if it was going to be a lot of work, but actually finishing the project, it was like a breath of fresh air. Some were more interesting than others. The one where we focused on a gun march, participating. That one was a big issue in the country. That one was really great. And we were helping out with the fires that had just happened. I enjoyed doing that.

In summary, the thematic analysis of participant interviews espoused a theme of the equitable science classroom. Participants described experiencing a change in academic achievement in transitioning from previous schools to YCSC and reaching academic achievement in YCSC science classes. This transformation and current success was supported by an equitable learning space that consisted of the following: educators who develop authentic supportive relationships with students, an epistemological pluriverse that is inclusive of multiple perspectives and values the knowledge students bring to the classroom, the use of culturally relevant science that empowers students to make informed decisions, a localized-critical-action-based curriculum, and a wide array of equitable learning practices.

DISCUSSION

The purpose of this study was to examine the factors that may contribute to student academic achievement in their YCSC science courses. In addition, this study sought to better understand what factors may impact student STEM aspirations. The study set out to examine how each of the following areas—student perception of teachers, critical science education, student sense of agency to create knowledge, student engagement in science class, and relevance of science to the student—impact student academic achievement in their class-based science course and their STEM aspirations. Chapter five, the final chapter, provides a discussion of findings, implications for practice, and researcher's implications. This chapter ends with recommendations for further research and conclusions.

Research Questions

The study was guided by the following central research questions:

1. What factors contribute to student academic achievement in YCSC class-based science courses?
2. What factors impact YCSC student future STEM aspirations?

Methodology

The study utilized a mixed-methods approach, specifically structural equation modeling as a quantitative technique and thematic analysis as a qualitative technique to examine the factors that impact student academic achievement in their science classes and student future STEM aspirations. The use of mixed methods research:

> allows for a deeper look at our survey design; the purpose and context surrounding each survey item and element; whether our variables and measures are adequately capturing

the experiences and self-identities of . . . students . . . and how our interpretive and analytical choices influence what part of the picture we see, what suggestions we make and for whom. (Metcalf, 2016, p. 4)

Structural equation modeling combines factor analysis for identifying latent factors, path analysis for conceptualizing relationships between latent variables, and multiple regression for testing relationships between latent variables (Hox & Bechger, 1998). Thematic analysis is a method for identifying, analyzing, and reporting patterns (themes) within data (Braun & Clarke, 2006, p. 79). Thematic analysis allows for flexibility in the analysis of data, provides a structure for organization of themes, and assists in interpreting the research topic (Braun & Clarke, 2006). A quick recap of Braun and Clarke's six-phase guide for completing thematic analysis is provided in the Figure 8, below.

Figure 8. Braun and Clarke's six-phase guide for completing thematic analysis.

Participants

The study included 100 participants who completed the YCSC Adult Student Science Survey; 10 participants were interviewed. All participants in the survey portion of the study were current YCSC students age 18 or older. All participants in the interview portion of the study were 18 or older; 5 participants had graduated from YCSC and 5 participants were current students. Additional information regarding the participants is provided below.

Survey participants.

- Participants were representative of 17 of the 18 YCSC locations
- 54 males, 45 females, and 1 participant who identified as other
- 5 participants identified as White, 17 participants identified as Black or African American, 2 participants identified as Asian or Asian American, 2 participants identified as Hawaiian or Pacific Islander, 72 participants identified as Hispanic or Latina/o, 2 participants identified as other, and 1 participant declined to state
- 16 participants had passed zero science classes at YCSC, 22 participants had passed one science class at YCSC, 31 participants had passed two science classes at YCSC, and 8 participants had passed three science classes at YCSC

Interview participants.

- Five females and five males participated
- Five participants identified as Hispanic, two participants identified as Black or African American, and one participant identified as Mexican American and one identified as Latino
- All participants had passed at least two science classes through YCSC
- Nine out of the 10 participants had attended at least one high school and had "dropped out" prior to enrolling at YCSC

The participants provided rich data regarding their experience with science classes offered at YCSC, specifically with regard to the student perception of teachers, critical science education, the student sense of agency to create knowledge, the student engagement in science class, and the relevance of science to the student impacted student academic achievement in their class-based science course and their STEM aspirations.

Discusion of findings

When seeking to re-engage youth who have dropped out of their traditional high school, educators must provide multiple forms of support for their academic success. YCSC was an alternative education program that strives to do just that. Through its small classroom setting, project-based approach, and focus on social justice, it worked to provide an equitable learning opportunity to all students who attended.

This study found that YCSC science classes supported student academic achievement and STEM aspirations. Through direct and indirect impacts, all factors evaluated in our structural equation models—the student perception of teachers, critical science education, the student sense of agency to create knowledge, the student engagement in science class, and the relevance of science to the student—had an effect on student academic achievement in science class and student future STEM aspirations. Further, through thematic analysis, the theme of an equitable science classroom that supported student academic success emerged. Students identified the YCSC science classrooms as an equitable learning space with the following components: educators who develop authentic supportive relationships with students, an epistemological pluriverse inclusive of multiple perspectives and values the knowledge students bring to the classroom, the use of culturally relevant science that empowers students to make informed decisions, a localized-critical-action-based curriculum, and a wide array of equitable learning practices.

Student Academic Achievement-Equitable Learning Space

Based on our thematic analysis, academic achievement came in two forms for the students of YCSC. The first was a change in academic achievement by YCSC students from their previous high school science courses to their current YCSC science courses. This change was two-fold: a change of motivation and a change in academic success. The second form of success identified by participants was current academic success, meaning they were completing YCSC science courses, whereas they had trouble completing science courses at their previous schools. In addition, academic achievement was exhibited by YCSC science classes passed by students.

Given that students of color, such as Black and Latinx students, perform at lower levels on assessments and earn fewer credits, on average, than their White peers in the traditional high school science classroom, it is important to note the change in academic achievement for students at YCSC (Dalton et al., 2018; NAEP, 2015; National Center for Education Statistics, 2017). Based on this study's SEM, the greatest predictors of student academic achievement in YCSC science classes came from science relevance to student (direct effect), student sense of agency to create knowledge (indirect effect), and critical science education (indirect effect). In addition, our thematic analysis found that the equitable learning space—as described above—contributed to student academic achievement.

Relevance of Science to Students—Culturally Relevant Science

The traditional science curriculum found in the classrooms of many traditional high schools consists of units, lessons, and assessments that are unrelated to students' everyday lives. It is reflective of a view of science practice that is too far removed from the students' worldview and the issues or questions they may face in their communities (Brickhouse et al., 2000). When asked why they had not succeeded academically in their traditional high school science classes, many of the participants in the present study expressed that they had not seen the class as useful.

Relevance of science to students was the only factor that had a direct effect on student academic achievement in science class. Based on our principal components analysis, students identified science as relevant because they learned topics in science class that they could connect to their everyday lives; they could use science to solve issues in their lives; they could use science to solve issues in their community; and they learned science topics in their YCSC science class that they could use to solve problems important to them. Based on our thematic analysis, a component of the equitable learning space was culturally relevant science, which participants identified as empowering them to make informed decisions and undertake successful problem solving. Students expressed that culturally relevant science provided support to take action on issues relevant to them; a source of knowledge for pursuing further education in science fields; awareness of issues relevant to them; and evidence for issues relevant to them.

These findings align with the tenets of culturally relevant education (Aronson & Laughter, 2016; Gay, 2013; Ladson-Billings, 1995), in which underrepresented students' cultural and linguistic practices are viewed as assets rather than deficits or barriers to the learning process. The data show that culturally relevant science is a powerful framework for supporting student academic success. The power here is in valuing the student experience and using it as a source of generative themes that can ground the science curriculum.

If a student views science as relevant to their lives, it may be the case that they view this subject as important, as useful, and as a worthwhile endeavor. This finding harmonizes with a meta-analysis by Schroeder et al. (2007), which found that the largest impact on student achievement was the use of enhanced context strategies in the classroom. Enhanced context strategies relate student learning to the students' previous experiences or knowledge.

If a student views science as a subject that provides them strategies, skills, and knowledge to pursue further education or to take action against issues important to them then it may be that they are motivated to perform well academically in science class. This idea corresponds with justice-centered science pedagogy, which posits that through relevant and critical science, education students can achieve academically, while taking up issues of urgent social and environmental justice in their communities (Doyle-Morales, 2017).

Student Sense of Agency to Create Knowledge-Epistemological Pluriverse

Asakalli (2018) has spoken to how the marketization of education had led to a transformation of schools into businesses and—by extension—has changed science education. This shift is concerning, as it encourages current science education to focus on what Aikenhead (2006) has called the "pipeline" approach, whereby science education is seen primarily as a tool to develop future engineers, doctors, or science professionals. With such a mode, students who do not want to go into these fields may lose a sense of agency to engage with science and thus may lose motivation to perform well in science courses.

Student sense of agency to create knowledge in science class had an indirect effect on student academic achievement in science class. Based on principal components analysis, students identified a sense of agency to create knowledge in science class when they could contribute to science knowledge; when they learned a science topic and felt that they could add what they know to that topic; and because they felt empowered in science class (e.g., they could contribute knowledge and have value). Based the study's thematic analysis, a component of the equitable learning space was an epistemological pluriverse identified by participants as a space that allowed and encouraged student realizations; student experiences relevant to science phenomena; a connection to the science phenomenon; something different that has not been seen before; and learning something, and then changing it.

According to Kincheloe (2008), traditional schools have a standardized view of knowledge. When students do not perform well academically it is assumed that they are not proficient or lack the academic ability to learn the science content. Kincheloe argued that a critical complex epistemology, which is dedicated to bringing in the view of people who have been traditionally excluded from the scholarly conversation—in this case, science—is necessary. A critical complex epistemology is a multidimensional view of a phenomenon that goes against the one-dimensional view of a phenomenon, which is what we see in traditional science courses.

If a student feels that they have the ability to engage in knowledge creation within a science classroom, then they may feel that science is discipline that aligns with their experiences. That is, they understand science, are able to integrate their personal experience with science content, and feel the self-efficacy to contribute to science. In line with social justice education, which “perceives students as critical consumers and producers of knowledge capable and responsible for enacting their own sense of agency to bring positive social change for themselves and their community” (Rodriguez, 1998, 2015).

Critical Science Education-Localized-Critical-Action-Based Curriculum

While current trends in science education—such as standards and testing—cater to global economic objectives, they promote a generic science education that has no local ties and therefore no relevance to the students in a given class. Aikenhead and his colleagues (2006) argued that school science, driven by standards and high stakes exams, is a culture of science education grounded in a specific worldview and way of knowing that continues to be reproduced in traditional schools, thus normalizing this culture. According to Pratt (1994), this occurs through a process of “cultural transmission,” a perspective that maintains that the primary purpose of curriculum (in this case, traditional science curriculum) is to “transmit the best products of the intellectual culture” (p. 9). With this in mind, researchers have argued that the science classroom should serve to develop students who challenge social inequality through teaching, curriculum, and social transformation (Dos Santos, 2009; Finkel 2018; Mutegi, 2011; Rodriguez, 1998). Further, Moje (2007) maintained that teaching science for social justice “not only provides access to mainstream knowledge and practices but also provides opportunities to question, challenge, and reconstruct knowledge. Social justice pedagogy should, in other words, offer possibilities for transformation” (p. 4).

Critical science education had an indirect effect on student academic achievement in science class for the students in this study. The YCSC science curriculum encourages a project-based approach in the classroom that integrates social justice–based content with the discipline content and is applied to the completion of authentic performance tasks. Based on our principal components analysis, elements of critical science education were seeing things from different perspectives; conducting science investigations; being based in social justice; using evidence to support conclusions; valuing student voice and experience; working on authentic performance tasks that encourage student knowledge creation; and encouraging students to think of social issues (e.g., inequality and oppression). Based on thematic analysis, a component of the equitable learning space was a localized-critical-action-based curriculum. This curriculum, as seen from the perspective of the student, was identified as relevant, supportive, and action-based.

With the goal of providing an equitable education that supports student academic achievement in science class, the YCSC science curriculum can be seen as a vehicle. The YCSC science curriculum aligned with critical pedagogy as practiced through the problem-posing model (Freire, 1970). Similar to the problem-posing model of education in which knowledge is not static, but rather is constantly changing and being created, students and educators critically analyze the science content in the reality of the community they live in. The curriculum is student-centered and provides students opportunities to engage in knowledge creation through authentic performance tasks. As proposed by social justice science education, the YCSC science curriculum encouraged students to use science knowledge and skills to contribute to navigate, critically question, and examine issues related to their social factors (Rodriguez, 1998, 2015).

Student Engagement in Science Class—Equitable Learning Practices

Traditional science classrooms that promote a standardized view of knowledge that is pre-defined tend employ universal teaching methods that are more managerial, with the goal of performing well on a test (Kincheloe, 2008). The issue here is that when performance on a standardized test is seen as a "true measure" to determine a student's academic ability and the quality of education, it directly dictates the method by which educators teach (Aydeniz & Southerland, 2012). When educators are expected to "teach to the test," they are not allowed to engage students in the practice of learning and knowledge creation; rather, their role is that of information deliverer. Such a pedagogical model has been found to have a negative impact on teacher practice and achievement by students of color in math and science (Lomax, West, Harmon, Viator, & Madaus, 1995).

For participants in this study, student engagement in science class had an indirect effect on student academic achievement in science class. This finding concurs with a study by Skinner et al. (2008), which found that students who are engaged in school are likely to find greater academic success. Based on principal components analysis, students identified engagement in science class as being focused, interested, wanting to succeed, participating, feeling motivated, sharing their opinion, and participating in discussions. Based on thematic analysis, a component of the equitable learning space was the use of equitable learning practices identified in science class as consisting of hands-on activities, visual stimulation, simplified topics, dialoguing with peers and teacher, science topics relevant to them, experiments, community-building activities, and science based in real life perspectives. Akey (2006) found that students learned more when they were active rather than passive participants in the learning process and when they could relate to what is being taught (Akey, 2006). Also, it can be an effective tool for engaging students in lessons when educators can draw connections between information taught and real life (Heller et al., 2003).

Student Perception of Science Teacher—Authentic Educator

Hattie (2009) found that teachers play a major role in student achievement, where the quality of the teacher and the nature of the teacher-student relationship had the greatest effect, followed by teacher expectations of their students. It was also found that impact on quality of teacher from highest to lowest effect were as follows: teacher had a deeper understanding of their teaching and its effect on student learning; teacher had high level of passion for teaching and learning; teacher had a deep understanding of their subject; teacher had a problem-solving disposition toward teaching teacher promoted a positive climate; teacher had respect for their students, challenging students and encouraging them to think (Hattie, 2009). Some of the powerful affective outcomes for teacher-student relationship from higher to lower effect size were as follows: non-directivity (i.e., student-regulated and student-initiated activities), empathy, warmth, encouragement, higher-order thinking, encouraging learning, adapting to differences, genuineness, and learner-centered beliefs (Hattie, 2009). The educator may serve as a facilitator, guide, support system, and all of the above for the young people in their classroom. The effect they have on a student must not be underestimated.

When asked why they did not succeed in science courses in their traditional high schools, many participants noted that their science educators did not motivate them or show interest in their success. Science educators play a pivotal role in student academic success. Student perception of science teachers had an indirect effect on student academic achievement in science class. Based on principal components analysis, students identified positive perceptions of their science educator at YCSC. Science educators were identified as encouraging, patient, wanting students to succeed academically, having high expectations of students, respecting student contributions in science class, supporting all students, using content relevant to student's lives, and engaging. Based on our thematic analysis, a component of the equitable learning space was an authentic educator who develops trusting and supportive relationships with students. An authentic educator was identified as students as having knowledge in the given discipline; having a fun learning perspective; providing extra support; working with students individually; dialoguing with students; having friendly and positive vibes; taking into consideration all students; motivating, encouraging, and connecting with students on a personal level; being considerate of students' lives and issues outside of school; and showing a determination to see all students succeed.

The attitude an educator has with regard to who can and cannot succeed in school can be communicated explicitly and implicitly to students (Rosenthal & Jacobsen 1968). Valenzuela (1999) showed that there is a disconnect between what educators view as caring and students view as caring. She posited that authentic caring requires the development of a trusting teacher-student relationship, which includes having an understanding of the students' cultural world and their structural positions (Valenzuela, 1999). Love (2019) spoke about the important role educators play in protecting the potential of students. She stated that educators must be committed to developing relationships with students, their families, and their communities in ways that are authentic and that honor their knowledge of growing up how they did. Protecting the potential that student bring into the classroom by showing students that they matter, that they have a voice is one of the most important roles of an educator.

Future STEM Aspirations

Extant research has shown that a student's STEM aspirations, as an educational endeavor and as a career choice, are directed by a wide array of factors. Some of the factors are belief in intellectual ability, self-concept and self-efficacy in STEM subjects; school environment, which includes classrooms and educators; and student STEM identity (Arias & Walker, 2004; Dweck, 2007, 2008; Eccles et al., 1998; Jussim et al., 1996; Makarova, 2019; Martin-Hansen, 2018; Metheny et al., 2008; Mulkey et al., 2005; Vincent-Ruz & Schunn, 2018; Wang & Degol, 2013).

The greatest direct effect on the student's future STEM aspirations came from critical science education, followed by science relevance to students. In line with Wang and Degol (2013), the YCSC science curriculum was grounded in a project-based approach in which students were encouraged to engage in real-world applications of science based in issues of social justice. Through this project-based approach, students were given the opportunity to develop self-generated academic work, work collaboratively with peers on science topics, and be assessed in a manner that promotes student growth as opposed to judging student ability. In line with Martin-Hansen (2018), students who felt science was relevant to them were more likely to show future STEM aspirations.

The greatest indirect effect on future STEM aspirations came from students' sense of agency to create knowledge. This finding aligns with the study by Dweck (2008), who found that students who have a higher self-efficacy in STEM are more likely to pursue STEM. Students who felt they could engage with, contribute to, and create science knowledge may feel more comfortable in science class and experience more success in science class. According to Eccles et al. (1998), students were more likely to choose activities in which they had a higher expectancy for success.

Student perceptions of their science teacher also had an indirect effect on future STEM aspirations. Since the teacher is the one responsible for developing, presenting, and engaging students in STEM content, it makes sense that they will have an effect on student STEM perceptions. Students who expressed a positive perception of their science teachers were more likely to express interest in STEM as a future endeavor. In line with Metheny et al. (2008), it has been shown that teacher expectations can affect student self-concept and performance in STEM.

Lastly, Martin-Hansen (2018) and Vincent-Ruz and Schunn (2018) posited that positive STEM identity is a predictor of student STEM aspiration. A positive student STEM identity can be inferred based on student feelings of science relevance and student sense of agency to create knowledge in science class.

Implications

This study was conducted with the hope of providing insights to educators, educational program directors, education researchers, and community organizations that strive to re-engage young people who have dropped out of traditional high schools. In addition, this study sought to contribute to a critical pedagogy of science that supports the development of all students who enter a science space to be creators of knowledge. Based on the findings of this study, there are implications in applied practice for educators, science curriculum, engagement in STEM, and implementation of the Next Generation Science Standards (NGSS).

Educators

Educators are tasked with facilitating the development of all young people who enter their classrooms. This study found that educators contribute to student academic achievement and student future STEM aspirations in a number of ways. The finding produce the following suggestions for science educators. First, science educators need to understand that traditional science education has worked from an epistemology that is not inclusive of many worldviews, that is a formal, intractable, universalistic, reductionist, and one dimensional (Kincheloe, 2008). As an extension of this epistemology—and reinforced by this epistemology—many groups of people have been excluded and oppressed. Further, science educators need to understand that there are systemic inequities and institutionalized racism that extend into the education system and continue to impact achievement of students of color. Lastly, science educators need to fully understand that the classroom is not a politically neutral site and that it can serve to either reinforce oppression and inequity, or to politicize and empower students (Freire, 1970; Giroux, 2011; Kincheloe, 2008). Second, science educators need to be real with their students; that is, they need to actively work to develop authentic relationships with their students, show students that they matter, allow a student's voice to be heard, and nurture a student's potential (Love, 2019). If a student does not know that you care for them, it will be very difficult for them to care about what you have to say. Part of building this authentic relationship is being honest with your students; educators should not lie to their students. If a student asks a question, be honest and real with them.

Third, science educators should practice community building in the classroom; that is, actively develop a community in their classrooms through activities that encourage the class to get to know each other. This practice can support student success by creating a space in which students feel comfortable to make mistakes and communicate openly with their classmates. Fourth, to support all students, science educators must develop a pedagogy that has the goal of engaging all young people—not just those who show interest in pursuing a STEM field; that is, educators must present science in a manner that is inclusive and representative of many worldviews (e.g., the view of people oppressed by science research), not a view of science as an abstract field for "smart people" or as a future financial opportunity. Fifth, science educators must use a culturally relevant science that integrates the student experience; that is, a curriculum that allows students to localize the science content to their community and their individual lives. This model promotes the development of students who can use science to make active decisions about their lives and their communities. Sixth, science educators should integrate action-based projects into science class, using science content and skills to facilitate student-led inquiry from inception toward an action. Encourage students to practice their inquiry skills by investigating a science phenomenon that revolves around an issue that is important to them and then support them to take action toward the issue. Throughout this process, educators must actively dialogue with students to understand the purpose of the knowledge being used and that will be created. For example: Why is this knowledge valid? Whom is the knowledge benefiting? Where are we getting our information? Whose voice is being empowered or silenced? This model can contribute to the development of young people who are empowered and critical science practitioners.

Localized-Critical-Action-Based Science Curriculum

"As a political and moral practice, education always presupposes a vision of the future in its introduction to, preparation for, and legitimation of particular forms of social life" (Giroux, 2011, p. 14). This quotation captures the essence of what it means to truly promote an educational space that understands its purpose. A curriculum consists of the lessons, direction, and objectives of a course. A curriculum embodies the vision of the future that is presupposed in any given course. Therefore, a curriculum is tied to the development, agency, and "success" of the student in any course.

The findings from this study contribute to a science curriculum that supports the academic achievement and empowerment of students who have dropped out of their traditional high schools. It is a curriculum that presupposes a future in which students access science in a localized, critical, and action-based manner. Proposed here are facets of this curriculum that seeks to engage young people in equitable learning. This science curriculum should be localized, meaning that it must be relevant to students in taking from students' localized experiences as the context for all class content. For example, when learning about issues of climate change, the local impacts of climate change should be at the foreground of the class discussion. Students should be able to understand global science phenomena in the context of their lives and their community. Second, this science curriculum must be critical, meaning that it must engage students in deconstructing power dynamics that denote the narrative of the science content and inquire into the impact of the science content on their own lives. Further, students should understand the epistemology in which traditional science has been grounded, why certain knowledge is valued by science while other knowledge is not, and how this dynamic has served to marginalize different communities. Further, students should understand that science has a history of racism and that it has been used, and continues to be used, as a tool for oppression.

Lastly, this science curriculum should be action-based, meaning it promotes student knowledge creation and empowers students to take agency in enacting action in their community with regard to the science content. For example, when learning about diseases in a biology course, in addition to understanding biological causes of disease, students should be engaged in researching how different diseases may disproportionately affect groups of people. Then using that data, students can research this effect on their communities and tie in personal experiences. Students can research root causes of disproportionate effects of disease on different communities and question why this is the case. As a capstone, students can develop local initiatives and work with community organizations currently doing the work that allows them to take action to support people affected by certain diseases. By placing value on the knowledge that students and their communities bring into the classroom, we open up the field of science to a multi-perspective view of phenomena.

Engagement in STEM Education

The majority of students in our study had attended multiple traditional high schools prior to enrolling at their respective YCSC locations. One of the major issues that students spoke about with respect to their science class experience at the traditional high school was a lack of engagement. Some of the factors that contributed to their disengagement in science class were disruptions and distractions by other students in the classroom, unprepared lessons by educators, “busy work” that has no substance, excessive use of slideshows, extensive note-raking, educator not engaging the class in dialogue, and “boring” topics. Disengagement may impact a student in many different ways and for many different reasons. As educators working with young people, it is our responsibility to consistently reflect on and remix our practice to provide a more engaging classroom environment. Some suggestions for cultivating an engaging STEM classroom follow.

First, understanding that there are no "one size fits all" strategies for engaging students. Practices that support engagement in one classroom may not necessarily support engagement in another classroom. Every classroom must be developed in conjunction with the students and educator in that specific classroom community. A suggestion is that from day one begin, educators begin to build community in their classroom: dialogue with students about how the classroom can be equitable for all of them; develop classroom guidelines; and speak with students about how issues should be resolved if they arise. Valuing student input can contribute to a sense of respect that students feel. In addition, undertake consistent check-ins with students on how they are doing. These check-ins should not serve as an opportunity to tell students how they need to "improve," but rather be an opportunity for students to speak with the educator one on one and let them know how they are doing or if they need any support.

Second, equitable learning practices should be integrated into daily lessons. Equitable learning practices contribute to student participation in the development of classroom discourse; examples of such practices are collaborative activities that encourage student dialogue, hands-on activities, culturally relevant science topics in which generative themes are based on student experience, authentic inquiry (i.e., student curiosity is encouraged), visually stimulating lessons that attempt to bring science phenomenon to life, and a reduction in educator-led lectures. I want to highlight this last point about educator-led lectures. As educators, we sometimes feel that if we are not directly lecturing we are not doing our job. This is not the case; as educators, we must provide a space in which student experience and voice can juxtapose with science content so that student knowledge creation can occur. A reduction of science lectures does not mean that an educator never lectures. It means that the lecture is not the centerpiece of the class lesson, rather it is a supplement to the lesson.

Third, alternative measures of assessment should be implemented. STEM education should stop relying on standardized tests for more than what it is: a narrow view of an individual's ability to memorize a pre-determined set of information. Kincheloe (2008) argued that knowledge is culturally produced and thus requires the construction of criteria for evaluating its quality. Alternative measures of assessment need to be implemented, such as authentic performance tasks. One suggestion is to use of authentic performance task that allows students to show their understanding of the content through application of STEM content—for example, a project-based approach in which students actively work through a project in conjunction with their STEM course. Authentic performance tasks encourage a less constrained and more localized curriculum that allows educators to develop content that integrates students' lived experience.

Implementation of the Next Generation Science Standards (NGSS)

Although this study was conducted with the goal of understanding contributions to the academic achievement of youth who have "dropped out" of their traditional schools, all of the aforementioned implications can inform traditional secondary school education. According to Lee, Miller, and Januszyk (2014):

> The NGSS increase academic rigor and demand that all students apply science and engineering practices (e.g., develop and use models, construct explanations, argue from evidence) and crosscutting concepts (e.g., cause and effect, patterns) across a range of disciplinary core ideas (e.g., structure and properties of matter). While integral to advanced science programs, developing such a comprehensive

understanding of science has been missing in science programs at schools with limited resources. The NGSS provide this rich foundation for all students. (p. 225)

In writing the NGSS, diversity and equity issues were addressed from the inception by the NGSS Diversity and Equity Team, led by Okhee Lee, with the goal of ensuring that the NGSS were accessible to all students, especially those who have been traditionally underserved in the science classroom. This team provided their expertise on poverty, race and ethnicity, special education, English language learners, alternative education, and gifted and talented students. Findings identified some common themes with regard to strategies for implementing the NGSS: (a) value and respect the experiences that all students bring from their backgrounds (e.g., homes or communities); (b) articulate students' background knowledge (e.g., cultural or linguistic knowledge) with disciplinary knowledge; and (c) offer sufficient school resources to support student learning. The diversity and equity team also expressed that a shift will be required for teaching science by educators who are grounded in conventional or traditional teaching strategies. Lastly, the team expressed that science educators must acquire effective strategies to include all students regardless of racial, ethnic, cultural, linguistic, socioeconomic, and gender backgrounds (Lee et al., 2014). The findings of this study can inform the implementation of the NGSS through an equitable learning space that consists of educators who develop authentic supportive relationships with students, an epistemological pluriverse that is inclusive of multiple perspectives and values the knowledge students bring to the classroom, culturally relevant science that empowers students to make informed decisions, a localized-critical-action-based curriculum, and a wide array of equitable learning practices.

Recommendations

Re-Engaging Youth Who Have Dropped Out

The following are suggestions based on the researcher's experience as an educator serving young people who have "dropped out" of traditional schools. They are not grounded in data collected via this study. Developing programs that effectively re-engage young people who have dropped out of their traditional high schools requires a multi-faceted approach. Re-engagement programs must provide multiple opportunities for young people to experience success in and out of the classroom. According to Bloom (2010), re-engagement programs should not set out to "fix" their participants. With this philosophy in mind, I present four recommendations for re-engagement programs. First, re-engagement programs should provide an alternative education pathway that includes flexible schedules (e.g., students only take morning courses, afternoon courses, or a mix of class-based courses and independent study courses); alternative assessments that encourage student application of content rather than rote memorization; smaller class sizes; and a trimester system as opposed to a semester system. A trimester system allows students to earn more credits in a shorter time period. Many young people who drop out of traditional high schools are behind in credits (America's Promise Alliance, 2014). Second, re-engagement programs should provide work-readiness programs and employment pathways. One reason that young people drop out of school is financial hardship; providing them with employment opportunities tied to educational expectations may support their completion of a high school diploma (Doll et al., 2013). Third, re-engagement programs should provide supportive services, such as on-site counseling, on-site meals, daycare referrals, healthcare referrals, legal services, and further social services to support the needs of their young people. Many young people who drop out may have one or several life circumstances that present an obstacle to their continuing in school (America's Promise Alliance, 2014). Supporting young people in navigating with their extenuating circumstances can support their effort to continue with their education. Fourth, provide opportunities for young people to experience potential postsecondary options; examples include organizing speakers from diverse fields to share experience and potential opportunities to young people, and taking young people on field trips where they learn about different opportunities for them after they graduate, trips to colleges, and on-site resource fairs for young people to learn about local services they can tap into.

Future Research

In making recommendations for future research, I reviewed the literature to determine where there are gaps and a need for further exploration. New scholarship in two areas will add value in supporting the academic success and future STEM aspirations of youth who are re-engaging informal education opportunities and action-based science curriculum.

Informal education opportunities have the potential to engage youth in STEM, make STEM relevant to youth, and provide a low-stress environment for practicing STEM. Informal education opportunities can come in many forms, such as STEM fairs hosted by education programs, field trips to STEM-based organizations, STEM-based clubs, and internships with STEM-based organizations. Studying the effect that such informal education opportunities has on young people could support the development of such programs.

Action-based science curriculum aligns with project-based learning and participatory action research. A better understanding on the effect of supporting youth who are re-engaging in the process of developing inquiry into issues relevant to them, implementing said investigation, and taking action based on the findings of the inquiry can develop curriculum that re-engages youth in STEM. Further, educators need a better understanding of how such a curriculum can affect student self-efficacy and achievement in courses outside of STEM.

Limitations

This study had the following limitations. This study was limited to only adult students enrolled at YCSC, even though the population of students enrolled at YCSC consisted of students as young as 16. The sample used for this study was only representative of one school (YCSC) that served youth who had previously "dropped out"; this could limit how generalizable the findings are to other similar alternative programs that seek to re-engage youth who have "dropped out." Further, although YCSC has 19 locations, each location is partnered with a different community organization and each develops its "own" culture, which could have an impact on educators and students alike. This study only focused on young people who had returned to an education program after "dropping out"; it did not take into account young people classified as "drop outs" who were not currently enrolled in an education program. Lastly, interpretation of the data in this study was performed by a researcher who is also an educator at YCSC. He has a certain worldview and positionality that may have influenced the interpretation of the data.

Conclusion

Providing multiple opportunities for the re-engagement of young people who have dropped out of school is an issue of social justice. Compared to high school graduates, they are less likely to find a job and earn a living wage, and more likely to be in poverty and suffer from a variety of adverse health outcomes (Rumberger, 2011). Further, once someone drops out, they are at a higher risk of being funneled into some form of detention (Sum et al., 2009).

Youth dropout for many reasons—being underserved in the classroom is just one of them. When a student does not receive an equitable education that is engaging and provides them with support to succeed academically, they may become apathetic and lose a desire to continue in school. For many students who drop out, challenges in the science classroom only serve to perpetuate the drop out phenomenon. These challenges are exemplified by lower test scores and lower credits earned in science class by Black and Latinx students compared to their White peers (Dalton et al., 2018; National Research Council 2011). In addition, a critical understanding and practice of scientific thought is imperative to the future of our global society. Issues that currently face our society that are not remedied by those who are presently in positions of power will be solved by the youth. Providing an equitable science education to Black and Latinx youth who have dropped out of their traditional schools is a significant issue for three reasons: (a) it can provide a pathway to a quality employment opportunity, (b) success in science classes can support success in academics, and (c) development of youth who have an efficient and critical understanding of science phenomena is an issue of social justice.

Alternative education programs have the potential to support youth who have dropped out. These programs provide an opportunity for completion of a secondary education for youth who have dropped out of their traditional secondary programs. Youthbuild Charter School of California (YCSC) is one such program. The YCSC science classroom is a space that re-engages and supports youth for academic achievement. The purpose of this research was to better understand what factors contribute to the academic achievement of students in their class-based science courses at Youthbuild Charter School of California. In addition, this study sought to understand what factors contribute to students' future STEM aspirations. Specifically, this study will be looked at how each of the following areas—student perception of teachers, critical science education, student sense of agency to create knowledge, student engagement in science class, and relevance of science to the student—impacts student academic achievement in their class-based science course.

This study found that each of the aforementioned factors had either a direct or indirect impact on student academic achievement in a YCSC science classroom or on student STEM future aspirations. The best predictor of student academic achievement came from the relevance of science to the student, followed by student sense of agency to create knowledge and critical science education. The best predictor of future STEM aspiration came from critical science education, followed by relevance of science to the student, and student sense of agency to create knowledge in science class.

In closing, it is important to understand that student academic achievement and student future STEM aspirations need to be supported by educators and education programs that work with youth re-engagement. They are multi-faceted phenomena that need to be made accessible to young people who have dropped out of traditional secondary schools. These are youth of promise who, provided with an opportunity, can re-engage, succeed, and contribute to STEM fields.

APPENDIX A

YCSC Adult Student Science Survey

The term knowledge is operationally defined as an understanding of a topic. The term knowledge creation refers to the ability you feel you have to create knowledge and contribute knowledge. The term engagement refers to you being actively involved in the class content and activities, as well as you being interested in the course (e.g. you feel that you are gaining from and contributing to the science class).

Q1 For the following question please mark the feeling that best represents your opinion on the statement.

	Strongly Agree (1)	Agree (2)	Disagree (3)	Strongly disagree (4)
When I am in my YCSC science class I am focused (1)	○	○	○	○
When I am in my YCSC science class I am interested (2)	○	○	○	○
When I am in my YCSC science class I want to succeed (3)	○	○	○	○
When I am in my YCSC science class I participate (4)	○	○	○	○
When I am in my YCSC science class I feel motivated (5)	○	○	○	○
When I am in my YCSC science classes I feel like I don't learn (44)	○	○	○	○
When I am in my YCSC science class I am bored (6)	○	○	○	○

I enjoy my YCSC science class (7)	○	○	○	○
When I learn a science topic, I feel I can add what I know to that topic (10)	○	○	○	○
I share my opinions in my YCSC science class (11)	○	○	○	○
I participate in discussions in my YCSC science class (12)	○	○	○	○
When I work on Authentic Performance Tasks (APT), I am creating knowledge (13)	○	○	○	○
I can contribute to science knowledge (14)	○	○	○	○
My YCSC science teacher encourages me (15)	○	○	○	○
My YCSC science teacher is patient (16)	○	○	○	○
My YCSC science teacher wants me to	○	○	○	○

succeed academically (17)				
My YCSC science teacher has high expectations of me (18)	○	○	○	○
My YCSC science teacher does not care about my success (45)	○	○	○	○
My YCSC science teacher respects my contributions to class (19)	○	○	○	○
My YCSC science teacher supports all students (20)	○	○	○	○
My YCSC science teacher uses content relvant to my life (21)	○	○	○	○
My YCSC science teacher is engaging (22)	○	○	○	○
Science knowledge is relevant to my life (23)	○	○	○	○

I use science outside of school in my everyday life (24)	○	○	○	○
When I learn a new topic in science, I can connect it to my lfe (25)	○	○	○	○
I can use science to solve issues in my life (26)	○	○	○	○
I can use science to solve issues in my community (28)	○	○	○	○
The topics covered in my YCSC science class are important to me (29)	○	○	○	○
In my YCSC science class see things from different perspectives (e.g. how people see things differently) (31)	○	○	○	○
In my YCSC science class I conduct	○	○	○	○

science investigations (32)				
In my YCSC science class I learn science that I can use to solve problems important to me (33)	○	○	○	○
My YCSC science class is based in social justice (e.g. it encourages a view of equality) (34)	○	○	○	○
When I work on APT's I am learning (36)	○	○	○	○
In my YCSC science class we use evidence to support conclusions (37)	○	○	○	○
In my YCSC science class my voice and experience is valued (38)	○	○	○	○
I want to go to college (40)	○	○	○	○

I want to study a science in college (41)	○	○	○	○
I want to work in a science-based career (42)	○	○	○	○
Science is a tool I can use in my life (43)	○	○	○	○
When I am in science class I feel empowered (e.g. I can contribute and have value) (46)	○	○	○	○
My YCSC science class encourages me to think about social issues (e.g. inequality and oppression) (48)	○	○	○	○
When I learn science that relates to me I feel engaged (50)	○	○	○	○
My YCSC science class makes me feel discouraged (51)	○	○	○	○

I can create knowledge in my YCSC science class (i.e. contribute to what we are learning in class) (52)	○	○	○	○

Demographics/Background

Q11 My gender is: (Check all that apply)

○ Male (1)

○ Female (2)

○ Other (3)

Q10 My age:

____

Q13 My ethnicity is (check all that apply):

- ◯ White (1)
- ◯ Black or African American (2)
- ◯ American Indian or Alaska Native (3)
- ◯ Asian or Asian American (4)
- ◯ Native Hawaiian or Pacific Islander (5)
- ◯ Hispanic/Latina/o (6)
- ◯ Decline to state (7)
- ◯ Other (8) ____

Q16 What is your current Grade Point Average (GPA)?

- ◯ Between 3.5-4.0 (1)
- ◯ Between 3.0-3.4 (2)
- ◯ Between 2.5-3.0 (3)
- ◯ Between 2.0-2.4 (4)
- ◯ Below 2.0 (5)

Q19 For this section please respond to the following questions and statements about your education.

Q20 At which YCSC location are you a student? (For example, Compton, El Monte, etc.)

____

Q18 How many YCSC science classes have you passed? Do you remember the grades for each class? If so, please list the class and grade. (**For Example, I have passed 2 science classes Physical Science & Biology, I received an A and a B**)

____

Q3 I came to Youthbuild Charter School of California (YCSC) because:

____

____

____

____

____

Thank you for your participation

End of Block: YCSC Science Student Survey

APPENDIX B

Email to counselor's for interview participants:

Hello (Counselor's Name),

My name is Anthony Pena. I am a PhD candidate at Claremont Graduate University and I am emailing you for support in identifying potential candidates for a research study that seeks to better understand the factors that contribute to student academic achievement in YCSC science classes. With your support, my goal is to identify YCSC students who have shown great success in their YCSC science classes. Potential candidates should meet the following criteria: 1) Have an age of 18 years or older and 2) Have passed at least 2 YCSC science classes with a grade of A or B. The participation of students who agree to participate will consist of a recorded interview that will take approximately one hour of their time. Students who agree to participate will also be compensated with a $10 Starbucks gift card.

Thank you for your time,
Anthony

Email to students for participation in survey:

Hello,

You are being asked to participate in a survey research project entitled "Creators of Knowledge: Academic Success in Youthbuild Charter School of California's Science Classrooms", which is being conducted by Anthony Peña, a doctoral student at Claremont Graduate University. The survey will take approximately 5-10 minutes to complete.

This survey is anonymous. No one will be able to associate your responses with your identity. This includes the researcher who will have no way of connecting any participants to their responses.

Your participation is voluntary. You may choose not to take they survey, to stop responding at any time, or to skip any questions that do you not wish to answer. You must be at least 18 years of age to participate in this study. If you have already taken it please do not take it again.

The Claremont Graduate University Institutional Review Board (IRB) has deemed this research project exempt from their oversight. This means that this research does not require further review from the IRB. Questions regarding the purpose or procedures of the research should be directed to Anthony Peña at anthony.pena@cgu.edu or the Supervising Professor David Drew at david.drew@cgu.edu

By beginning the survey you are verifying that you have read the explanation of the study, you are over 18 years of age, and that you agree to participate. You also understand that your participation in this study is strictly voluntary, you may cease participation at any time, and that all responses will be anonymous.

Thank you very much for your participation,
Anthony Peña

APPENDIX C

Script

Welcome and thank you for your participation today. My name is Anthony Peña and I am a graduate student at the School of Education at Claremont Graduate University conducting a study that will serve to inform my Dissertation and Ph.D. Thank you for participating in this study and this interview will take approximately 40 minutes and will include a demographic questionnaire and 15 questions regarding your experiences and what might affect your achievement in a YCSC science classroom. I would like your permission to tape record this interview, so I may accurately document the information you express. If at any time during the interview you wish to discontinue the use of the recorder or the interview itself, please feel free to let me know. All of your responses are confidential, further you will be given a pseudonym so you may maintain anonymity. Your responses will remain confidential and will be used to better develop education programs, strategies, and curriculum for youth at Youthbuild Charter School of California. The purpose of this study is to understand the agency that you feel with regards to academic achievement in the YCSC science classroom.

At this time I would like to remind you of your written consent to participate in this study. I am the responsible investigator, specifying your participation in the research project. You and I have both signed and dated each copy, certifying that we agree to continue this interview. You will receive one copy and I will keep the other under lock and key, separate from your reported responses. Thank you.

Your participation in this interview is completely voluntary. If at any time you need to stop, take a break, please let me know. You may also withdraw your participation at any time without consequence. Do you have any questions or concerns before we begin? Then with your permission we will begin the interview.

Questions:

24. Do you consider yourself a "high achiever in school"? In science class?
25. Has your achievement in school changed from your other schools to YCSC? In science class?
26. Do you feel engaged in science class?
27. What do you feel contributes to you being engaged in science class?
28. What do you feel takes away from your engagement in science class?
29. Do you feel that you can create knowledge in science class?
30. What are some examples of you creating knowledge in science class?
31. How would you describe your science teacher?
32. What are the qualities (both positive and negative) that your science teacher brings into the classroom?
33. How would you explain your relationship to science?
34. Do you feel that science is relevant to you? Please explain.
35. What is your opinion of the YCSC science classes?
36. What is your opinion of the Authentic Performance Tasks?
37. When you work on Authentic Performance Tasks, do you feel you are creating knowledge?
38. Do you think that science can be used to solve issues in your community? In your life?
39. Which YCSC location do you attend?
40. Why do you feel you stopped attending your previous High School?
41. What led you to enroll at YCSC?
42. What do you identify as ethnically/racially?
43. What gender do you identify as?
44. What are your future educational goals?

45. What are your future career goals?
46. Do you have any questions for me?

Thank you very much for your time and participation. Please feel free to contact me if you have any future questions about this interview or study.

APPENDIX D

YCSC Adult Student Science Survey:

You are being asked to participate in a survey research project entitled “Creators of Knowledge: Academic Success in Youthbuild Charter School of California’s Science Classrooms”, which is being conducted by Anthony Peña, a doctoral student at Claremont Graduate University. The survey will take approximately 5-10 minutes to complete.

This survey is anonymous. No one will be able to associate your responses with your identity. This includes the researcher who will have no way of connecting any participants to their responses.

Your participation is voluntary. You may choose not to take they survey, to stop responding at any time, or to skip any questions that do you not wish to answer. You must be at least 18 years of age to participate in this study. If you have already taken it please do not take it again.

The Claremont Graduate University Institutional Review Board (IRB) has deemed this research project exempt from their oversight. This means that this research does not require further review from the IRB. Questions regarding the purpose or procedures of the research should be directed to Anthony Peña at anthony.pena@cgu.edu or the Supervising Professor David Drew at david.drew@cgu.edu

By beginning the survey you are verifying that you have read the explanation of the study, you are over 18 years of age, and that you agree to participate. You also understand that your participation in this study is strictly voluntary, you may cease participation at any time, and that all responses will be anonymous.

Thank you very much for your participation,
Anthony Peña

YCSC Adult Student Interview:

Claremont Graduate University

AGREEMENT TO PARTICIPATE IN *YOUTH OF PROMISE: ACADEMIC SUCCESS WITHIN THE SCIENCE CLASSROOM AT AN ALTERNATIVE EDUCATION PROGRAM*

You are invited to be interviewed for a research project. While volunteering will probably not benefit you directly, you will be helping to the investigators to explore, understand, and develop better science classrooms that serve youth in similar schools as the one you attend. If you decide to volunteer, you will be asked a series of question, which would require about one hour of your time. Volunteering for this study does not involve risk beyond what a typical person would experience on an ordinary day. Since your involvement is entirely voluntary, you may withdraw at any time for any reason. Please continue reading for more information about the study.

STUDY LEADERSHIP: This research project is led by Anthony Peña a Doctoral student of the Claremont Graduate University School of Educational Studies, who is being supervised by Professor David Drew a Professor of Education at Claremont Graduate University.

PURPOSE: The purpose of this study is to learn more about what factors contribute to the academic success of students at Youthbuild Charter School of California within their science classes

ELIGIBILITY: To be in this study you must be 18 years of age or older and must have passed at least 2 science classes at Youthbuild Charter School of California with an A or B grade.

PARTICIPATION: During the study, you will be asked to participate in an interview about your experience in science classes at Youthbuild Charter School of California. This will take about one hour of your day. Example of questions that will be asked: 1) Do you consider yourself a "high achiever in science class"? 2) What is your opinion of the YCSC science class?

RISKS OF PARTICIPATION: The risks that you run by taking part in this study are minimal. These risks include the potential for the participant being identified since the interview is being recorded. The researchers will transcribe the interviews and then delete any and all recordings.

BENEFITS OF PARTICIPATION: We do not expect the study to benefit you personally. This study will benefit the researcher by contributing to his dissertation research. This study is also intended to benefit Youthbuild Charter School of California by providing them with evidenced based research that will inform how to better support the academic success of their students in the science classroom.

COMPENSATION: You will be directly compensated a $10 Starbucks gift card for participating in this study.

VOLUNTARY PARTICIPATION: Your participation in this study is completely voluntary. You may stop or withdraw from the study at any time or refuse to answer any particular question for any reason without it being held against you. Your decision whether or not to participate will have no effect on your current or future connection with anyone at CGU or Youthbuild Charter School of California.

CONFIDENTIALITY: Your individual privacy will be protected in all papers, books, talks, posts, or stories resulting from this study. Your identity will remain confidential because you will be referred to by a Pseudonym, However, you will not be anonymous since the researcher will know your identity. We may use the data we collect for future research or share it with other researchers, but we will not reveal your identity with it. In order to protect the confidentiality of your responses, only the research team will have access to the voice recordings and questionnaires. I will erase the interview recordings after transcribing, coding, and summarizing them. I estimate that I will keep the audio recordings between 2-4 weeks from the date of the interview. I will safely store the transcriptions on an external hard drive under lock and key in my home. I will use the pseudonyms throughout the study to protect the identities of the participants. I will not disclose or make it possible for anyone outside of the research team to learn their personal information.

SPONSORSHIP: Not Applicable

FURTHER INFORMATION: If you have any questions or would like additional information about this study, please contact Anthony Peña at anthony.pena@cgu.edu. You may also contact Professor David Drew at david.drew@cgu.edu. The CGU Institutional Review Board has approved this project. If you have any ethical concerns about this project or about your rights as a human subject in research, you may contact the CGU IRB at (909) 607-9406 or at irb@cgu.edu. A copy of this form will be given to you if you wish to keep it.

CONSENT: Your signature below means that you understand the information on this form, that someone has answered any and all questions you may have about this study, and you voluntarily agree to participate in it.

Signature of Participant ______________________ Date ____________

Printed Name of Participant ____________________

The undersigned researcher has reviewed the information in this consent form with the participant and answered any of his or her questions about the study.

Signature of Researcher ______________________ Date ___________

Printed Name of Researcher __________________

REFERENCES

ACLU Fact Sheet. (2017). Retrieved from https://www.aclu.org/fact-sheet/what-school-prison-pipeline

Aikenhead, G. (2006). *Science education for everyday life: Evidence-based practice*. New York, NY: Teacher College Press.

Aikenhead, G., Calabrese, A. B., & Chinn, P. W. (2006). Forum: Toward a politics of place-based science education. *Cultural Studies of Science Education*, *1*(2), 403–416.

Aikens, N. L., & Barbarin, O. (2008). Socioeconomic differences in reading trajectories: The contribution of family, neighborhood, and school contexts. *Journal of Educational Psychology*, 100, 235–251. http://dx.doi.org/10.1037/0022-0663.100.2.235

Akey, T. M. (2006, January). *School context, student attitudes and behavior, and academic achievement: An exploratory analysis.* New York, NY: MDRC. Retrieved from http://www.mdrc.org/publications/419/full.pdf

Aksakalli, A. (2018). The effects of science teaching based on critical pedagogy principles on the classroom climate. *Science Education International*, *29*(4), 250–260.

Alegria, A. (2014). Supporting English language learners in the science classroom through critical pedagogy. *International Journal of Science and Mathematics Education*, *12*(1), 99–121.

America's Promise Alliance. (2014). *Don't call them dropouts: Understanding the experiences of young people who leave high school before graduation.* Medford, MA: Center for Promise, Tufts University.

Anyon, J. (1980). Social Class and the Hidden Curriculum of Work. *Journal of Education, 162*(1), 67–92. Retrieved from https://doi.org/10.1177/002205748016200106

Arias J., & Walker D. (2004). Additional evidence on the relationship between class size and student performance. *The Journal of Economic Education*, *35*, 311–329.

Aronowitz, S. (1993). *Roll over Beethoven: The return of cultural strife.* Lebanon, NH: University Press of New England.

Aronson, B., & Laughter, J. (2015). The theory and practice of culturally relevant education: A synthesis of research across content areas. *Review of Educational Research, 86,* 163–206. doi:10.3102/0034654315582066

Aydeniz, M., & Southerland, S. A.(2012). A national survey of middle and high school science teachers' responses to standardized testing: Is Science being devalued in schools? *Journal of Science Teacher Education, 23*(3), 233–257. doi: 10.1007/s10972-012-9266-3

Barmby, P., Kind, P., & Jones, K. (2008). Examining changing attitudes in secondary school science. *International Journal of Science Education*, 30 (8), 1075-1093. doi.10.1080/09500690701344966.

Barton, A. C., Turner, E. E., Gutiérrez, M. V., & Tan, E. (2012). *Empowering science and mathematics education in Urban Schools.* Chicago, IL: University of Chicago Press.

Basu, S. J., & Barton, A. C. (2007). Developing a sustained interest in science among urban minority youth. *Journal of Research in Science Teaching, 44*(3), 466-489.

Becker, K., & Park, K. (2011). Effects of integrative approaches among science, technology, engineering, and mathematics (STEM) subjects on students' learning: A preliminary meta-analysis. *Journal of STEM Education*, *12, 23-27..*

Ben-Zeev, T., Fein, S., & Inzlicht, M. (2005). Arousal and stereotype threat. *Journal of Experimental Social Psychology, 41,* 174–181.

Bereiter, C. (2002). *Education and mind in the Knowledge Age.* Lawrence Erlbaum Associates Publishers.

Bloom, D. (2010). Programs and policies to assist high school dropouts in the transition to adulthood. *The Future of children / Center for the Future of Children, the David and Lucile Packard Foundation, 20*, 89–108. doi.10.1353/foc.0.0039

Bourdieu, P. (1986). The forms of capital. In J. G. Richardson (Ed.), *Handbook of Theory and Research for the Sociology of Education* (pp. 241–258). New York, NY: Greenwood Press.

Braun, V., & Clarke, V. (2006) Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101.

Brickhouse, N., Lowery, P., & Schultz, K. (2000). What kind of a girl does science? The construction of school science identities. *Journal of Research in Science Teaching, 37*, 441–458.

Burrus, J., & Roberts, R. (2012). Dropping-out of High School: Prevalence, risk factors, and remediation strategies. *R&D Connections*, 18. Retrieved from https://www.ets.org/Media/Research/pdf/RD_Connections18.pdf

Cakir, M. (2008). Constructivist approaches to learning in science and their implications for science pedagogy: A literature review. *International Journal of Environmental and Science Education, 3*(4), 193–206.

California Department of Education (2018, November 18). *State Superintendent Torlakson announces 2018 rates for high school graduation, suspension and chronic absenteeism.* Retrieved from https://www.cde.ca.gov/nr/ne/yr18/yr18rel76.asp

Carver, P. R., & Lewis, L. (2010). *Alternative schools and programs for public school students at risk of educational failure: 2007–08* (NCES 2010–026). Washington, DC: U.S. Department of Education, National Center for Education Statistics. http://eric. ed.gov/?id=ED508882

Chen, B., & Zhang, J. (2016). Analytics for knowledge creation: Towards epistemic agency and design-mode thinking. *Journal of Learning Analytics, 3*(2), 139–163.

Child Trends Databank. (2018). *High school dropout rates.* Retrieved from https://www.childtrends.org/?indicators=high-school-dropout-rates

Civil Rights Data Collection, U.S. Dep't of Educ. Office For Civil Rights (2014) Issue Brief no. 1, Data Snapshot: School Discipline 3. Retrieved from http://ocrdata.ed.gov/Downloads/cRDc-School-Discipline-Snapshot.pdf

Dalton, B., Ingels, S. J., & Fritch, L. (2018). *High School longitudinal study of 2009 (HSLS:09) 2013 update and high school transcript study: A first look at fall 2009 ninth-graders in 2013 (NCES 2015-037rev).* U.S. Department of Education. Washington, DC: National Center for Education Statistics. Retrieved from http://nces.ed.gov/pubsearch.

Deutsch, F. M. (2003). How small classes benefit high school students. *NASSP Bulletin*, 87, 35–44.

Diaz, E., & Flores, B. (2001). Teacher as sociocultural, sociohistorical mediator: Teaching to the potential. In M. Reyes & J. J. Halcón (Eds.), *The best for our children: Critical perspectives on literacy for Latino students* (pp. 29–47). New York, NY: Teachers College Press.

Doll, J. J., Eslami, Z., & Walters, L. (2013). *Understanding why students drop out of high school, according to their own reports: Are they pushed or pulled, or do they fall out? A comparative analysis of seven nationally representative studies.* SAGE Open. Retrieved from https://doi.org/10.1177/2158244013503834

Dos Santos, W. L. (2009). Scientific literacy: A Freirean perspective as a radical view of humanistic science education. *Science Education, 93*(2), 361–382.

Dweck C. (2007). Is math a gift? Beliefs that put females at risk. In S. J. Ceci & W. M. Williams (Eds.), *Why aren't more women in science? Top researchers debate the evidence* (pp. 47–55). American Psychological Association. http://doi.org/10.1037/11546-004

Dweck, C. (2008). *Mindsets and math/science achievement.* New York, NY: Carnegie Corporation of New York, Institute for Advanced Study, Commission on Mathematics and Science Education.

Eccles, J. S. (2009). Who am I and what am I going to do with my life? Personal and collective identities as motivators of action. *Educational Psychologist, 44*, 78–89. doi.10.1080/00461520902832368

Elligboe et al. (2015, January). *The anti-science climate denier caucus: 114th Congress Edition.* Retrieved from https://thinkprogress.org/the-anti-science-climate-denier-caucus-114th-congress-edition-c76c3f8bfedd/

Fayer, S., Lacey, A., & Watson, A. (2017). *STEM occupations: Past, present, and future.* Bureau of Labor Statistics. Retrieved from https://www.bls.gov/spotlight/2017/science-technology-engineering-and-mathematics-stem-occupations-past-present-and-future/pdf/science-technology-engineering-and-mathematics-stem-occupations-past-present-and-future.pdf.

Finkel, L. (2018). Infusing social justice into the science classroom: Building a social justice movement in science education. *The Journal of Educational Foundations, 31*(1/2), 40–58.

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research, 74*, 59–109.

Freire, P. (1970). Pedagogy of the oppressed. New York: Continuum

Garcia-Reid, P., Reid, R., & Peterson, N. A. (2005, May). School engagement among Latino youth in an urban middle school context: Valuing the role of social support. *Education and Urban Society, 37*(3), 257–275.

García, E., & Weiss, E. (2017). Education inequalities at the school starting gate: Gaps, trends, and strategies to address them. *Report, Economic Policy Institute*. Retrieved from epi.org/132500

Gasper, J., DeLuca, S., & Estacion, A. (2012). Switching schools: Revisiting the relationship between school mobility and high school dropout. *American Educational Research Journal, 49*(3), 487–519. Retrieved from https://doi.org/10.3102/0002831211415250

Gay, G. (2013) Teaching to and through cultural diversity. *Curriculum Inquiry, 43*(1), 48–70. doi.10.1111/curi.12002

Giroux, H. A. (1988). *Teachers as intellectuals: Toward a critical pedagogy of learning.* Boston, MA: Massachusetts Bergin & Garvey Publishers, Inc.

Giroux, H. A. (2006). *Critical pedagogy on the web.* Retrieved from http://mingo.info-science.uiowa.edu/~stevens/critped/giroux.htm

Giroux, H. A. (2011). *On critical pedagogy.* New York, NY: Continuum International Publishing Group.

Hattie, J. (2009). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement.* London, UK: Routledge.

Heller, R., Calderon, S., & Medrich, E. (2003). *Academic achievement in the middle grades: What does research tell us? A review of the literature.* Atlanta, GA: Southern Regional Education Board.

Hirschfield, P. (2009). Another way out: The impact of juvenile arrests on high school dropout. *Sociology of Education, 82*(4), 368–393. Retrieved from https://doi.org/10.1177/003804070908200404

Hox, J. J., & Bechger, T. M. (1999). An introduction to structural equation modeling. *Family Science Review*, 11, 354–373

Jordan, W. J., Lara, J., & McPartland, J. M. (1994). *Exploring the complexity of early dropout causal structures.* Baltimore, MD: Center for Research on Effective Schooling for Disadvantaged Students, The John Hopkins University.

Joyce, B. A., & Farenga, S. J. (2000). Young girls in science: Academic ability, perceptions, and future participation in science. *Roeper Review, 22,* 261–262.

Jussim L., Eccles J., & Madon S. (1996). Social perception, social stereotypes, and teacher expectations: Accuracy and the quest for the powerful self-fulfilling prophecy. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (pp. 281–388). New York, NY: Academic Press.

Kincheloe, J. L. (2008). *Knowledge and critical pedagogy: An introduction.* Dordrecht: Springer.

Ladson-Billings, G. (1995). But that's just good teaching! The case for culturally relevant pedagogy. *Theory into Practice, 34*(3). 159-165. doi:10.1080/00405849509543675

Landivar, L. C. (2013). *Disparities in STEM Employment by sex, race, and Hispanic origin, American community survey reports, ACS-24.* U.S. Census Bureau, Washington, DC.

Lareau, A. (1987). Social class differences in family-school relationships: The importance of cultural capital. *Sociology of Education*, 60(2), 73–85.

Layton, D. (1991). Science education and praxis: The relationship of school science to practical action. *Studies in Science Education, 19(1), 43-79.*

Lee, O. (2011). *Effective STEM education strategies for diverse and underserved learners.* Paper prepared for the National Academies Board on Science Education and Board on Testing and Assessment for "Highly Successful STEM Schools or Programs for K-12 STEM Education: A Workshop," Washington, DC.

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

Lee, O., Miller, E. C., & Januszyk, R. (2014). Next generation science standards: All standards, all students. *Journal of Science Teacher Education, 25*(2), 223–233. Retrieved from https://doi.org/10.1007/s10972-014-9379-y

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

Leone, P., & Wruble, P. (2015). Education services in juvenile corrections: 40 years of litigation and reform. *Education and Treatment of Children, 38*(4), 587–604.

Levin, K. (2017, April 20). *Attacks on science threaten us all.* World Resource Institute. Retrieved from https://www.wri.org/blog/2017/04/attacks-science-threaten-all-us

Liu, X., & Whitford, M. (2011). Opportunities-to-learn at home: Profiles of students with and without reaching science proficiency. *Journal of Science Education Technology, 20,* 375–387. doi: 10.1007/s10956-010-9259-y

Lomax, R., West, M., Harmon, M., Viator, K., & Madaus, G. (1995). The impact of mandated standardized testing on minority students. *The Journal of Negro Education*, 64 (2), 171-185. 10.2307/2967240.

Love, B. L. (2019). *We want to do more than survive: Abolitionist teaching and the pursuit of educational freedom.Boston, MA: Beacon Press*

Ma, X., & Wilkins, J. L. M. (2002). The development of science achievement in middle and high school: Individual differences and school effects. *Evaluation Review, 26*, 395–417. doi:10.1177/0193841X02026004003

Makarova, E., Aeschlimann, B., & Herzog, W. (2019). The gender gap in STEM Fields: The impact of the gender stereotype of math and science on secondary students' career aspirations. *Frontiers in Education,* 4 (60)
Doi: 10.33389/feduc.2019.00060

Maltese, A., & Tai, R. H. (2010). Eyeballs in the fridge: Sources of early interest in science. *International Journal of Science Education*, *32*(5), 669–685. doi: 10.1080/09500690902792385

Martin-Hansen, L. (2018). Examining ways to meaningfully support students in STEM. *International Journal of STEM Education, 5*(1), 53. Retrieved from https://doi.org/10.1186/s40594-018-0150-3.

McClure, P., & Rodriguez, A. (2007). *Factors related to advanced course-taking patterns, persistence in science, technology, engineering and mathematics, and the role of out-of-school time programs: A literature review.* Berkeley, CA: Coalition for Science After School

McKown, C., & Weinstein, R. S. (2008). Teacher expectations, classroom context, and the achievement gap. *Journal of School Psychology, 46*, 235–261.

Metcalf, H. (2016). Broadening the study of participation in the life sciences: How critical theoretical and mixed-methodological approaches can enhance efforts to broaden participation. *CBE-Life Sciences Education,* 15, rm3. Retrieved from http://www.lifescied.org/content/15/3/rm3. doi:10.1187/cbe.16-01-0064

Metheny J., McWhirter, E. H., & O'Neil, M. E. (2008). Measuring perceived teacher support and its influence on adolescent career development. *Journal of Career Assessment,* 16, 218–237.

Miles, M. B., Huberman, A. M., & Saldaña, J. (2013). *Qualitative data analysis: A methods sourcebook* (4th ed.). Thousand Oaks, CA: Sage Publications.

Moje, E. B. (2007). Chapter 1: Developing socially just subject-matter instruction: A review of the literature on disciplinary literacy teaching. *Review of Research in Education, 31*, 1–44.

Morris, M. W. (2016). *Pushout: The criminalization of Black girls in schools.* New York, NY: The New Press.

Mulkey, L. M., Catsambis, S., Carr Steelman, L., & Crain, R. L. (2005). The long-term effects of ability grouping in mathematics: A national investigation. *Social Psychology of Education*, *8*, 137–177.

Mutegi, J. W. (2011). The inadequacies of "Science for All" and the necessity and nature of a socially transformative curriculum approach for African American science education. *Journal of Research in Science Teaching*, *48*(3), 301–316.

Murphey, D., Belford, J., Balding, S., & Beckwith, S. (2018). In 33 states, Hispanic or black children are more than twice as likely to be in poverty than their white peers. *Child Trends. Poverty and Inequality.* Retrieved From: https://www.childtrends.org/in-33-states-hispanic-or-black-children-are-more-than-twice-as-likely-to-be-in-poverty-than-their-white-peers

NASA. (2019). *Climate change: How do we know?* Retrieved from https://climate.nasa.gov/evidence/

National Research Council. (2011). *High school dropout, graduation, and completion rates: Better data, better measures, better decisions.* Washington, DC: The National Academies Press.

National Science Foundation. (2016). *National Center for Science and Engineering Statistics, special tabulations of high school longitudinal study of 2009* (HSLS:09). National Center for Education Statistics.

National Science Foundation. (2016). *National Center for Science and Engineering Statistics, special tabulations of main NAEP 2015 science assessment.* National Center for Education Statistics.

National Science Foundation, National Center for Science and Engineering Statistics. 2019. *Women, minorities, and persons with disabilities in science and engineering: 2019.* Special Report NSF 19-304. Alexandria, VA. Retrieved from https://www.nsf.gov/statistics/wmpd.

National Women's Law Center calculations based on U.S. Department of Education, Civil Rights Data Collection, 2009-10 National and State Estimations, National total. Retrieved from http://ocrdata.ed.gov/downloads/projections/2009-10/2009- 10-Estimations-Nation.xls. Discipline data are for students without disabilities.

Paavola, S., & Hakkarainen, K. (2005). The knowledge creation metaphor – An emergent epistemological approach to learning. *Science Education 14*, 535–557.

Pew Research Center. (2018, January). *Women and men in STEM often at odds over workplace equity.*

Plunk, A. D, Tate, W. F., Bierut, L. J., & Grucza, R. A. (2014, June/July) Intended and unintended effects of state-mandated high school science and mathematics course graduation requirements on educational attainment. *Educational Researcher, 43*(5), 230-241. doi:10.3102/0013189X14540207

Pratt, D. (1994). Curriculum perspectives. *Curriculum planning: A handbook for professionals* (pp. 8–22). Fort Worth, TX: Harcourt Brace Jovanovich, Inc.

Reardon, S. F. (2011). The widening academic achievement gap between rich and poor: New evidence and possible explanations. In G. J. Duncan & R. J. Murnane (Eds.), *Whither opportunity? Rising inequality, schools, and children's life chances* (pp. 91–115). New York, NY: Russell Sage Foundation.

Rodriguez, A. J. (1998), Strategies for counterresistance: Toward sociotransformative constructivism and learning to teach science for diversity and for understanding. *Journal of Research Science Teaching, 35*, 589–622. doi:10.1002/(SICI)1098-2736(199808)35:6<589::AID-TEA2>3.0.CO;2-I

Rodriguez, A. J. (2015). What about a dimension of engagement, equity, and diversity practices? A critique of the next generation science standards. *Journal of Research in Science Teaching*, 52. 1031-1052. Doi:10.1002/tea.21232.

Rogoff, B. (1994). Developing understanding of the idea of communities. *Mind Culture and Society, 1*(4), 209–229.

Rosenthal, R., & Jacobson, L. (1968). *Pygmalion in the classroom: Teacher expectations and pupils' intellectual development.* New York, NY: Holt, Rinehart and Winston.

Rumberger, R. W. (2011). *Dropping out: Why students drop out of high school and what can be done about it.* Boston, MA: Harvard University Press. Retrieved from https://doi.org/10.4159/harvard.9780674063167

Sackes, M., Trundle, K. C., Bell, R. L., & O'Connell, A. A. (2011). The influence of early science experience in kindergarten on children's immediate and later science achievement: Evidence from the early childhood longitudinal study. *Journal of Research in Science Teaching, 48*, 217–235. doi:10.1002/tea.20395

Saini, A. (2017). *Inferior: How science got women wrong—and the new research that's rewriting the story.* Beacon, MA: Beacon Press.

Saini, A. (2019). *Superior: The return of race science.* Boston, MA. Beacon Press, Fourth Estate Books.

Saldaña, J. (2016). *The coding manual for qualitative researchers*. Los Angeles, CA: Sage.

Scardamalia, M., & Bereiter, C. (2003). Knowledge building. In *Encyclopedia of education* (2nd ed.) (pp. 1370–1373). New York, NY: MacMillan Reference.

Schroeder et al. (2007). *A meta-analysis of national research: Effect of teaching strategies on student achievement in science in the United States. Journal of Research in Science Teaching. 44: 1436-1460*

Shor, I. (1992). *Empowering education: Critical teaching for social change.* Chicago, IL: University of Chicago Press.

Skinner, E., Furrer, C., Marchand, G., & Kindermann, T. (2008). Engagement and disaffection in the classroom: Part of a larger motivational dynamic? *Journal of Educational Psychology*, *100*(4), 765–781.

Steele, C. M., & Aronson, J. (1995). Stereotype threat and the intellectual test performance of African Americans. *Journal of Personality and Social Psychology, 69*(5), 797–811. Retrieved from https://doi.org/10.1037/0022-3514.69.5.797

Sublett, C., & Rumberger, R. (2018). *What is California's high school graduation rate? Policy analysis for California education.* Retrieved from https://edpolicyinca.org/publications/what-californias-high-school-graduation-rate

Sum, A., Khatiwada, I., McLaughlin, J., & Palma, W. (2009). *The consequences of dropping out of high school.* Center for Labor Market Studies. Boston, MA: Northeastern University.

Tlali, M. (2017). Creating sustainable physical sciences learning environments: A case for decolonised and transformative learning. *Perspectives in Education*, 35(2), 85-98. doi. 10.18820/2519593X/pie.v35i2.7.

U.S. Bureau of Labor Statistics. (2014). *STEM 101: Intro to tomorrow's jobs.* Retrieved from https://www.bls.gov/careeroutlook/2014/spring/art01.pdf

U.S. Commission On Civil Rights. (2018). *Public education funding inequity in an era of increasing concentration of poverty and resegregation.* Retrieved from https://www.usccr.gov/pubs/2018/2018-01-10-Education-Inequity.pdf

U.S. Department of Commerce, Census Bureau, Current Population Survey (CPS), October, 2007 through 2017. (This table was prepared November 2018.)

U.S. Department of Education, National Center for Education Statistics. (2019). *The condition of education 2019* (NCES 2019-144). Status Dropout Rates.

U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP). *2009, 2011, and 2015 science assessments*. Retrieved January 10, 2017, from the Main NAEP Data Explorer (https://nces.ed.gov/nationsreportcard/naepdata/). (This table was prepared January 2017.)

U.S. Department of Education, Office for Civil Rights, 2013–2014 Civil Rights Data Collection: A first look (2016). Retrieved from https://www2.ed.gov/about/offices/list/ocr/docs/2013-14-first-look.pdf.

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

Vasquez, M. (2020, March 12). *Calling COVID-19 the "Wuhan Virus" or "China Virus" is inaccurate and xenophobic.* Yale School of Medicine. Retrieved from https://medicine.yale.edu/news-article/23074/

Vincent-Ruz, P., & Schunn, C. D. (2018). The nature of science identity and its role as driver of student choices. *International Journal of STEM Education, 5,* 48. Retrieved From: https://doi.org/10.1186/s40594-018-0140-5

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

Wang, M. T., & Degol, J. (2013). Motivational pathways to STEM career choices: Using expectancy-value perspective to understand individual and gender differences in STEM Fields. *Developmental review: DR, 33*(4), 10. doi.1016/j.dr.2013.08.001. https://doi.org/10.1016/j.dr.2013.08.001

Wang, M.-T., & Eccles, J. S. (2013). School context, achievement motivation, and academic engagement: A longitudinal study of school engagement using a multidimensional perspective. *Learning and Instruction, 28*, 12–23. Retrieved from https://doi.org/10.1016/j.learninstruc.2013.04.002

Warren, P. (2016). *Accountability for California's alternative schools.* San Francisco, CA. Public Policy Institute of California. Retrieved from https://www.ppic.org/content/pubs/report/R_516PWR.pdf

Watt, D., & Roessingh, H. (1994). Some you win, most you lose: Tracking ESL dropout in high school (1988-1993). *English Quarterly, 26*, 5–7.

Youthbuild Charter School of California. (2018). Retrieved from http://www.youthbuildcharter.org/